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HEART RATE SERVICE

Abstract:

This service exposes heart rate and other data from a Heart Rate Sensor intended for fitness applications.

Heart Rate Service

Revision History

Revision	Date (yyyy-mm-dd)	Comments
D09r00	2011-02-04	Initial Draft from Health Thermometer Service.
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D09r04	2011-03-23	Incorporated feedback from MED WG reviews.
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D09r09	2011-05-18	Incorporated feedback from BARB. Version approved by BARB and Board.
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D10r01	2011-06-28	Version submitted to BARB for approval. Incorporated feedback from GPA WG.
D10r02	2011-06-28	Accepted all changes.
V10r00	2011-07-12	Adopted by the Bluetooth SIG Board of Directors

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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*).

Table of Contents

1	Introduction	6
1.1	Conformance	6
1.2	Service Dependency	6
1.3	Bluetooth Specification Release Compatibility	6
1.4	GATT Sub-Procedure Requirements	6
1.5	Transport Dependencies	6
1.6	Error Codes	7
1.7	Byte Transmission Order	7
2	Service Declaration	8
3	Service Characteristics	9
3.1	Heart Rate Measurement	9
3.1.1	Characteristic Behavior	10
3.1.1.1	Flags Field	10
3.1.1.2	Heart Rate Measurement Value Field	11
3.1.1.3	Energy Expended Field	11
3.1.1.4	RR-Interval Field	11
3.1.1.5	Transmission Interval	12
3.1.2	Characteristic Descriptors	12
3.1.2.1	Client Characteristic Configuration Descriptor	12
3.2	Body Sensor Location	12
3.2.1	Characteristic Behavior	12
3.3	Heart Rate Control Point	12
3.3.1	Characteristic Behavior	12
3.4	Requirements for Time-Sensitive Data	13
4	Acronyms and Abbreviations	14
5	References	15

1 Introduction

The Heart Rate Service exposes heart rate and other data related to a heart rate sensor intended for fitness 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) specification and the Bluetooth Low Energy Controller specification.

1.4 GATT Sub-Procedure Requirements

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

[Table 1.1](#) summarizes additional GATT sub-procedure requirements beyond those required by all GATT Servers.

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

Table 1.1: GATT Sub-procedure Requirements

C.1: Mandatory if the Heart Rate Control Point characteristic is supported, otherwise excluded for this service.

1.5 Transport Dependencies

This service shall operate over an LE transport.

1.6 Error Codes

This service defines the following Attribute Protocol Application error codes:

Name	Error Code	Description
Control Point Not Supported	0x80	Control Point value not supported.

1.7 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 [\[2\]](#).

2 Service Declaration

The Heart Rate Service shall be instantiated as a «Primary Service».

The service UUID shall be set to «Heart Rate Service». The UUID value assigned to «Heart Rate Service» is defined in [\[2\]](#).

3 Service Characteristics

The following characteristics are exposed in the Heart Rate Service. Unless otherwise specified, only one instance of each characteristic is permitted within this service.

Characteristic Name	Requirement	Mandatory Properties	Optional Properties	Security Permissions
Heart Rate Measurement	M	Notify		None.
Heart Rate Measurement Client Characteristic Configuration descriptor	M	Read, Write		None.
Body Sensor Location	O	Read		None.
Heart Rate Control Point	C.1	Write		None.

Table 3.1: Heart Rate Service characteristics

C.1: Mandatory if the Energy Expended feature is supported, otherwise excluded.

Notes:

- Security Permissions of “None” means that this service does not impose any requirements.
- Properties not listed as Mandatory or Optional are Excluded.

3.1 Heart Rate Measurement

The Heart Rate Measurement characteristic is used to send a heart rate measurement. Included in the characteristic are a Flags field (for showing the presence of optional fields and features supported), a heart rate measurement value field and, depending upon the contents of the Flags field, an Energy Expended field and an RR-Interval field. The RR-Interval represents the time between two consecutive R waves in an Electrocardiogram (ECG) waveform (see [Figure 3.1](#)).

