Cycling Power Service

Bluetooth® Service Specification

Abstract:
This service exposes power- and force-related data and optionally speed- and cadence-related data from a Cycling Power sensor intended for sports and fitness applications.
Revision History

<table>
<thead>
<tr>
<th>Revision Number</th>
<th>Date</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>v1.0</td>
<td>2013-04-30</td>
<td>Adopted by the Bluetooth SIG Board of Directors</td>
</tr>
<tr>
<td>v1.1</td>
<td>2016-05-03</td>
<td>Adopted by the Bluetooth SIG BoD</td>
</tr>
</tbody>
</table>

Contributors

<table>
<thead>
<tr>
<th>Name</th>
<th>Member</th>
</tr>
</thead>
<tbody>
<tr>
<td>Robert Hughes</td>
<td>Intel Corporation</td>
</tr>
<tr>
<td>Jari Miettinen</td>
<td>Polar</td>
</tr>
<tr>
<td>Niclas Granqvist</td>
<td>Polar</td>
</tr>
<tr>
<td>Guillaume Schatz</td>
<td>Polar</td>
</tr>
<tr>
<td>Ed Watson</td>
<td>Saris</td>
</tr>
<tr>
<td>Donny Warbritton</td>
<td>Stages Cycling</td>
</tr>
</tbody>
</table>
DISCLAIMER AND COPYRIGHT NOTICE

Use of Bluetooth Specifications and any related intellectual property is governed by the Promoters Membership Agreement among the Promoter Members and Bluetooth SIG (the “Promoters Agreement”), certain membership agreements between Bluetooth SIG and its Adopter and Associate Members, including, but not limited to, the Membership Application, the Bluetooth Patent/Copyright License Agreement and the Bluetooth Trademark License Agreement (collectively, the “Membership Agreements”) and the Bluetooth Specification Early Adopters Agreements (1.2 Early Adopters Agreements) among Early Adopter members of the unincorporated Bluetooth SIG and the Promoter Members (the “Early Adopters Agreement”). Certain rights and obligations of the Promoter Members under the Early Adopters Agreements have been assigned to Bluetooth SIG by the Promoter Members.

Use of the Specification by anyone who is not a member of Bluetooth SIG or a party to an Early Adopters Agreement (each such person or party, a “Member”) is prohibited. The use of any portion of a Bluetooth Specification may involve the use of intellectual property rights (“IPR”), including pending or issued patents, or copyrights or other rights. Bluetooth SIG has made no search or investigation for such rights and disclaims any undertaking or duty to do so. The legal rights and obligations of each Member are governed by the applicable Membership Agreements, Early Adopters Agreement or Promoters Agreement. No license, express or implied, by estoppel or otherwise, to any intellectual property rights are granted herein.

Any use of the Specification not in compliance with the terms of the applicable Membership Agreements, Early Adopters Agreement or Promoters Agreement is prohibited and any such prohibited use may result in (i) termination of the applicable Membership Agreements or Early Adopters Agreement and (ii) liability claims by Bluetooth SIG or any of its Members for patent, copyright and/or trademark infringement claims permitted by the applicable agreement or by applicable law.

THE SPECIFICATION IS PROVIDED “AS IS” WITH NO WARRANTIES WHATSOEVER, INCLUDING ANY WARRANTY OF MERCHANTABILITY, NONINFRINGEMENT, FITNESS FOR ANY PARTICULAR PURPOSE, SATISFACTORY QUALITY, OR REASONABLE SKILL OR CARE, OR ANY WARRANTY ARISING OUT OF ANY COURSE OF DEALING, USAGE, TRADE PRACTICE, PROPOSAL, SPECIFICATION OR SAMPLE.

Each Member hereby acknowledges that products equipped with the Bluetooth wireless technology (“Bluetooth Products”) may be subject to various regulatory controls under the laws and regulations applicable to products using wireless non licensed spectrum of various governments worldwide. Such laws and regulatory controls may govern, among other things, the combination, operation, use, implementation and distribution of Bluetooth Products. Examples of such laws and regulatory controls include, but are not limited to, airline regulatory controls, telecommunications regulations, technology transfer controls and health and safety regulations. Each Member is solely responsible for the compliance by their Bluetooth Products with such laws and regulations and for obtaining any and all required authorizations, permits, or licenses for their Bluetooth Products related to such regulations within the applicable jurisdictions. Each Member acknowledges that nothing in the Specification provides any information or assistance in connection with securing such compliance, authorizations or licenses. NOTHING IN THE SPECIFICATION CREATES ANY WARRANTIES, EITHER EXPRESS OR IMPLIED, REGARDING SUCH LAWS OR REGULATIONS.

ALL LIABILITY, INCLUDING LIABILITY FOR INFRINGEMENT OF ANY INTELLECTUAL PROPERTY RIGHTS OR FOR NONCOMPLIANCE WITH LAWS, RELATING TO USE OF THE SPECIFICATION IS EXPRESSLY DISCLAIMED. To the extent not prohibited by law, in no event will Bluetooth SIG or its Members or their affiliates be liable for any damages, including without limitation, lost revenue, profits, data or programs, or business interruption, or for special, indirect, consequential, incidental or punitive damages, however caused and regardless of the theory of liability, arising out of or related to any furnishing, practicing, modifying, use or the performance or implementation of the contents of this Specification, even if Bluetooth SIG or its Members or their affiliates have been advised of the possibility of such damages. BY USE OF THE SPECIFICATION, EACH MEMBER EXPRESSLY WAIVES ANY CLAIM AGAINST BLUETOOTH SIG AND ITS MEMBERS OR THEIR AFFILIATES RELATED TO USE OF THE SPECIFICATION.

If this Specification is an intermediate draft, it is for comment only. No products should be designed based on it except solely to verify the prototyping specification at SIG sponsored IOP events and it does not represent any commitment to release or implement any portion of the intermediate draft, which may be withdrawn, modified, or replaced at any time in the adopted Specification.

Bluetooth SIG reserves the right to adopt any changes or alterations to the Specification it deems necessary or appropriate.

Copyright © 2012–2016. The Bluetooth word mark and logos are owned by Bluetooth SIG, Inc. All copyrights in the Bluetooth Specifications themselves are owned by Ericsson AB, Lenovo (Singapore) Pte. Ltd., Intel Corporation, Microsoft Corporation, Motorola Mobility, LLC, Nokia Corporation and Toshiba Corporation. Other third-party brands and names are the property of their respective owners.
Document Terminology

The Bluetooth SIG has adopted portions of the IEEE Standards Style Manual which dictate 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.
# Contents

1  Introduction .......................................................................................................................................... 7  
   1.1 Conformance .................................................................................................................................. 7  
   1.2 Service Dependency ....................................................................................................................... 7  
   1.3 Bluetooth Core Specification Release Compatibility ...................................................................... 7  
   1.4 GATT Sub-Procedure Requirements ............................................................................................. 7  
   1.5 Transport Dependencies ................................................................................................................ 8  
   1.6 Error Codes .................................................................................................................................... 8  
   1.7 Byte Transmission Order ................................................................................................................ 8  
2  Service Declaration .............................................................................................................................. 9  
3  Service Characteristics ..................................................................................................................... 10  
   3.1 Cycling Power Feature ................................................................................................................. 10  
      3.1.1 Characteristic Behavior ........................................................................................................... 10  
   3.2 Cycling Power Measurement ........................................................................................................ 11  
      3.2.1 Characteristic Behavior ........................................................................................................... 11  
      3.2.1.1 Flags Field ....................................................................................................................... 12  
      3.2.1.2 Instantaneous Power Field .............................................................................................. 13  
      3.2.1.3 Pedal Power Balance Field ............................................................................................. 14  
      3.2.1.4 Accumulated Torque Field .............................................................................................. 14  
      3.2.1.5 Wheel Revolution Data Field Pair ................................................................................... 14  
      3.2.1.6 Crank Revolutions Data Field Pair .................................................................................. 15  
      3.2.1.7 Extreme Force Magnitudes Field Pair ............................................................................. 15  
      3.2.1.8 Extreme Torque Magnitudes Field Pair .......................................................................... 16  
      3.2.1.9 Extreme Angles Field Pair ............................................................................................... 16  
      3.2.1.10 Top Dead Spot Angle Field ......................................................................................... 16  
      3.2.1.11 Bottom Dead Spot Angle Field .................................................................................... 17  
      3.2.1.12 Accumulated Energy Field .......................................................................................... 17  
      3.2.1.13 Cycling Power Measurement Broadcast Feature ....................................................... 17  
   3.3 Sensor Location ............................................................................................................................ 18  
      3.3.1 Characteristic Behavior ........................................................................................................... 18  
   3.4 Cycling Power Control Point ......................................................................................................... 18  
      3.4.1 Cycling Power Control Point Procedure Requirements .......................................................... 18  
      3.4.2 Cycling Power Control Point Behavioral Description ............................................................... 21  
      3.4.2.1 Set Cumulative Value Procedure .................................................................................... 21  
      3.4.2.2 Update Sensor Location Procedure ................................................................................ 22  
      3.4.2.3 Request Supported Sensor Locations Procedure ........................................................... 22  
      3.4.2.4 Set Crank Length Procedure ........................................................................................... 22
3.4.2.5 Request Crank Length Procedure................................................................................... 23
3.4.2.6 Set Chain Length Procedure......................................................................................... 23
3.4.2.7 Request Chain Length Procedure................................................................................... 23
3.4.2.8 Set Chain Weight Procedure......................................................................................... 24
3.4.2.9 Request Chain Weight Procedure................................................................................... 24
3.4.2.10 Set Span Length Procedure......................................................................................... 24
3.4.2.11 Request Span Length Procedure................................................................................... 25
3.4.2.12 Start Offset Compensation Procedure......................................................................... 25
3.4.2.13 Mask Cycling Power Measurement Characteristic Content....................................... 26
3.4.2.14 Request Sampling Rate Procedure............................................................................. 27
3.4.2.15 Request Factory Calibration Date Procedure ............................................................. 27
3.4.3 General Error Handling procedures .................................................................................. 28
3.4.4 Procedure Timeout ............................................................................................................ 29
3.5 Cycling Power Vector .......................................................................................................... 29
3.5.1 Characteristic Behavior ................................................................................................... 30
3.5.1.1 Flags Field..................................................................................................................... 31
3.5.1.2 Crank Revolution Data Field Pair ................................................................................ 31
3.5.1.3 First Crank Measurement Angle Field......................................................................... 32
3.5.1.4 Instantaneous Force Magnitude Array Field................................................................. 32
3.5.1.5 Instantaneous Torque Magnitude Array Field............................................................... 33
3.6 Requirements for Time-Sensitive Data................................................................................ 34
3.7 Requirements for Servers Used for a Distributed Power System ....................................... 34
4 SDP Interoperability................................................................................................................. 35
5 Acronyms and Abbreviations.................................................................................................. 36
6 References............................................................................................................................... 37
1 Introduction

