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# BLOOD PRESSURE SERVICE

**Abstract:**

This service exposes blood pressure and other data from a blood pressure monitor for use in consumer and professional healthcare applications.

## Revision History

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D09r00	2011-01-25	Initial Draft from Blood Pressure Monitor UCRDD.
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## Document Terminology

The Bluetooth SIG has adopted Section 13.1 of the IEEE Standards Style Manual, which dictates use of the words “shall”, “should”, “may”, and “can” in the development of documentation, as follows:

The word shall is used to indicate mandatory requirements strictly to be followed in order to conform to the standard and from which no deviation is permitted (shall equals is required to).

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

The use of the word will is deprecated and shall not be used when stating mandatory requirements; will is only used in statements of fact.

The word should is used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required; or that (in the negative form) a certain course of action is deprecated but not prohibited (should equals is recommended that).

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

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

The term Reserved for Future Use (RFU) is used to indicate Bluetooth SIG assigned values that are reserved by the Bluetooth SIG and are not otherwise available for use by implementations.

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## 1 Introduction

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The Blood Pressure Service exposes blood pressure and other data related to a non-invasive blood pressure monitor for consumer and professional healthcare applications.

### 1.1 Conformance

If a device claims conformance to this service, all capabilities indicated as mandatory for this service shall be supported in the specified manner (process-mandatory). This also applies for all optional and conditional capabilities for which support is indicated. All mandatory capabilities, and optional and conditional capabilities for which support is indicated, are subject to verification as part of the Bluetooth qualification program.

### 1.2 Service Dependency

This service is not dependent upon any other services.

### 1.3 Bluetooth Specification Release Compatibility

This specification is compatible with any Bluetooth core specification [1] that includes the Generic Attribute Profile (GATT) and the Bluetooth Low Energy Controller portions of the core specification.

### 1.4 GATT Sub-Procedure Requirements

Requirements in this section represent a minimum set of requirements for a Blood Pressure Sensor (Server). Other GATT sub-procedures may be used if supported by both Client and Server.

The table below summarizes additional GATT sub-procedure requirements beyond those required by all GATT Servers.

GATT Sub-Procedure	Requirements
Notifications	C.1
Indications	M
Read Characteristic Descriptors	M
Write Characteristic Descriptors	M

Table 1.1: GATT Sub-Procedure Requirements

C.1: Mandatory if the Intermediate Cuff Pressure characteristic is supported, otherwise excluded for this service.

### 1.5 Transport Dependencies

This service shall operate over LE transport only. For BR/EDR (and HS) the Health Device Profile [2] is to be used.

## **1.6 Byte Transmission Order**

All characteristics used with this service shall be transmitted with the least significant octet first (i.e. little endian). The least significant octet is identified in the characteristic definitions in [\[3\]](#).

## **2 Service Declaration**

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The Blood Pressure Service is recommended to be instantiated as a «Primary Service».

The service UUID shall be set to «Blood Pressure Service». The UUID value assigned to «Blood Pressure Service» is defined in [\[3\]](#).



### 3 Service Characteristics

The characteristic requirements for an instance of the Blood Pressure Service are shown in [Table 3.1](#). Unless otherwise specified, only one instance of each characteristic is permitted within each instance of this service.

Characteristic Name	Requirement	Mandatory Properties	Optional Properties	Security Permissions
Blood Pressure Measurement	M	Indicate		None
Blood Pressure Measurement - Client Characteristic Configuration descriptor	M	Read, Write		None
Intermediate Cuff Pressure	O	Notify		None
Intermediate Cuff Pressure - Client Characteristic Configuration descriptor	C.1	Read, Write		None
Blood Pressure Feature	M	Read		None

Table 3.1: Blood Pressure Service characteristics

C.1: Mandatory if Intermediate Cuff Pressure characteristic is supported, otherwise excluded for this service.

Note 1: Properties not listed as Mandatory, Conditional or Optional are Excluded.

Note 2: Security Permissions of “None” means that this service does not impose any requirements.

#### 3.1 Blood Pressure Measurement

The Blood Pressure Measurement characteristic shall be used to send Blood Pressure measurements. Included in the characteristic are a Flags field (containing units of Blood Pressure and used to show presence of optional fields), the Blood Pressure Measurement Compound Value field and, depending upon the contents of the Flags field, Time Stamp (time of the measurement), Pulse Rate, User ID and Measurement Status fields.

##### 3.1.1 Characteristic Behavior

When the *Client Characteristic Configuration* descriptor is configured for indications and a Blood Pressure measurement is available, this characteristic shall be indicated while in a connection.

If a Blood Pressure measurement is available, the *Client Characteristic Configuration* descriptor is configured for indications, and a connection is not currently established, the Server shall become connectable to allow the Collector to create a link.