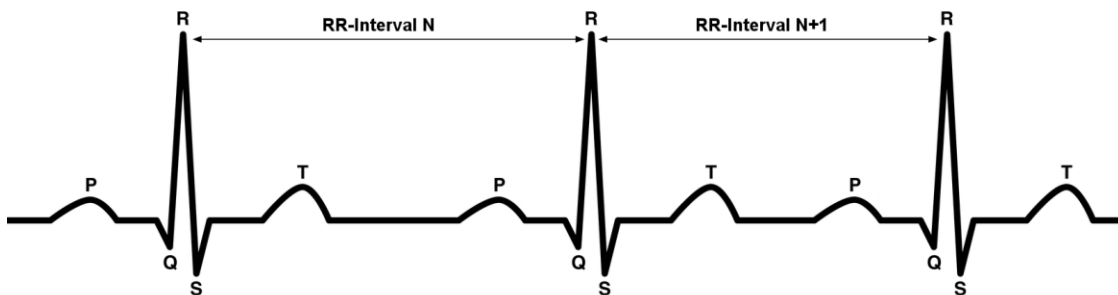


Figure 3.1: ECG Waveform and RR-Interval

The RR-Interval field is variable length and, for a 23-octet ATT_MTU, may contain 0 or up to 8 or 9 RR-Interval sub-fields depending upon the Heart Rate Measurement Value format and if the Energy Expended field is present or not.

3.1.1 Characteristic Behavior

When the *Client Characteristic Configuration* descriptor is configured for notification and a heart rate measurement is available, this characteristic shall be notified while in a connection.

The Heart Rate 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 shall be included in the Heart Rate Measurement characteristic.

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

The bits of the Flags field are defined in the following subsections.

3.1.1.1.1 Heart Rate Value Format bit

The Heart Rate Value Format bit (bit 0 of the Flags field) indicates if the data format of the Heart Rate Measurement Value field is in a format of UINT8 or UINT16.

When the Heart Rate Value format is sent in a UINT8 format, the Heart Rate Value Format bit shall be set to 0. When the Heart Rate Value format is sent in a UINT16 format, the Heart Rate Value Format bit shall be set to 1.

The value of the Heart Rate Value Format bit may change during a connection.

3.1.1.1.2 Sensor Contact Status bits

The Sensor Contact Status bits (bits 1 and 2 of the Flags field) indicate whether or not, the Sensor Contact feature is supported and if supported whether or not skin contact is detected.

If the Sensor Contact feature is supported by the Server, the Sensor Contact Support bit (bit 2 of the Flags field) shall be set to 1. If the Sensor Contact feature is not supported by the Server, the Sensor Contact Support bit shall be set to 0.

The value of the Sensor Contact Support bit is static while in a connection.

The value of the Sensor Contact Status bit may change while in a connection.

If the Sensor Contact feature is supported and if the device detects no or poor contact with the skin, the Sensor Contact Status bit (bit 1 of the Flags field) shall be set to 0. Otherwise it shall be set to 1.

3.1.1.1.3 Energy Expended Status bit

The Energy Expended Status bit (bit 3 of the Flags field) indicates whether or not, the Energy Expended field is present in the Heart Rate Measurement characteristic.

If the Energy Expended field is not present, the Energy Expended Status bit shall be set to 0. If the Energy Expended field is present, the Energy Expended Status bit shall be set to 1.

The value of the Energy Expended Status bit may change while in a connection.

3.1.1.1.4 RR-Interval bit

The RR-Interval bit indicates whether or not RR-Interval values are present in the Heart Rate Measurement characteristic.

If RR-Interval values are not present, the RR-Interval bit shall be set to 0. If one or more RR-Interval values are present, the RR-Interval bit shall be set to 1.

The value of the RR-Interval bit may change while in a connection.

3.1.1.2 Heart Rate Measurement Value Field

The Heart Rate Measurement Value field shall be included in the Heart Rate Measurement characteristic.

While most human applications require support for only 255 bpm or less, special applications (e.g. animals) may require support for higher bpm values.

If the Heart Rate Measurement Value is less than or equal to 255 bpm a UINT8 format should be used for power savings.

If the Heart Rate Measurement Value exceeds 255 bpm a UINT16 format shall be used.

See [3.1.1.1.1](#) for additional requirements on the Heart Rate Value format change.

3.1.1.3 Energy Expended Field

The Energy Expended field represents the accumulated energy expended in kilo Joules since the last time it was reset.

If the Server supports energy expended calculations, the Energy Expended field may be included in the Heart Rate Measurement characteristic.