The Cycling Power (CP) Service exposes power- and force-related data and optionally speed- and cadence-related data from a Cycling Power sensor (Server) intended for sports and 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 Core Specification Release Compatibility

This specification is compatible with any of the following:

- Bluetooth Core Specification 4.0 with CSA2, CSA3 and CSA4 [1]
- A Bluetooth Core Specification later than 4.0.

1.4 GATT Sub-Procedure Requirements

Requirements in this section represent a minimum set of requirements for a 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.

<table>
<thead>
<tr>
<th>GATT Sub-Procedure</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Write Characteristic Value</td>
<td>C.1</td>
</tr>
<tr>
<td>Notifications</td>
<td>M</td>
</tr>
<tr>
<td>Indications</td>
<td>C.1</td>
</tr>
<tr>
<td>Read Characteristic Descriptors</td>
<td>M</td>
</tr>
<tr>
<td>Write Characteristic Descriptors</td>
<td>M</td>
</tr>
</tbody>
</table>

Table 1.1: GATT Sub-procedure Requirements

C.1: Mandatory if the Cycling Power Control Point characteristic is supported, otherwise excluded for this service.
1.5 Transport Dependencies

With the exception of the Cycling Power Measurement Broadcast feature (see Section 3.2.1.13) used in an advanced mode of operation, there are no transport restrictions imposed by this service specification. In that case, the LE method of broadcasting is used and broadcasting over BR/EDR is not supported.

Where the term BR/EDR is used throughout this document, this also includes the use of AMP.

1.6 Error Codes

This service defines the following Attribute Protocol Application Error code:

<table>
<thead>
<tr>
<th>Name</th>
<th>Error Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inappropriate Connection Parameters</td>
<td>0x80</td>
<td>The notifications of the Cycling Power Vector characteristic cannot be sent due to inappropriate connection parameters.</td>
</tr>
</tbody>
</table>

Table 1.2: Application Error Codes

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 Cycling Power Service should be instantiated as a "Primary Service".

The service UUID shall be set to "Cycling Power Service" defined in [2].
3 Service Characteristics

The following characteristics are exposed in the Cycling Power Service. Only one instance of each characteristic is permitted within this service. The characteristic formats and UUIDs are defined in [2].

Where a characteristic can be notified or indicated, a Client Characteristic Configuration descriptor shall be included in that characteristic as required by the Core Specification [1].

Where a characteristic can be broadcasted, a Server Characteristic Configuration descriptor shall be included in that characteristic as required by the Core Specification [1].

<table>
<thead>
<tr>
<th>Characteristic Name</th>
<th>Requirement</th>
<th>Mandatory Properties</th>
<th>Optional Properties</th>
<th>Security Permissions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cycling Power Feature</td>
<td>M</td>
<td>Read</td>
<td></td>
<td>None.</td>
</tr>
<tr>
<td>Cycling Power Measurement</td>
<td>M</td>
<td>Notify</td>
<td>LE: Broadcast</td>
<td>None.</td>
</tr>
<tr>
<td>Sensor Location</td>
<td>M</td>
<td>Read</td>
<td>BR/EDR: None</td>
<td>None.</td>
</tr>
<tr>
<td>Cycling Power Control Point</td>
<td>O</td>
<td>Write, Indicate</td>
<td></td>
<td>None.</td>
</tr>
<tr>
<td>Cycling Power Vector</td>
<td>O</td>
<td>Notify</td>
<td></td>
<td>None.</td>
</tr>
</tbody>
</table>

Table 3.1: Cycling Power Service characteristics

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

3.1 Cycling Power Feature

The Cycling Power Feature characteristic shall be used to describe the supported features of the Server.

Reserved for Future Use (RFU) bits in the Cycling Power Feature characteristic value shall be set to 0.

3.1.1 Characteristic Behavior

When read, the Cycling Power Feature characteristic returns a value that is used by a Client to determine the supported features of the Server.

The bits of the Cycling Power 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. Although all defined bits (i.e., bits 0 to 21) in this version of this specification are required to be static during the lifetime of a device, it is possible that some future bits will be defined as being static only during a connection.

Other than the Distributed System Support bits, when the Server supports a feature, the associated bit of the Cycling Power Feature characteristic shall be set to 1 (Feature supported), otherwise, the associated bit shall be set to 0 (Feature not supported). The feature bits are defined in [2].

If the Server is not designed for use in a distributed system (i.e., the Server measures the total amount of power generated by the user), it shall set the Distributed System Support bits to 01 (Not for use in a distributed system).

If the Server is designed such that it can be used as part of a distributed system (i.e., the Instantaneous Power value of the Cycling Power Measurement characteristic might represent only a portion of the total amount of power generated by the user), it shall set the Distributed System Support bits to 10 (Can be used in a distributed system).

### 3.2 Cycling Power Measurement

The Cycling Power Measurement characteristic is used to send power-related data, speed-related data, and/or cadence-related data. Included in the characteristic value are a Flags field (for showing the presence of optional fields and measurement status), an Instantaneous Power field and depending upon the contents of the Flags field, may include one or more optional fields defined in [2].

#### 3.2.1 Characteristic Behavior

When the Cycling Power Measurement characteristic is configured for notification via the Client Characteristic Configuration descriptor and a power-related measurement is available, this characteristic shall be notified. The Server should notify this characteristic at a regular interval, typically once per second while in a connection and is not configurable by the Client.

If the Cycling Power Measurement Broadcast feature is supported by the LE Server (see Section 3.2.1.13) and when the Cycling Power Measurement characteristic is configured for broadcast via the Server Characteristic Configuration descriptor and a power-related measurement is available, this characteristic shall be broadcasted (e.g., non-connectable undirected advertisement events) while in a connection (e.g. the Server stops broadcasting when disconnected). The Server should broadcast this characteristic at a regular interval. This should be typically broadcasted at the same interval as the notification of this characteristic.

For an LE Server that supports the Cycling Power Measurement Broadcast feature, it shall support the sending of notifications and broadcasts while in a connection.

If the Server supports the Cycling Power Measurement Characteristic Content Masking feature and if the Client does not need a particular field of the Cycling Power Measurement characteristic, the Server may allow the Client to turn off that particular field of the Cycling
Power Measurement characteristic as described in Section 3.4.2.13. When a Client turns off some fields of the Cycling Power Measurement characteristic, this may affect the broadcast of the Cycling Power Measurement characteristic as described in Section 3.2.1.13 and is left to the implementation.

Refer to Section 3.7 for additional recommendations for distributed power sensor systems (e.g., one Server on each pedal measuring the left and right power contribution).

For LE, all the fields of this characteristic cannot be present simultaneously if using a default MTU size. For notification, if the characteristic size exceeds the current MTU size, the remaining optional fields shall be sent in the subsequent notification. Refer to Section 3.2.1.13 for additional requirements on the Cycling Power Measurement Broadcast feature.

For BR/EDR, this restriction does not exist due to a larger MTU size.

The Cycling Power Measurement characteristic contains time-sensitive data, thus the requirements for time-sensitive data and data storage defined in Section 3.6 apply.

### 3.2.1.1 Flags Field

The Flags field shall be included in the Cycling Power Measurement characteristic.

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

The bits of the Flags field, their function, and relationship to bits in the Cycling Power Feature characteristic are shown in Table 3.2.