The Blood Pressure Measurement characteristic contains time-sensitive data, thus the requirements for time-sensitive data and data storage defined in [Section 3.4](#) apply.

### 3.1.1.1 Flags Field

The Flags field is included in the Blood Pressure Measurement characteristic.

Reserved for Future Use (RFU) bits in the Flags field shall be set to 0.

### 3.1.1.2 Blood Pressure Measurement Compound Value Field

This Blood Pressure Measurement Compound Value field is composed of three subfields: Systolic, Diastolic and Mean Arterial Pressure (MAP) and is included in the Blood Pressure Measurement characteristic.

If a value for Systolic, Diastolic or MAP subfields is unavailable (e.g. due to an invalid result from a computation step or missing data due to the hardware's inability to provide a valid measurement), the special short float value NaN (see Section 4) defined in ISO/IEEE 11073-20601a [4] shall be used in each of the unavailable subfields.

If the unit of the Blood Pressure Measurement is in mmHg, bit 0 of the Flags field is set to 0. Otherwise, the unit is kPa and bit 0 of the Flags field is set to 1.

### 3.1.1.3 Time Stamp Field

The Time Stamp field is optional, but shall be included in the Blood Pressure Measurement characteristic if the device supports storing of data.

If the Time Stamp field is present in the Blood Pressure Measurement characteristic, bit 1 of the Flags field is set to 1; otherwise bit 1 of the Flags field is set to 0.

The value of the Time Stamp field is derived from a source of date and time at the time of measurement. If the Time Stamp feature is supported, a source of date and time is mandatory.

The date and time of the device may be updated by various means such as via a simple user interface on the device or via the Current Time Service [5].

The time stamp field is defined to use the same format as the Date Time characteristic defined in [3]. However, a value of 0 for the month or day fields shall not be used for this service. A value of 0 for the year field (meaning unknown year) may be used for devices not supporting the year value in their real-time clock. It is left to the implementation to ensure the user sets the correct date and time before the Blood Pressure Sensor is used.

### 3.1.1.4 Pulse Rate Field

The Pulse Rate field may be included in the Blood Pressure Measurement characteristic if the device supports pulse rate measurements.

If a value for the Pulse Rate field is unavailable (e.g. due to an invalid result from a computation step or missing data due to the hardware's inability to provide a valid measurement), the special short float value NaN (see Section 4) defined in ISO/IEEE 11073-20601a [4] shall be used.

If the Pulse Rate field is present in the Blood Pressure Measurement characteristic, bit 2 of the Flags field is set to 1; otherwise bit 2 of the Flags field is set to 0.

### 3.1.1.5 User ID Field

The User ID field shall be included in the Blood Pressure Measurement characteristic if the device supports multiple users.

If the User ID field is present in the Blood Pressure Measurement characteristic, bit 3 of the Flags field is set to 1; otherwise bit 3 of the Flags field is set to 0.

The values used for User ID shall be unique per Server, but are otherwise left to the implementation. For example, if the Server supports two User IDs to distinguish between two users, the Server may use User ID 1 and 2 or User ID 35 and 97 or other unique combinations.

Special User ID value of 0xFF represents “unknown user”.

### 3.1.1.6 Measurement Status Field

The Measurement Status field may be included in the Blood Pressure Measurement characteristic if the device supports measurement status flags.

If the Measurement Status field is present in the Blood Pressure Measurement characteristic, bit 4 of the Flags field is set to 1; otherwise bit 4 of the Flags field is set to 0.

Reserved for Future Use (RFU) bits in the Measurement Status field shall be set to 0.

## 3.1.2 Characteristic Descriptors

### 3.1.2.1 Client Characteristic Configuration Descriptor

The *Client Characteristic Configuration* descriptor shall be included in the Blood Pressure Measurement characteristic.

## 3.2 Intermediate Cuff Pressure

The Intermediate Cuff Pressure characteristic may be used to send Current Cuff Pressure values to a device for display purposes while the measurement is in progress.

### 3.2.1 Characteristic Behavior

The Intermediate Cuff Pressure characteristic may be notified frequently during the course of a measurement so that a receiving device can effectively update the display on its user interface during the measurement process. The update rate is defined by the Server and should not be greater than a rate necessary to provide an acceptable user display on the Client. Typical update intervals range from 0.25 seconds to 2 seconds.

When the *Client Characteristic Configuration* descriptor is configured for notifications and an intermediate Cuff Pressure value is available, the Server shall send a notification of this characteristic while in a connection.

If an Intermediate Cuff Pressure characteristic is available, the *Client Characteristic Configuration* descriptor is configured for notifications, and a connection is not currently established, the Server shall become connectable to allow the Collector to create a link. If there is a delay in connection and several Intermediate Cuff Pressure characteristic

values are pending, only the last cached value should be sent once the link is established. This avoids a poor user experience where the display rapidly changes with out-dated real-time values.