If energy expended is used, it is typically only included in the Heart Rate Measurement characteristic once every 10 measurements at a regular interval.

See [3.1.1.1.3](#) for information regarding the Energy Expended Status bit.

Since Energy Expended is a UINT16, the highest value that can be represented is 65535 kilo Joules. If the maximum value of 65535 kilo Joules is attained (0xFFFF), the field value should remain at 0xFFFF so that the client can be made aware that a reset of the Energy Expended Field is required. See Section [3.3.1](#) for requirements related to resetting the value of this field.

3.1.1.4 RR-Interval Field

The RR-Interval field may be included in the Heart Rate Measurement characteristic if the device supports RR-Interval measurements.

If RR-Interval values are present in the Heart Rate Measurement characteristic, the Server shall set bit 4 of the Flags field (RR-Interval bit) to 1 and shall include one or more RR-Interval values in the Heart Rate Measurement characteristic. Otherwise RR-Interval values shall not be included and bit 4 of the Flags field shall be set to 0.

For a 23-octet ATT_MTU and the Heart Rate Measurement Value format set to UINT8, the maximum number of RR-Interval Values that can be notified if Energy Expended is

Heart Rate Service

present is 8 and the maximum number of RR-Interval Values that can be notified if Energy Expended is not present is 9.

For a 23-octet ATT_MTU and the Heart Rate Measurement Value format set to UINT16, when notifying the Heart Rate Measurement characteristic, the maximum number of RR-Interval values that can be contained within a single Heart Rate Measurement characteristic with Energy Expended is 7 and the maximum number of RR-Interval values that can be notified if Energy Expended is not present is 8.

If more RR-Interval values are measured since the last notification than fit into one Heart Rate Measurement characteristic, then the remaining RR-Interval values should be included in the next available Heart Rate Measurement characteristic.

If there is no available space in the internal buffer of the Heart Rate Sensor, it may discard the oldest RR-Interval values.

3.1.1.5 Transmission Interval

In typical applications, the Heart Rate Measurement characteristic is notified approximately 1 time per second and includes the Heart Rate Measurement Value field and, if supported, the RR-Interval field. The Energy Expended field, if supported, is typically included in the Heart Rate Measurement characteristic for transmission approximately 1 time per every 10 seconds. These intervals may vary and are determined by the Server and are not configurable by the Client.

3.1.2 Characteristic Descriptors

3.1.2.1 Client Characteristic Configuration Descriptor

The *Client Characteristic Configuration* descriptor shall be included in the Heart Rate Measurement characteristic.

3.2 Body Sensor Location

The Body Sensor Location characteristic of the device is used to describe the intended location of the heart rate measurement for the device.

The value of the Body Sensor Location characteristic is static while in a connection.

3.2.1 Characteristic Behavior

The Body Sensor Location characteristic returns the sensor location value when read.

3.3 Heart Rate Control Point

The Heart Rate Control Point characteristic is used to enable a Client to write control points to a Server to control behavior.

Support for this characteristic is mandatory if the Server supports the Energy Expended feature.

3.3.1 Characteristic Behavior

The Heart Rate Control Point characteristic sets a control point value when written.

Heart Rate Service

If the Client attempts to write a value to the Heart Rate Control Point characteristic that is not supported by the Server, the Server shall send an error response with the error code set to *Control Point Not Supported*.

If supported by the Server, when a value of 0x01 is written to the Heart Rate Control Point characteristic (Reset Energy Expended), the Server shall restart the accumulation of energy expended from zero.

3.4 Requirements for Time-Sensitive Data

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

Since this service does not provide for a time stamp to identify the measurement time (and age) of the data, the value of the Heart Rate Measurement characteristic shall be discarded if either the connection does not get established or if the notification is not successfully sent to the Client (e.g., link loss).

4 Acronyms and Abbreviations

Acronyms and Abbreviations	Meaning
BR/EDR	Basic Rate / Enhanced Data Rate
ECG	Electrocardiogram
GAP	Generic Access Profile
GATT	Generic Attribute Profile
LE	Low Energy
RFU	Reserved for Future Use
UUID	Universally Unique Identifier

Table 4.1: Acronyms and Abbreviations

5 References

- [1] Bluetooth Core Specification v4.0
- [2] Characteristic and Descriptor descriptions are accessible via the [Bluetooth SIG Assigned Numbers](#).