<table>
<thead>
<tr>
<th>Flags Bit Name</th>
<th>When Set to 0</th>
<th>When Set to 1</th>
<th>Corresponding Cycling Power Feature support bit (see Section 3.1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pedal Power Balance Present (bit 0), see 3.2.1.3</td>
<td>Corresponding field not present</td>
<td>Corresponding field present</td>
<td>Pedal Power Balance Supported (bit 0)</td>
</tr>
<tr>
<td>Pedal Power Balance Reference (bit 1), see Note 1 and 3.2.1.3</td>
<td>Unknown</td>
<td>Left</td>
<td>Pedal Power Balance Supported (bit 0)</td>
</tr>
<tr>
<td>Accumulated Torque Present (bit 2), see 3.2.1.4</td>
<td>Corresponding field not present</td>
<td>Corresponding field present</td>
<td>Accumulated Torque Supported (bit 1)</td>
</tr>
<tr>
<td>Accumulated Torque Source (bit 3), see Note 1 and 3.2.1.4</td>
<td>Wheel Based</td>
<td>Crank Based</td>
<td>Accumulated Torque Supported (bit 1)</td>
</tr>
<tr>
<td>Wheel Revolution Data Present (bit 4), see 3.2.1.5</td>
<td>Corresponding field pair not present</td>
<td>Corresponding field pair present</td>
<td>Wheel Revolution Data Supported (bit 2)</td>
</tr>
<tr>
<td>Crank Revolution Data Present (bit 5), see 3.2.1.6</td>
<td>Corresponding field pair not present</td>
<td>Corresponding field pair present</td>
<td>Crank Revolution Data Supported (bit 3)</td>
</tr>
</tbody>
</table>
### Table 3.2: Bit Definitions for the Cycling Power Measurement Characteristic

<table>
<thead>
<tr>
<th>Flags Bit Name</th>
<th>When Set to 0</th>
<th>When Set to 1</th>
<th>Corresponding Cycling Power Feature support bit (see Section 3.1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extreme Force Magnitudes Present (bit 6), see 3.2.1.7</td>
<td>Corresponding field pair not present</td>
<td>Corresponding field pair present</td>
<td>Extreme Magnitudes Supported (bit 4) and Sensor Measurement Context set to Force-based (bit 16)</td>
</tr>
<tr>
<td>Extreme Torque Magnitudes Present (bit 7), see 3.2.1.8</td>
<td>Corresponding field pair not present</td>
<td>Corresponding field pair present</td>
<td>Extreme Magnitudes Supported (bit 4) and Sensor Measurement Context set to Torque-based (bit 16)</td>
</tr>
<tr>
<td>Extreme Angles Present (bit 8), see 3.2.1.9</td>
<td>Corresponding field pair not present</td>
<td>Corresponding field pair present</td>
<td>Extreme Angles Supported (bit 5)</td>
</tr>
<tr>
<td>Top Dead Spot Angle Present (bit 9), see 3.2.1.10</td>
<td>Corresponding field pair not present</td>
<td>Corresponding field present</td>
<td>Top and Bottom Dead Spot Angles Supported (bit 6)</td>
</tr>
<tr>
<td>Bottom Dead Spot Angle Present (bit 10), see 3.2.1.11</td>
<td>Corresponding field pair not present</td>
<td>Corresponding field present</td>
<td>Top and Bottom Dead Spot Angles Supported (bit 6)</td>
</tr>
<tr>
<td>Accumulated Energy Present (bit 11), see 3.2.1.12</td>
<td>Corresponding field pair not present</td>
<td>Corresponding field present</td>
<td>Accumulated Energy Supported (bit 6)</td>
</tr>
<tr>
<td>Offset CompensationIndicator (bit 12), see Note 1 and 3.4.2.12</td>
<td>No required action</td>
<td>Offset compensation action required</td>
<td>Offset Compensation Indicator Supported (bit 8)</td>
</tr>
</tbody>
</table>

**Note 1:** If the corresponding feature bit of the Cycling Power Feature characteristic is set to 0, then this bit has no meaning and shall be set to 0.

Each of the Flags bits in the table above may change during a connection if the corresponding support bit in the Cycling Power Feature characteristic is set to 1 indicating that the feature is supported. If the corresponding support bit is however set to 0, then the corresponding Flags bit shall also be set to 0 since the feature is not supported.

### 3.2.1.2 Instantaneous Power Field

The Instantaneous Power field shall be included in the Cycling Power Measurement characteristic.

The Instantaneous Power field represents the value of the power measured by the Server. It represents either the total power the user is producing or a part of the total power depending on the type of sensor (e.g., single sensor or distributed power sensor system). Refer to Section 3.7
for additional requirements for distributed power sensor systems (e.g., one Server on each pedal measuring the left and right power contribution).

3.2.1.3 Pedal Power Balance Field
The Pedal Power Balance field may be included in the Cycling Power Measurement characteristic if the Server supports the Pedal Power Balance feature (see Table 3.2).

The Pedal Power Balance field represents the ratio between the total amount of power measured by the sensor and a reference (either unknown or left). For example, if the sensor provides the power balance referenced to the left pedal, the power balance is calculated as \( \frac{\text{LeftPower}}{\text{LeftPower} + \text{RightPower}} \times 100 \) in units of percent.

When supported, the Pedal Power Balance Reference bit of the Flags field (bit 1) describes whether the value is referenced from 'left' or the reference is 'unknown'.

3.2.1.4 Accumulated Torque Field
The Accumulated Torque field may be included in the Cycling Power Measurement characteristic if the device supports the Accumulated Torque feature (see Table 3.2).

The Accumulated Torque field represents the cumulative value of the torque measured by the Sensor. When a connection is established, this value starts at 0 Newton meter and is may roll over.

When supported, the Accumulated Torque Source bit of the Flags field (bit 3) describes whether the value is 'wheel based' or 'crank based'.

The Accumulated Torque value may decrease.

3.2.1.5 Wheel Revolution Data Field Pair
The Wheel Revolution Data field pair (Cumulative Wheel Revolutions and Last Wheel Event Time fields) may be included in the Cycling Power Measurement characteristic if the device supports the Wheel Revolution Data feature (see Table 3.2). When present, these fields shall always be present as a pair.

The Cumulative Wheel Revolution value is not permitted to roll over.

The Cumulative Wheel Revolutions value, which represents the number of times a wheel rotates, is used in combination with the Last Wheel Event Time and the wheel circumference value available on the collector device to enable it to calculate 1) the speed of the bicycle, 2) the distance traveled and 3) and the power if combined with the Crank Revolution Data. In addition, if there is link loss, the Cumulative Wheel Revolutions value can be used to calculate the average speed of the bicycle during the link loss. This value is expected to be set to 0 (or another desired value in case of e.g., a sensor upgrade) at initial installation on a bicycle as described in Section 3.4.2.1. The Cumulative Wheel Revolutions value may decrement for some implementations (e.g., If the bicycle is rolled in reverse), but shall not decrease below 0.
The ‘wheel event time’ is a free-running-count of 1/2048 second units and it represents the time when the wheel revolution was detected by the wheel rotation sensor. Since several wheel events can occur between transmissions, only the Last Wheel Event Time value is transmitted. See Section 3.4.2.1 for requirements related to setting the value of the Cumulative Wheel Revolutions field.

The Last Wheel Event Time value rolls over every 32 seconds.

3.2.1.6 Crank Revolutions Data Field Pair
The Crank Revolution Data field pair (Cumulative Crank Revolutions and Last Crank Event Time fields) may be included in the Cycling Power Measurement characteristic if the device supports the Crank Revolution Data feature (see Table 3.2). When present, these fields shall always be present as a pair.

The Cumulative Crank Revolutions value, which represents the number of times a crank rotates, is used in combination with the Last Crank Event Time to enable the Client to

1. Determine if the cyclist is coasting and
2. Calculate the instantaneous and average cadence
3. Calculate the power if combined with the Wheel Revolution Data

Average cadence is not accurate unless 0 cadence events (i.e., coasting) are subtracted. In addition, if there is link loss, the Cumulative Crank Revolutions value can be used to calculate the average cadence during the link loss. This value is intended to roll over and is not configurable.

The ‘crank event time’ is a free-running-count of 1/1024 second units and it represents the time when the crank revolution was detected by the crank rotation sensor. Since several crank events can occur between transmissions, only the Last Crank Event Time value is transmitted. The Last Crank Event Time value rolls over every 64 seconds.

To enhance the user experience, the Server should ignore the extra crank revolutions that may be detected when the user is not pedaling (e.g., coasting down the hill) but the sensor is facing the crank revolution detection system (e.g., a magnet installed on the crankset) and may cause unwanted crank revolution detections.

3.2.1.7 Extreme Force Magnitudes Field Pair
The Extreme Force Magnitude field pair (Maximum Force Magnitude and Minimum Force Magnitude fields) may be included in the Cycling Power Measurement characteristic if the device supports the Extreme Magnitudes feature and the Sensor Measurement Context of the Cycling Power Feature characteristic is set to 0 (Force-based). Otherwise, this field pair is
excluded from this characteristic (see Table 3.2). When present, these fields shall always be present as a pair.

The Maximum Force Magnitude field represents the maximum force value measured in a single crank revolution; respectively the Minimum Force Magnitude field represents the minimum force value measured in a single crank revolution.

Since a Server supports only one measurement context (e.g., Force-based or Torque-based), the support of these fields excludes the support of the Maximum Torque Magnitude and Minimum Torque Magnitude fields.