To avoid transmitting unnecessary data, the Time Stamp and Pulse Rate fields should not be used in the Intermediate Cuff Pressure characteristic.

Once the measurement process is complete and a stable Blood Pressure measurement is available, the Server shall stop notifications of the Intermediate Cuff Pressure characteristic and, if indications are enabled, shall indicate the Blood Pressure Measurement characteristic.

#### **3.2.1.1 Flags Field**

The Flags field is included in the Intermediate Cuff Pressure characteristic.

Reserved for Future Use (RFU) bits in the Flags field shall be set to 0.

#### **3.2.1.2 Intermediate Cuff Pressure Compound Value Field**

This Intermediate Cuff Pressure Compound Value field is composed of three subfields: Current Cuff Pressure and two unused subfields and is included in the Intermediate Cuff Pressure characteristic.

The two unused subfields shall be set to special value NaN (see Section 4) as defined in ISO/IEEE 11073-20601a [4].

The Current Cuff Pressure subfield may contain special short float value NaN (see Section 4) as defined in ISO/IEEE 11073-20601a [4] to report an invalid result from a computation step or missing data due to the hardware's inability to provide a valid measurement.

If the unit of the Current Cuff Pressure is in mmHg, bit 0 of the Flags field is set to 0. Otherwise, the unit is kPa and bit 0 of the Flags field is set to 1.

#### **3.2.1.3 Time Stamp Field**

The Time Stamp field may be included in the Intermediate Cuff Pressure characteristic, but is not recommended in order to avoid sending unnecessary data.

If the Time Stamp field is present in the Intermediate Cuff Pressure characteristic the same requirements apply as in Section 3.1.1.3.

#### **3.2.1.4 Pulse Rate Field**

The Pulse Rate field may be included in the Intermediate Cuff Pressure characteristic if the device supports pulse rate measurements, but is not recommended in order to avoid sending unnecessary data.

If a value for the Pulse Rate field is unavailable (e.g. due to an invalid result from a computation step or missing data due to the hardware's inability to provide a valid measurement), the special short float value NaN (see Section 4) defined in ISO/IEEE 11073-20601a [4] shall be used.

If the Pulse Rate field is present in the Intermediate Cuff Pressure characteristic, the same requirements apply as in Section 3.1.1.4.

#### 3.2.1.5 User ID Field

The User ID shall be included in the Intermediate Cuff Pressure characteristic if the device supports multiple users.

If the User ID field is present in the Intermediate Cuff Pressure characteristic, the same requirements apply as in Section 3.1.1.5.

#### 3.2.1.6 Measurement Status Field

The Measurement Status field may be included in the Intermediate Cuff Pressure characteristic if the device supports measurement status flags.

If the Measurement Status field is present in the Intermediate Cuff Pressure characteristic, the same requirements apply as in Section 3.1.1.6.

For requirements in relation to bits in this field and bits in the Blood Pressure Feature characteristic, see Section 3.3.1.

### 3.2.2 Characteristic Descriptors

#### 3.2.2.1 Client Characteristic Configuration Descriptor

The *Client Characteristic Configuration* descriptor shall be included in the Intermediate Cuff Pressure characteristic.

## 3.3 Blood Pressure Feature

The Blood Pressure Feature characteristic shall be used to describe the supported features of the Blood Pressure Sensor.

### 3.3.1 Characteristic Behavior

When read, the Blood Pressure Feature characteristic returns a value that is used by a Collector to determine the supported features of the Blood Pressure Sensor.

The bits of the Blood Pressure Feature characteristic may either be static for the lifetime of the device (i.e. static permanently or until Service Changed is indicated) or guaranteed to be static only during a connection. This requirement is defined in the table below on a bit-by-bit basis. Although all defined bits as of this printing are required to be static during the lifetime of a device, it is possible that some future bits are defined that are guaranteed to be static only during a connection.

Bit	Blood Pressure Feature Bit	Static Requirement
0	Body Movement Detection Support bit	Lifetime
1	Cuff Fit Detection Support bit	Lifetime
2	Irregular Pulse Detection Support bit	Lifetime
3	Pulse Rate Range Detection Support bit	Lifetime
4	Measurement Position Detection Support bit	Lifetime
5	Multiple Bond Support bit	Lifetime
6-15	Reserved for Future Use	Not defined.

Table 3.2: Static Requirements for Blood Pressure Feature Bits

If the Body Movement Detection feature is not supported, the Body Movement Detection Support bit shall be set to 0 and the Body Movement Detection Flag (from the Measurement Status field of the Blood Pressure Measurement characteristic) shall be set to 0. Otherwise the Body Movement Detection Support bit shall be set to 1 (Body Movement Detection feature supported) and the Body Movement Detection Flag shall be used to show whether or not movement was detected during a given measurement.