3.2.1.8 Extreme Torque Magnitudes Field Pair
The Extreme Torque Magnitudes field pair (Maximum Torque Magnitude and Minimum Torque Magnitude fields) may be included in the Cycling Power Measurement characteristic if the device supports the Extreme Magnitudes feature and the Sensor Measurement Context of the Cycling Power Feature characteristic is set to 1 (Torque-based). Otherwise, this field pair is excluded from this characteristic (see Table 3.2). When present, these fields shall always be present as a pair.

The Maximum Torque Magnitude field represents the maximum torque value measured in a single crank revolution; respectively the Minimum Torque Magnitude field represents the minimum torque value measured in a single crank revolution.

Since a Server supports only one measurement context (e.g., Force-based or Torque-based), the support of these fields excludes the support of the Maximum Force Magnitude and Minimum Force Magnitude fields.

3.2.1.9 Extreme Angles Field Pair
The Extreme Angles field pair (Maximum Angle and Minimum Angle fields) may be included in the Cycling Power Measurement characteristic if the device supports the Extreme Angles feature (see Table 3.2). When present, these fields shall always be present as a pair.

The Maximum Angle field represents the angle of the crank when the maximum value is measured in a single crank revolution. Similarly the Minimum Angle field represents the angle of the crank when the minimum value is measured in the same crank revolution. The maximum and minimum values measured in a single crank revolution refer to either Maximum Force Magnitude and Minimum Force Magnitude field pairs or Maximum Torque Magnitude and Minimum Torque Magnitude field pairs.

3.2.1.10 Top Dead Spot Angle Field
The Top Dead Spot Angle field may be included in the Cycling Power Measurement characteristic if the device supports the Top and Bottom Dead Spot Angles feature (see Table 3.2).
The Top Dead Spot Angle field represents the crank angle when the value of the Instantaneous Power value becomes positive.

### 3.2.1.11 Bottom Dead Spot Angle Field

The Bottom Dead Spot Angle field may be included in the Cycling Power Measurement characteristic if the device supports the Top and Bottom Dead Spot Angles feature (see Table 3.2).

The Bottom Dead Spot Angle field represents the crank angle when the value of the Instantaneous Power value becomes negative.

### 3.2.1.12 Accumulated Energy Field

The Accumulated Energy field may be included in the Cycling Power Measurement characteristic if the device supports the Accumulated Energy feature (see Table 3.2).

The Accumulated Energy field represents the accumulated value of the energy measured by the sensor. When a connection is established, this value starts at 0 kilo Joules and is not expected to roll over.

### 3.2.1.13 Cycling Power Measurement Broadcast Feature

The Cycling Power Measurement Broadcast feature is optional when using the LE transport and it is not applicable to BR/EDR.

When the Cycling Power Measurement Broadcast is enabled by the Client (e.g., via the Server Characteristic Configuration descriptor), the Server shall send the Cycling Power Measurement characteristic value in a non-connectable undirected advertising event. The Advertising Data shall not exceed 31 octets and shall include the AD Structure Data described in Table 3.3:

<table>
<thead>
<tr>
<th>AD Type</th>
<th>AD Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advertising Interval</td>
<td>advInterval value</td>
</tr>
<tr>
<td>Service Data</td>
<td>Cycling Power Service UUID followed by the Cycling Power Measurement characteristic value</td>
</tr>
</tbody>
</table>

### Table 3.3: Broadcast AD Structures Requirements

When the Cycling Power Measurement Broadcast is disabled by the Client (e.g., via the Server Characteristic Configuration descriptor), the Server shall stop advertising. The Server shall also stop advertising when disconnected from the Client.

The Server may elect to send different fields of the Cycling Power Measurement characteristic when broadcasting (non-connectable undirected advertisement) as when notifying. Typically, the fields included in the broadcast are the mandatory fields (i.e., the Flags field and the Instantaneous Power field) and the Crank Revolution Data field (i.e., the Cumulative Crank Revolutions and the Last Crank Event Time field pair).
3.3 Sensor Location

The Sensor Location characteristic of the device may be used to describe the physical location of the Server when correctly fitted.

If the Server supports the Multiple Sensor Locations feature, the value of the Sensor Location characteristic may be updated while in a connection as described in Section 3.4.2.2. Otherwise, if the Sensor Location characteristic is present and the Multiple Sensor Locations feature is not supported, the value of the Sensor Location shall be static for the lifetime of the Server or until Service Changed characteristic is indicated.

If the Server supports the Multiple Sensor Locations feature, the Client should not assume that the value of the Sensor Location characteristic of the Server is set to the same value as at the end of a previous connection. This is primarily because the value may have been altered by a different Client after the previous connection (e.g., the user has moved his sensor to another location and configured the new Sensor Location with another Client).

Refer to Section 3.7 for additional recommendations for distributed power sensor systems (e.g., one Server on each pedal measuring the left and right power contribution).

3.3.1 Characteristic Behavior

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

3.4 Cycling Power Control Point

If the Cycling Power Control Point is supported, profiles utilizing this service are required to ensure that the Client configures the Cycling Power Control Point characteristic for indications (i.e., via the Client Characteristic Configuration descriptor) at the first connection.

Support for this characteristic is mandatory if the Server supports Wheel Revolution Data or Multiple Sensor Locations features, or if settings are configurable or if the Server allows a Client to do offset compensation or if the Server allows a Client to request some parameters; otherwise, it is excluded for this version of the service in accordance with Table 3.1:

Refer to Section 3.7 for additional recommendations for distributed power sensor systems (e.g., one Server on each pedal measuring the left and right power contribution).

3.4.1 Cycling Power Control Point Procedure Requirements

Table 3.4 shows the requirements for the Cycling Power Control Point characteristic in the context of this service.

A Client shall use the Write Characteristic Value procedure to initiate a procedure defined in Table 3.4.
<table>
<thead>
<tr>
<th>Procedure</th>
<th>Requirement</th>
<th>Parameter Description</th>
<th>Applicable Response Value</th>
<th>Response Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Set Cumulative Value</td>
<td>C.1</td>
<td>Cumulative Value</td>
<td>Success, Operation Failed, Invalid Parameter, Op Code Not Supported</td>
<td>None</td>
</tr>
<tr>
<td>Update Sensor Location</td>
<td>C.2</td>
<td>Sensor Location</td>
<td>Success, Operation Failed, Invalid Parameter, Op Code Not Supported</td>
<td>None</td>
</tr>
<tr>
<td>Request Supported Sensor Locations</td>
<td>C.2</td>
<td>None</td>
<td>Success</td>
<td>Byte array – see 3.4.2.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Operation Failed, Op Code Not Supported</td>
<td>None</td>
</tr>
<tr>
<td>Set Crank Length</td>
<td>C.3</td>
<td>Crank Length</td>
<td>Success, Operation Failed, Invalid Parameter, Op Code Not Supported</td>
<td>None</td>
</tr>
<tr>
<td>Request Crank Length</td>
<td>C.4</td>
<td>None</td>
<td>Success</td>
<td>Crank Length</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Operation Failed, Op Code Not Supported</td>
<td>None</td>
</tr>
<tr>
<td>Set Chain Length</td>
<td>C.5</td>
<td>Chain Length</td>
<td>Success, Operation Failed, Invalid Parameter, Op Code Not Supported</td>
<td>None</td>
</tr>
<tr>
<td>Request Chain Length</td>
<td>C.6</td>
<td>None</td>
<td>Success</td>
<td>Chain Length</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Operation Failed, Op Code Not Supported</td>
<td>None</td>
</tr>
<tr>
<td>Set Chain Weight</td>
<td>C.7</td>
<td>Chain Weight</td>
<td>Success, Operation Failed, Invalid Parameter, Op Code Not Supported</td>
<td>None</td>
</tr>
<tr>
<td>Request Chain Weight</td>
<td>C.8</td>
<td>None</td>
<td>Success</td>
<td>Chain Weight</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Operation Failed, Op Code Not Supported</td>
<td>None</td>
</tr>
<tr>
<td>Set Span Length</td>
<td>C.9</td>
<td>Span Length</td>
<td>Success, Operation Failed, Invalid Parameter, Op Code Not Supported</td>
<td>None</td>
</tr>
<tr>
<td>Request Span Length</td>
<td>C.10</td>
<td>None</td>
<td>Success</td>
<td>Span Length</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Operation Failed, Op Code Not Supported</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>C.11</td>
<td>None</td>
<td>Success</td>
<td>Raw Data</td>
</tr>
<tr>
<td>Procedure</td>
<td>Requirement</td>
<td>Parameter Description</td>
<td>Applicable Response Value</td>
<td>Response Parameter</td>
</tr>
<tr>
<td>------------------------------------------------</td>
<td>-------------</td>
<td>-----------------------</td>
<td>---------------------------------------------------------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>Start Offset Compensation</td>
<td></td>
<td></td>
<td>Operation Failed, Invalid Parameter, Op Code Not Supported</td>
<td>None</td>
</tr>
<tr>
<td>Mask Cycling Power Measurement Characteristic Content</td>
<td>C.12</td>
<td>Content Mask</td>
<td>Success, Operation Failed, Invalid Parameter, Op Code Not Supported</td>
<td>None</td>
</tr>
<tr>
<td>Request Sampling Rate</td>
<td>C.13</td>
<td>None</td>
<td>Success</td>
<td>Sampling Rate</td>
</tr>
<tr>
<td>Request Factory Calibration Date</td>
<td>C.14</td>
<td>None</td>
<td>Success, Factory Calibration Date</td>
<td>None</td>
</tr>
<tr>
<td>Start Enhanced Offset Compensation</td>
<td>C.15</td>
<td>None</td>
<td>Success, Operation Failed</td>
<td>See 3.4.2.16</td>
</tr>
</tbody>
</table>

**Table 3.4: Cycling Power Control Point Procedure Requirements**

C.1: Mandatory if Wheel Revolutions Data feature is supported, otherwise excluded from this version of this Service.

C.2: Mandatory if Multiple Sensor Locations feature is supported, otherwise excluded from this version of this Service.

C.3: Mandatory if the Crank Length Adjustment feature is supported, otherwise excluded from this version of this Service.

C.4: Mandatory if the Crank Length Adjustment feature is supported, otherwise optional.

C.5: Mandatory if the Chain Length Adjustment feature is supported, otherwise excluded from this version of this Service.

C.6: Mandatory if the Chain Length Adjustment feature is supported, otherwise optional.

C.7: Mandatory if the Chain Weight Adjustment feature is supported, otherwise excluded from this version of this Service.

C.8: Mandatory if the Chain Weight Adjustment feature is supported, otherwise optional.

C.9: Mandatory if the Span Length Adjustment feature is supported, otherwise excluded from this version of this Service.

C.10: Mandatory if the Span Length Adjustment feature is supported, otherwise optional.
C.11: Mandatory if the Offset Compensation feature is supported, otherwise excluded from this version of this Service.

C.12: Mandatory if the Cycling Power Measurement Characteristic Content Masking feature is supported, otherwise excluded from this version of this Service.

C.13: Mandatory if the Cycling Power Vector characteristic is supported, otherwise optional.

C.14: Mandatory if the Factory Calibration Date feature is supported, otherwise optional.

C.15: Mandatory if the Enhanced Offset Compensation feature is supported, otherwise excluded from this version of this Service.

### 3.4.2 Cycling Power Control Point Behavioral Description

The Cycling Power Control Point is used by a Client to control certain behaviors of the Server. Procedures are triggered by a Write to this characteristic value that includes an Op Code specifying the operation (see Table 3.4) which may be followed by a Parameter that is valid within the context of that Op Code.

#### 3.4.2.1 Set Cumulative Value Procedure

When the Set Cumulative Value Op Code is written to the Cycling Power Control Point and if the Wheel Revolution Data feature is supported by the Server, the Server shall set the Cumulative Wheel Revolutions value to the desired cumulative wheel revolution value transmitted as a Parameter of the Cycling Power Control Point. The format of the Parameter Value of this Control Point is UINT32 and represents the cumulative value in number of revolutions with a resolution of 1 revolution. The response shall be indicated when the Cumulative Wheel Revolutions value is applied using the Response Code Op Code, the Request Op Code along with “Success” or other appropriate Response Value.

If the operation results in an error condition, or if this Op Code is not supported by the Server, see Section 3.4.3 for details on handling this condition.

This procedure shall not be used to set the following values since they are not configurable.

- The Cumulative Crank Revolutions value of the Cycling Power Measurement characteristic or
- The Cumulative Crank Revolutions value of the Cycling Power Vector characteristic or
- The Accumulated Torque value or the Accumulated Energy of the Cycling Power Measurement characteristic.

This procedure should be used when the bicycle is not moving to avoid erroneous value of instantaneous speed, which may also impact other values calculated by the collector device (i.e., average speed, maximum speed).
### 3.4.2.2 Update Sensor Location Procedure

When the *Update Sensor Location* Op Code is written to the Cycling Power Control Point and if the Multiple Sensor Locations feature is supported by the Server, the Server shall update the value of the Sensor Location characteristic with the value of the desired sensor location transmitted as a Parameter Value of the Cycling Power Control Point. The format of the Parameter Value of this Control Point is UINT8 and represents the sensor location as defined in the Sensor Location characteristic [2]. For example, a parameter of 0x0D will set the sensor location to “Rear Hub”. The response shall be indicated when the sensor location is updated in the Server using the *Response Code* Op Code, the *Request* Op Code along with “Success” or other appropriate *Response Value*.

The Server should cache the most recent value of the Sensor Location characteristic to avoid reconfiguration of this characteristic by the Client each time a connection is established.

If the operation results in an error condition, or if this Op Code is not supported by the Server, see Section 3.4.3 for details on handling this condition.

This procedure should be used when the bicycle is not moving to avoid unexpected behavior.

### 3.4.2.3 Request Supported Sensor Locations Procedure

When the *Request Supported Sensor Locations* Op Code is written to the Cycling Power Control Point and if the Multiple Sensor Locations feature is supported by the Server, the Server shall send a list of the supported sensor location values (i.e., a byte array containing values of each supported sensor location). The response shall be indicated using the *Response Code* Op Code, the *Request* Op Code, the appropriate *Response Value* and, if the procedure succeeds, the *Response Value* shall be set to “Success” followed by a list of supported sensor location values in the Response Parameter. The format of the Response Parameter, in response to this Control Point, is a UINT8 array and represents the sensor locations the Server supports.

For LE Transport and a default ATT MTU, a maximum of 17 supported sensor locations can be sent.

If the operation results in an error condition, or if this Op Code is not supported by the Server, see Section 3.4.3 for details on handling this condition.

### 3.4.2.4 Set Crank Length Procedure

When the *Set Crank Length* Op Code is written to the Cycling Power Control Point and if the Crank Length Adjustment feature is supported by the Server, the Server shall store the desired crank length transmitted as a Parameter of the Cycling Power Control Point. The format of the Parameter Value of this Control Point is UINT16 and represents the crank length in millimeters with a resolution of 1/2 millimeter. The crank length value is typically used as a parameter for internal signal processing. The response shall be indicated when the Crank Length is updated in the Server using the *Response Code* Op Code, the *Request* Op Code along with “Success” or other appropriate *Response Value*. 

The Server should cache the most recent value of the crank length to avoid reconfiguration of this value by the Client each time a connection is established.

If the operation results in an error condition, or if this Op Code is not supported by the Server, see Section 3.4.3 for details on handling this condition.

This procedure should be used when the bicycle is not moving to avoid unexpected behavior (e.g., inconsistent instantaneous power value).

### 3.4.2.5 Request Crank Length Procedure

When the Request Crank Length Op Code is written to the Cycling Power Control Point and if the Crank Length Adjustment feature is supported by the Server, the Server shall send the current value of the crank length. The response shall be indicated using the Response Code Op Code, the Request Op Code, the appropriate Response Value and, if the procedure succeeds, the Response Value shall be set to “Success” followed by the value of the crank length in the Response Parameter. The format of the Response Parameter, in response to this Control Point, is UINT16 and represents the crank length in millimeters with a resolution of 1/2 millimeter.

If the operation results in an error condition, or if this Op Code is not supported by the Server, see Section 3.4.3 for details on handling this condition.

### 3.4.2.6 Set Chain Length Procedure

When the Set Chain Length Op Code is written to the Cycling Power Control Point and if the Chain Length Adjustment feature is supported by the Server, the Server shall store the desired chain length transmitted as a Parameter of the Cycling Power Control Point. The format of the Parameter Value of this Control Point is UINT16 and represents the chain length in millimeters with a resolution of 1 millimeter. The chain length value is typically used as a parameter for internal signal processing. The response shall be indicated when the Chain Length is updated in the Server using the Response Code Op Code, the Request Op Code along with “Success” or other appropriate Response Value.

The Server should cache the most recent value of the chain length to avoid reconfiguration of this value by the Client each time a connection is established.

If the operation results in an error condition, or if this Op Code is not supported by the Server, see Section 3.4.3 for details on handling this condition.

This procedure should be used when the bicycle is not moving to avoid unexpected behavior (e.g., inconsistent instantaneous power value).

### 3.4.2.7 Request Chain Length Procedure

When the Request Chain Length Op Code is written to the Cycling Power Control Point and if the Chain Length Adjustment feature is supported by the Server, the Server shall send the current value of the chain length. The response shall be indicated using the Response Code Op
Code, the Request Op Code, the appropriate Response Value and, if the procedure succeeds, the Response Value shall be set to “Success” followed by the value of the chain length in the Response Parameter. The format of the Response Parameter, in response to this Control Point is UINT16 and represents the chain length in millimeters with a resolution of 1 millimeter.

If the operation results in an error condition, or if this Op Code is not supported by the Server, see Section 3.4.3 for details on handling this condition.

3.4.2.8 Set Chain Weight Procedure

When the Set Chain Weight Op Code is written to the Cycling Power Control Point and if the Chain Weight Adjustment feature is supported by the Server, the Server shall store the desired chain weight transmitted as a Parameter of the Cycling Power Control Point. The format of the Parameter Value of this Control Point is UINT16 and represents the chain weight in grams with a resolution of 1 gram. The chain weight value is typically used as a parameter for internal signal processing. The response shall be indicated when the Chain Weight is updated in the Server using the Response Code Op Code, the Request Op Code along with “Success” or other appropriate Response Value.