If the Cuff Fit Detection feature is not supported, the Cuff Fit Detection Support bit shall be set to 0 and the Cuff Fit Detection Flag (from the Measurement Status field of the Blood Pressure Measurement characteristic) shall be set to 0. Otherwise the Cuff Fit Detection Support bit shall be set to 1 (Cuff Fit Detection feature supported) and the Cuff Fit Detection Flag shall be used to show whether or not improper fit of the cuff was detected during a given measurement.

If the Irregular Pulse Detection feature is not supported, the Irregular Pulse Detection Support bit shall be set to 0 and the Irregular Pulse Detection Flag (from the Measurement Status field of the Blood Pressure Measurement characteristic) shall be set to 0. Otherwise the Irregular Pulse Detection Support bit shall be set to 1 (Irregular Pulse Detection feature supported) and the Irregular Pulse Detection Flag shall be used to show whether or not an irregular pulse was detected during a given measurement.

If the Pulse Rate Range Detection feature is not supported, the Pulse Rate Range Detection Support bit shall be set to 0 and the Pulse Rate Range Detection Flags (from the Measurement Status field of the Blood Pressure Measurement characteristic) shall both be set to 0. Otherwise the Pulse Rate Range Detection Support bit shall be set to 1 (Pulse Rate Range Detection feature supported) and the Pulse Rate Range Detection Flags shall be used to show whether or not an irregular pulse rate was detected during a given measurement.

If the Measurement Position Detection feature is not supported, the Measurement Position Detection Support bit shall be set to 0 and the Measurement Position Detection Flag (from the Measurement Status field of the Blood Pressure Measurement characteristic) shall be set to 0. Otherwise the Measurement Position Detection Support bit shall be set to 1 (Measurement Position Detection feature supported) and the Measurement Position Detection Flag shall be used to show whether or not an irregular measurement position was detected during a given measurement.

If the Blood Pressure Sensor supports multiple bonds, the Multiple Bond Support bit shall be set to 1. Otherwise it shall be set to 0.

### **3.4 Requirements for Time-Sensitive Data**

The Blood Pressure Measurement characteristic contains time sensitive data and is considered a time-sensitive characteristic, thus the following requirements apply:

If the time stamp feature is not supported:

The value of the time-sensitive characteristic shall be discarded either if the connection does not get established or if the indication is not successfully acknowledged by the Client in a timely manner as decided by the implementation.

If the time stamp feature is supported:

It is strongly recommended that the value of the time-sensitive characteristic be stored if either the connection does not get established or if the indication is not successfully acknowledged by the Client during the connection.

For basic scenarios, the Blood Pressure Sensor should be able to store at least 100 data measurements. Multi-user devices should be able to store that number of measurements per user supported.

If the maximum storage capacity in the Server is reached, the Server should overwrite the oldest measurement data first when writing the new measurement data. For multi-user devices should purge the oldest data for a given user to make room for the most recent data for that user.

When transmitting stored data, the oldest data shall be sent first followed by the next oldest data (in FIFO order) until all stored data has been transferred.

## 4 Special Values

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### 4.1 Special Short Float Values

The following special short float values are defined in IEEE 11073-20601 [4].

Special Short Value	Value
NaN (not a number)	0x07FF
NRes (not at this resolution)	0x0800
+ INFINITY	0x07FE
– INFINITY	0x0802
Reserved for future use	0x0801

Table 4.1: Special Short Float Values

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 perturbation.

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.



## 5 Acronyms and Abbreviations

Acronyms and Abbreviations	Meaning
BR/EDR	Basic Rate / Enhanced Data Rate
FIFO	First-In-First-Out
GAP	Generic Access Profile
GATT	Generic Attribute Profile
HS	High Speed
LE	Low Energy
MAP	Mean Arterial Pressure
NaN	Not a Number
NRes	Not at this Resolution
RFU	Reserved for Future Use
UUID	Universally Unique Identifier
SM1L2	Security Mode 1 Level 2
SM1L3	Security Mode 1 Level 3

Table 5.1: Acronyms and Abbreviations

## 6 References

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- [1] *Bluetooth* Core Specification v4.0
- [2] Health Device Profile v1.0
- [3] Characteristic and Descriptor descriptions are accessible via the [Bluetooth SIG Assigned Numbers](#)
- [4] ISO/IEEE Std 11073-20601™- 2008 Health Informatics - Personal Health Device Communication - Application Profile - Optimized Exchange Protocol - version 1.0 or later. This also includes ISO/IEEE Std 11073-20601a™- 2010 – Amendment 1.
- [5] Current Time Service Specification v1.0