The Server should cache the most recent value of the chain weight to avoid reconfiguration of this value by the Client each time a connection is established.

If the operation results in an error condition, or if this Op Code is not supported by the Server, see Section 3.4.3 for details on handling this condition.

This procedure should be used when the bicycle is not moving to avoid unexpected behavior (e.g., inconsistent instantaneous power value).

3.4.2.9 Request Chain Weight Procedure

When the Request Chain Weight Op Code is written to the Cycling Power Control Point and if the Chain Weight Adjustment feature is supported by the Server, the Server shall send the current value of the chain weight. The response shall be indicated using the Response Code Op Code, the Request Op Code, the appropriate Response Value and, if the procedure succeeds, the Response Value shall be set to “Success” followed by the value of the chain weight in the Response Parameter. The format of the Response Parameter, in response to this Control Point is UINT16 and represents the chain weight in grams with a resolution of 1 gram.

If the operation results in an error condition, or if this Op Code is not supported by the Server, see Section 3.4.3 for details on handling this condition.

3.4.2.10 Set Span Length Procedure

When the Set Span Length Op Code is written to the Cycling Power Control Point and if the Span Length Adjustment feature is supported by the Server, the Server shall store the desired span length transmitted as a Parameter of the Cycling Power Control Point. The format of the Parameter Value of this Control Point is UINT16 and represents the span length in millimeters.
with a resolution of 1 millimeter. The span length value is typically used as a parameter for internal signal processing. The response shall be indicated when the Span Length is updated in the Server using the Response Code Op Code, the Request Op Code along with “Success” or other appropriate Response Value.

The Server should cache the most recent value of the span length to avoid reconfiguration of this value by the Client each time a connection is established.

If the operation results in an error condition, or if this Op Code is not supported by the Server, see Section 3.4.3 for details on handling this condition.

This procedure should be used when the bicycle is not moving to avoid unexpected behavior (e.g., inconsistent instantaneous power value).

3.4.2.11 Request Span Length Procedure
When the Request Span Length Op Code is written to the Cycling Power Control Point and if the Span Length Adjustment feature is supported by the Server, the Server shall send the current value of the span length. The response shall be indicated using the Response Code Op Code, the Request Op Code, the appropriate Response Value and, if the procedure succeeds, the Response Value shall be set to “Success” followed by the value of the span length in the Response Parameter. The format of the Response Parameter, in response to this Control Point is UINT16 and represents the span length in millimeters with a resolution of 1 millimeter.

If the operation results in an error condition, or if this Op Code is not supported by the Server, see Section 3.4.3 for details on handling this condition.

3.4.2.12 Start Offset Compensation Procedure
When the Start Offset Compensation Op Code is written to the Cycling Power Control Point and if the Offset Compensation feature is supported by the Server, the Server shall initiate the offset compensation procedure. The response shall be indicated upon completion of the offset compensation procedure using the Response Code Op Code, the Request Op Code, the appropriate Response Value and, if the procedure succeeds, the Response Value shall be set to “Success” followed by the value of the force in Newton or the torque in 1/32 Newton meter based on the server capabilities (e.g., based on the Sensor Measurement Context bit of the Cycling Power Feature characteristic as described in Section 3.1) before the offset is compensated in the Response Parameter.

The format of the Response Parameter Value, in response to this Control Point, is SINT16. This Parameter Value represents either the raw force in Newton or the raw torque in 1/32 Newton meter based on the server capabilities (e.g., based on the Sensor Measurement Context of the Cycling Power Feature characteristic defined in 3.1). If the Server does not support the measurement of this value, the Server shall use the special value 0xFFFF which means “Not Available”.
If the operation results in an error condition, or if this Op Code is not supported by the Server, see Section 3.4.3 for details on handling this condition.

### 3.4.2.13 Mask Cycling Power Measurement Characteristic Content

When the Mask Cycling Power Measurement Characteristic Content Op Code is written to the Cycling Power Control Point and if the Cycling Power Measurement Characteristic Content Masking feature is supported by the Server, the Server shall disable unneeded optional fields of the Cycling Power Measurement characteristic based on the transmitted Parameter of the Cycling Power Control Point. The format of the Parameter Value of this Control Point is UINT16 and represents the fields of the Cycling Power Measurement characteristic to turn off as described in Table 3.5.

<table>
<thead>
<tr>
<th>Bit Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Pedal Power Balance</td>
</tr>
<tr>
<td></td>
<td>0: Leave as default</td>
</tr>
<tr>
<td></td>
<td>1: Turn off</td>
</tr>
<tr>
<td>1</td>
<td>Accumulated Torque</td>
</tr>
<tr>
<td></td>
<td>0: Leave as default</td>
</tr>
<tr>
<td></td>
<td>1: Turn off</td>
</tr>
<tr>
<td>2</td>
<td>Wheel Revolution Data</td>
</tr>
<tr>
<td></td>
<td>0: Leave as default</td>
</tr>
<tr>
<td></td>
<td>1: Turn off</td>
</tr>
<tr>
<td>3</td>
<td>Crank Revolution Data</td>
</tr>
<tr>
<td></td>
<td>0: Leave as default</td>
</tr>
<tr>
<td></td>
<td>1: Turn off</td>
</tr>
<tr>
<td>4</td>
<td>Extreme Magnitudes</td>
</tr>
<tr>
<td></td>
<td>0: Leave as default</td>
</tr>
<tr>
<td></td>
<td>1: Turn off</td>
</tr>
<tr>
<td>5</td>
<td>Extreme Angles</td>
</tr>
<tr>
<td></td>
<td>0: Leave as default</td>
</tr>
<tr>
<td></td>
<td>1: Turn off</td>
</tr>
<tr>
<td>6</td>
<td>Top Dead Spot Angle</td>
</tr>
<tr>
<td></td>
<td>0: Leave as default</td>
</tr>
<tr>
<td></td>
<td>1: Turn off</td>
</tr>
<tr>
<td>7</td>
<td>Bottom Dead Spot Angle</td>
</tr>
<tr>
<td></td>
<td>0: Leave as default</td>
</tr>
<tr>
<td></td>
<td>1: Turn off</td>
</tr>
<tr>
<td>8</td>
<td>Accumulated Energy</td>
</tr>
<tr>
<td></td>
<td>0: Leave as default</td>
</tr>
<tr>
<td></td>
<td>1: Turn off</td>
</tr>
<tr>
<td>9-15</td>
<td>Reserved for future use (RFU)</td>
</tr>
</tbody>
</table>
Table 3.5: Mask Cycling Power Measurement Characteristic Content Procedure Parameter Requirements

This Control Point is typically used to save power in the Server. When the Client does not need a particular optional field of the Cycling Power Measurement characteristic, the Client may turn off that particular field of the Cycling Power Measurement characteristic. This Control Point procedure affects the content of the notification of the Cycling Power Measurement characteristic and may also affect the content of the broadcast of the Cycling Power Measurement characteristic, but this is up to the Server since some data may not be relevant to broadcast. The response shall be indicated when the content of the Cycling Power Measurement characteristic is updated in the Server using the Response Code Op Code, the Request Op Code along with “Success” or other appropriate Response Value.

The Server shall not cache the most recent value of the fields configuration of the Cycling Power Measurement characteristic and each time a connection is established it shall use its default configuration (i.e., none of the fields of the Cycling Power Measurement characteristic are disabled).

If the operation results in an error condition, or if this Op Code is not supported by the Server, see Section 3.4.3 for details on handling this condition.

3.4.2.14 Request Sampling Rate Procedure
When the Request Sampling Rate Op Code is written to the Cycling Power Control Point and if the Cycling Power Vector characteristic is supported by the Server, the Server shall send the current value of the sampling rate. The response shall be indicated using the Response Code Op Code, the Request Op Code, and the appropriate Response Value and, if the procedure succeeds, the Response Value shall be set to “Success” followed by the value of the sampling rate in the Response Parameter. The format of the Response Parameter, in response to this Control Point, is UINT8 and represents the sampling rate in Hertz with a resolution of 1 Hertz.

If the operation results in an error condition, or if this Op Code is not supported by the Server, see Section 3.4.3 for details on handling this condition.

3.4.2.15 Request Factory Calibration Date Procedure
When the Request Factory Calibration Date Op Code is written to the Cycling Power Control Point and if the Factory Calibration Date feature is supported by the Server, the Server shall send the date of the factory calibration. The response shall be indicated using the Response Code Op Code, the Request Op Code, the appropriate Response Value and, if the procedure succeeds, the Response Value shall be set to “Success” followed by the value of the factory calibration date in the Response Parameter. The format of the Response Parameter value, in the response to this Control Point, is defined to use the same format as the Date Time characteristic defined in [2]. However, a value of 0 for the year, month or day fields shall not be used.
If the operation results in an error condition, or if this Op Code is not supported by the Server, see Section 3.4.3 for details on handling this condition.

### 3.4.2.16 Start Enhanced Offset Compensation Procedure

When the `Start Enhanced Offset Compensation` Op Code is written to the Cycling Power Control Point and if the Enhanced Offset Compensation feature is supported by the Server, the Server shall initiate the enhanced offset compensation procedure. The response shall be indicated upon completion of the offset compensation procedure using the `Response Code` Op Code, the `Request` Op Code, the appropriate Response Value and, if the procedure succeeds, the Response Value shall be set to “Success” followed by the value (UINT16) representing the force in Newton or the torque in 1/32 Newton meter based on the server capabilities (e.g., based on the Sensor Measurement Context bit of the Cycling Power Feature characteristic as described in Section 3.1) before the offset is compensated followed by a UINT16 value representing the manufacturer Company ID as given in the SIG assigned numbers, a UINT8 representing the number of octets of manufacturer specific data (e.g., Analog to Digital Conversion data), and the corresponding manufacturer specific data in the Response Parameter. A value of 0 for the length of the manufacturer specific data is possible if the Server has no additional data to send along with the response to this procedure.

If the operation results in an error condition (e.g., the operation failed because the Server is in an inappropriate position for calibration), the Server shall use the Operation Failed Response Value and shall also include the following Response Parameter in order to provide more information on the cause of the error. The Response Parameters are defined in Table 3.6.

<table>
<thead>
<tr>
<th>Response Parameter</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x00</td>
<td>Reserved for future use</td>
</tr>
<tr>
<td>0x01</td>
<td>Incorrect calibration position</td>
</tr>
<tr>
<td>0x02-0xFE</td>
<td>Reserved for future use</td>
</tr>
<tr>
<td>0xFF</td>
<td>Manufacturer specific error follows</td>
</tr>
</tbody>
</table>

**Table 3.6: Response Parameter for handling Start Offset Compensation Procedure Errors**

If the Response Parameter is 0xFF, the response shall contain manufacturer’s Company ID (UINT16) as defined in the Bluetooth SIG assigned numbers, a Length field (UINT8), and a variable length manufacturer specific value with matching length. A value of 0 for the length of the manufacturer specific data is possible if the Server has no additional data to send along with the response to this procedure.

If the operation results in any other error condition, or if this Op Code is not supported by the Server, see Section 3.4.3 for details on handling this condition.

### 3.4.3 General Error Handling procedures

Other than error handling procedures that are specific to certain Op Codes, the following apply:
If an Op Code is written to the Cycling Power Control Point characteristic that is unsupported by the Server, the Server, after sending a Write Response, shall indicate the Cycling Power Control Point with a Response Code Op Code, the Request Op Code and Response Value set to Op Code Not Supported.

If a Parameter is written to the Cycling Power Control Point characteristic that is invalid (e.g., the Client writes the Update Sensor Location Op Code with a sensor location that is not valid in the context of the Server, or out of the supported range of the Server), the Server, after sending a Write Response, shall indicate the Cycling Power Control Point with a Response Code Op Code, the Request Op Code and Response Value set to Invalid Parameter.

If an Op Code is written to the Cycling Power Control Point characteristic while the Server is performing a previously triggered Cycling Power Control Point operation (i.e., resulting from invalid Client behavior), the Server shall return an error response with the Attribute Protocol error code set to Procedure Already In Progress as defined in CSS Part B, Section 1.2 [3].

If an Op Code is written to the Cycling Power Control Point characteristic and the Client Characteristic Configuration descriptor of the Cycling Power Control Point is not configured for indications, the Server shall return an error response with the Attribute Protocol error code set to Client Characteristic Configuration Descriptor Improperly Configured as defined in CSS Part B, Section 1.2 [3].

3.4.4 Procedure Timeout

In the context of the Cycling Power Control Point characteristic, a procedure is started when a write to the Cycling Power Control Point characteristic is successfully completed (i.e., the Server sends a Write Response). When a procedure is complete, the Server shall indicate the Cycling Power Control Point with the Op Code set to Response Code.

In the context of the Cycling Power Control Point characteristic, a procedure is not considered started and not queued in the Server when a write to the Cycling Power Control Point results in an error response with the Attribute Protocol error code defined in CSS Part B, Section 1.2 [3].

3.5 Cycling Power Vector

The Cycling Power Vector characteristic is used to send raw data (either force or torque). Included in the characteristic value are a Flags field (for showing the presence of optional fields) and depending upon the contents of the Flags field, a Crank Revolution Data field (which includes a Cumulative Crank Revolutions field and Last Crank Event Time field), and a First Crank Measurement Angle field. The Cycling Power Vector also includes an Instantaneous Magnitude Array field.

The Server measures the force-related data (or torque-related data) the cyclist is producing and cadence-related data which represents the number of times per minute the cyclist turns the crank. The Instantaneous Magnitude values of the Instantaneous Magnitude Array field are
related to a crank revolution and because the cadence varies along with the time, the amount of Instantaneous Magnitude values per crank rotations also varies. The First Crank Measurement Angle shall be present when the Server detects the beginning of a new crank revolution. If a cyclist rotates the pedals at a cadence of 90 revolutions per minute and the sampling rate of Server is 25 Hertz, there should be 16 or 17 Instantaneous Magnitude values per crank revolution.

3.5.1 Characteristic Behavior

When the Cycling Power Vector characteristic is configured for notification via the Client Characteristic Configuration descriptor and a force-related measurement (or torque-related measurement) is available, this characteristic shall be notified. The Server should notify this characteristic at a regular interval while in a connection and is not configurable by the Client.

In typical applications, the Cycling Power Vector characteristic is notified approximately once per 100 or 300 milliseconds, depending on the sampling rate of the transmitted data. The transmission interval is typically related to the sampling rate at which the Server samples the data. The sampling rate referenced in this section is not necessarily the sampling rate at which the Server samples the raw signal, but it represents the sampling rate at which the Instantaneous Magnitude values present in the Cycling Power Vector characteristic are sampled since those data are typically down sampled from the raw signal.

The value of the sampling rate used to send the Cycling Power Vector data can be requested using the procedure described in Section 3.4.2.14.

When a Client writes 0x0001 to the Client Characteristic Configuration descriptor to start the notifications, the Server may request new connection parameters (e.g. using the GAP Connection Parameter Update procedure described in Volume 3 Part C Section 9.3.9 of [1]) before the notifications are sent if the current connection parameters do not allow the sending of notification (e.g., the Server requires faster connection interval). If the Client does not change the connection parameters within a period of time defined by the Server (e.g., 7 seconds or more if the current connection interval is set to 1 second), the Server shall return an ATT Error Response to the Write Request with an Error Code set to the Application Error Code 0x80 (Inappropriate Connection Parameters). Otherwise, the Server shall respond with a Write Response and start sending notifications of the Cycling Power Vector characteristic.

When a Client writes 0x0000 to the Client Characteristic Configuration descriptor to stop the notifications, the Server should send a request to the Client to set the connection parameters to the same values as before the Client started the notifications (e.g., using the GAP Connection Parameter Update procedure described in Volume 3 Part C Section 9.3.9 of [1]).

Refer to Section 3.7 for additional recommendations for distributed power sensor systems (e.g., one Server on each pedal measuring the left and right power contribution).
The Cycling Power Vector characteristic contains time-sensitive data, thus the requirements for time-sensitive data and data storage defined in Section 3.6 apply.

3.5.1.1 Flags Field
The Flags field shall be included in the Cycling Power Vector characteristic.

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

The bits of the Flags field, their function, and relationship to bits in the Cycling Power Feature characteristic are shown in Table 3.7.

<table>
<thead>
<tr>
<th>Flags Bit Name</th>
<th>When Set To</th>
<th>Otherwise</th>
<th>Corresponding Cycling Power Feature support bit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crank Revolution Data Present (bit 0), see 3.5.1.2</td>
<td>Corresponding field pair not present</td>
<td>Corresponding field pair present</td>
<td>Crank Revolution Data Supported (bit 3)</td>
</tr>
<tr>
<td>First Crank Measurement Angle Present (bit 1), see 3.5.1.3</td>
<td>Corresponding field not present</td>
<td>Corresponding field pair present</td>
<td>Extreme Angles Supported (bit 5)</td>
</tr>
<tr>
<td>Instantaneous Force Magnitude Array Present (bit 2), see 3.5.1.4</td>
<td>Corresponding field not present</td>
<td>Corresponding field present</td>
<td>Sensor Measurement Context set to Force-based (bit 16)</td>
</tr>
<tr>
<td>Instantaneous Torque Magnitude Array Present (bit 3), see 3.5.1.5</td>
<td>Corresponding field not present</td>
<td>Corresponding field present</td>
<td>Sensor Measurement Context set to Torque-based (bit 16)</td>
</tr>
<tr>
<td>Instantaneous Measurement Direction (bits 4-5), see 3.5.1.4 and 3.5.1.5</td>
<td>Unknown direction</td>
<td>See direction definitions in [2]</td>
<td>Instantaneous Measurement Direction Supported (bit 17)</td>
</tr>
</tbody>
</table>

Table 3.7: Bit Definitions for the Cycling Power Vector Characteristic

Each of the Flags bits in the table above may change during a connection if the corresponding support bit in the Cycling Power Feature characteristic is set to 1 indicating that the feature is supported. If the corresponding support bit is however set to 0, then the corresponding Flags bit shall also be set to 0 since the feature is not supported. See Table 3.3 for further information on the Cycling Power Feature characteristic support bits and static requirements.

3.5.1.2 Crank Revolution Data Field Pair
The Crank Revolution Data field pair (Cumulative Crank Revolutions and Last Crank Event Time fields), which represents the number of times a crank rotates, is used in combination with the Last Crank Event Time to enable the Client to:

1. Determine if the cyclist is coasting,
2. Calculate the instantaneous and average cadence and

3. Rebuild a measurement vector based on the Crank Revolution Data and the First Crank Measurement Angle value.

Average cadence is not accurate unless 0 cadence events (i.e., coasting) are subtracted. In addition, if there is link loss, the Cumulative Crank Revolutions value can be used to calculate the average cadence during the link loss. This value is intended to roll over and is not configurable.

The ‘crank event time’ is a free-running-count of 1/1024 second units and it represents the time when the crank revolution was detected by the crank rotation sensor. Since several crank events can occur between transmissions, only the Last Crank Event Time value is transmitted.

The Last Crank Event Time value rolls over every 64 seconds.

To enhance the user experience, the Server should ignore the extra crank revolutions that may be detected when the user is not pedaling (e.g., coasting down the hill) but the sensor is facing the magnet installed on the crankset and may cause unwanted crank revolution detections.

3.5.1.3 First Crank Measurement Angle Field

If the Server supports the Extreme Angles feature (see Table 3.7), this field shall be supported, but is not necessarily required in every packet.

This represents the angle of the first sample at the start of a measurement and is used by the Client in conjunction with the Instantaneous Magnitude values and the Sampling Rate to assemble a force (or torque) vector array to show a user the forces throughout a crank rotation. If there are more Instantaneous Magnitude values for a rotation than will fit within a single packet, then the next packet shall include the remaining values, however the First Crank Measurement Angle field shall not be present in the continuation packet.

3.5.1.4 Instantaneous Force Magnitude Array Field

If the Sensor Measurement Context bit of the Cycling Power Feature characteristic is set to 0 (Force-based), then this field shall be supported, but is not necessarily required in every packet (see Table 3.7). Otherwise, this field is excluded from this characteristic. The support of this field excludes the support of the Instantaneous Torque Magnitude Array field.

The Instantaneous Force Magnitude Array field is a variable length field and it may be included in the Cycling Power Vector characteristic. Included in this field are one or more Instantaneous Magnitude values which are expressed in Newtons with a resolution of 1 Newton. These values represent the raw data the sensor measures. The sampling rate at which these data are sampled can be requested using the Request Sampling Rate procedure defined in Section 3.4.2.14).
The Instantaneous Measurement Direction bits of the Flags field describe the direction of the Instantaneous Magnitude values the Server measures (e.g., Unknown, Tangential Component, Radial Component, or Lateral Component).

The number of values in the array is related to the sampling rate of the sensor and the notification interval.

For LE Transport, the following restrictions exist for a 23-octet ATT_MTU,

- The maximum number of Instantaneous Magnitude values that can be notified if Crank Revolution Data and First Crank Measurement Angle are present is 6.
- The maximum number of Instantaneous Magnitude values that can be notified if Crank Revolution Data is not present and First Crank Measurement Angle is present is 8.
- The maximum number of Instantaneous Magnitude values that can be notified if Crank Revolution Data is present and First Crank Measurement Angle is not present is 7.
- The maximum number of Instantaneous Magnitude values that can be notified if Crank Revolution Data and First Crank Measurement Angle are not present is 9.

If more Instantaneous Magnitude values are measured since the last notification than fit into one Cycling Power Vector characteristic, then the Instantaneous Magnitude values should be included in the next available Cycling Power Vector in a continuation packet as described in Section 3.5.1.3.

Since a Server supports only one measurement context (e.g., Force-based or Torque-based), the support of this field excludes the support of the Instantaneous Torque Magnitude Array field.

3.5.1.5 Instantaneous Torque Magnitude Array Field

If the Sensor Measurement Context bit of the Cycling Power Feature characteristic is set to 1 (Torque-based), then this field shall be supported, but it is not necessarily required in every packet (see Table 3.7). Otherwise, this field is excluded from this characteristic. The support of this field excludes the support of the Instantaneous Torque Magnitude Array field.

The Instantaneous Torque Magnitude Array field is a variable length field and it may be included in the Cycling Power Vector characteristic. Included in this field are one or more Instantaneous Magnitude values which are expressed in Newton meter with a resolution of 1/32 Newton meter. These values represent the raw data the sensor measures. The sampling rate at which these data are sampled can be requested using the Request Sampling Rate procedure defined in Section 3.4.2.14).

The Instantaneous Measurement Direction bits of the Flags field describe the direction of the Instantaneous Magnitude values the Server measures (e.g., Unknown, Tangential Component, Radial Component, or Lateral Component).
The number of values in the array is related to the sampling rate of the sensor and the notification interval.

For LE Transport, the following restrictions exist for a 23-octet ATT_MTU,

- The maximum number of Instantaneous Magnitude values that can be notified if Crank Revolution Data and First Crank Measurement Angle are present is 6.
- The maximum number of Instantaneous Magnitude values that can be notified if Crank Revolution Data is not present and First Crank Measurement Angle is present is 8.
- The maximum number of Instantaneous Magnitude values that can be notified if Crank Revolution Data is present and First Crank Measurement Angle is not present is 7.
- The maximum number of Instantaneous Magnitude values that can be notified if Crank Revolution Data and First Crank Measurement Angle are not present is 9.

If more Instantaneous Magnitude values are measured since the last notification than fit into one Cycling Power Vector characteristic, then the Instantaneous Magnitude values should be included in the next available Cycling Power Vector in a continuation packet as described in Section 3.5.1.3.

Since a Server supports only one measurement context (e.g., Force-based or Torque-based), the support of this field excludes the support of the Instantaneous Force Magnitude Array field.

### 3.6 Requirements for Time-Sensitive Data

The Cycling Power Measurement characteristic as well as the Cycling Power Vector characteristic contain time sensitive data and are considered time-sensitive characteristics, thus the following requirements apply:

Since this service does not provide any data with a time stamp to identify the measurement time (and age) of the data, the value of the Cycling Power Measurement characteristic or the value of the Cycling Power Vector characteristic shall be discarded if either the connection does not get established or if the notification is not successfully transmitted (e.g., due to link loss).

### 3.7 Requirements for Servers Used for a Distributed Power System

The Instantaneous Power field of the Cycling Power Measurement characteristic of each Server represents a part of the total power (e.g., what is measured). The Client can calculate the total power based on each of these values. The Sensor Location characteristic value shall not be used to indicate that a Sensor is part of a Distributed Power System. The Sensor shall indicate that it is configured as part of a distributed system via the Cycling Power Feature Characteristic.
4 SDP Interoperability

If this service is exposed over BR/EDR then it shall have the following SDP record.

<table>
<thead>
<tr>
<th>Item</th>
<th>Definition</th>
<th>Type</th>
<th>Value</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service Class ID List</td>
<td></td>
<td></td>
<td></td>
<td>M</td>
</tr>
<tr>
<td>Service Class #0</td>
<td>UUID «Cycling Power»</td>
<td>M</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protocol Descriptor List</td>
<td></td>
<td></td>
<td></td>
<td>M</td>
</tr>
<tr>
<td>Protocol #0</td>
<td>UUID L2CAP</td>
<td>M</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parameter #0 for Protocol #0</td>
<td>PSM PSM = ATT</td>
<td>M</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protocol #1</td>
<td>UUID ATT</td>
<td>M</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parameter #0 for Protocol #1</td>
<td>GATT Start Handle</td>
<td>M</td>
<td>First handle of this service in the GATT database</td>
<td></td>
</tr>
<tr>
<td>Parameter #1 for Protocol #1</td>
<td>GATT End Handle</td>
<td>M</td>
<td>Last handle of this service in the GATT database</td>
<td></td>
</tr>
<tr>
<td>BrowseGroupList</td>
<td></td>
<td>M</td>
<td>PublicBrowseRoot*</td>
<td></td>
</tr>
</tbody>
</table>

*PublicBrowseRoot shall be present; however, other browse UUIDs may also be included in the list.

Table 4.1: SDP Record
## 5 Acronyms and Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation or Acronym</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMP</td>
<td>Alternate MAC/PHY</td>
</tr>
<tr>
<td>BR/EDR</td>
<td>Basic Rate / Enhanced Data Rate</td>
</tr>
<tr>
<td>GAP</td>
<td>Generic Access Profile</td>
</tr>
<tr>
<td>GATT</td>
<td>Generic Attribute Profile</td>
</tr>
<tr>
<td>LE</td>
<td>Low Energy</td>
</tr>
<tr>
<td>RFU</td>
<td>Reserved for Future Use</td>
</tr>
<tr>
<td>SDP</td>
<td>Service Discovery Protocol</td>
</tr>
<tr>
<td>UUID</td>
<td>Universally Unique Identifier</td>
</tr>
</tbody>
</table>

*Table 5.1: Acronyms and Abbreviations*
6 References

[1] Bluetooth Core Specification v4.0 with CSA2, CSA3 and CSA4 or later version of the Core Specification.

[2] Characteristic and Descriptor descriptions are accessible via the Bluetooth SIG Assigned Numbers.

[3] Supplement to the Bluetooth Core Specification, Version 2 or later