



CORE SENSOR - Core Body Temperature Service Specification

Bluetooth® Low Energy (BLE) GATT Service Specification

V1.2

Revision Number	Date	Comments
V1.0	2021-10-01	Initial draft based on the Fitness Machine Service of Bluetooth® SIG
V1.1	2021-12-06	Extended CoreTemp Control point, added battery service as complementary service, fixed contradictory 'quality and state' bit assignment, fixed spelling mistakes.
V1.2	2022-02-02	Add missing UUID information for CoreTemp Control point, reformatting.

CORE is a venture of greenTEG AG.



Hofwisenstr. 50A
8153 Rümlang, Switzerland

T: +41 44 515 09 15

info@CoreBodyTemp.com
CoreBodyTemp.com

1 Introduction

1.1 Byte Transmission Order

All characteristics used with this service shall be transmitted with the least significant octet first (i.e., little endian).

2 Service Declaration

The Core Body Temperature Service shall be instantiated as a "Primary Service".

The service UUID shall be set to the custom UUID 00002100-5B1E-4347-B07C-97B514DAE121.

2.1 Byte Ordering

Where characteristics and descriptors are comprised of multiple bytes (shown in several tables within this document), the Least Significant Octet (LSO) is defined as the eight low-numbered bits (i.e., bits 0 to 7) of the topmost field in the tables. The Most Significant Octet (MSO) is defined as the high-numbered bits of the bottommost field in the tables.

3 Service Characteristics

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

Characteristic Name	Requirement	Mandatory Properties	Optional Properties	Security Permissions
Core Body Temperature	M	Read	Notify	None.
<i>Client Characteristic Configuration</i> descriptor	C.1	Read, Write		None.
CoreTemp Control Point	M	Write, Indicate		None
<i>Client Characteristic Configuration</i> descriptor	M	Read, Write		None.

C.1 Mandatory, if Notify is supported, otherwise excluded.

Table 1 Core Body Temperature Service characteristics.

3.1 Core Body Temperature

The Core Body Temperature characteristic is used to send a body temperature measurement. Included in the characteristic are a Flags field (for showing the units of the temperature and presence of optional fields), and, depending upon the contents of the Flags field, the temperature measurement value and the data quality of that temperature measurement.

LSO				MSO	
	Flags	Core Body Temperature	Skin Temperature (if present)	Core reserved (if present)	Quality and State (if present)
Octet Order	N/A	LSO...MSO	LSO...MSO	LSO...MSO	N/A
Data type	8bit	SINT16	SINT16	SINT16	8bit
Size	1 octet	2 Octets	2 octets	2 octets	1 octet
Units	None	0.01°C or 0.01°F ¹⁾	0.01°C or 0.01°F ¹⁾	None	None

¹⁾ Temperature unit is encoded in Flags field as defined in 3.1.1.1.

Table 2 Structure of the Core Body Temperature characteristic.

3.1.1 Characteristic Behavior

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

If a temperature measurement is available and a connection is not currently established, the Server shall become connectable to allow the Collector to create a link.

The UUID for this characteristic shall be set to UUID 00002101-5B1E-4347-B07C-97B514DAE121.

3.1.1.1 Flags field

The Flags field shall be included in the Core Body Temperature Characteristic. Reserved for Future Use (RFU) bits in the Flags field shall be set to 0.

The bits of the Flags are shown in Table 3.

Bit Number	Flags Bit Name	When set to 0	When set to 1
0	Skin Temperature	Corresponding field <i>not</i> present	Corresponding field present
1	Core Reserved	Corresponding field <i>not</i> present	Corresponding field present
2	Quality and State	Corresponding field <i>not</i> present	Corresponding field present
3	Temperature Unit	Unit of Temperature field is in °C	Unit of Temperature field is in °F
4-7	<i>Reserved for Future use</i>	<i>shall be set to 0</i>	-

Table 3 Bit definitions of the Flags field for the Core Body Temperature Characteristic.

3.1.1.2 Core Body Temperature field

The Core Body Temperature field is mandatory for the Core Body Temperature characteristic. It represents the current core body temperature. If there is currently no valid reading available, the server shall send the special value 0x7FFF (i. e., decimal value of 32767 in SINT 16 format), which means 'Data not available'. The information encoded in the Quality and State field (3.1.1.5) may give further indications why no data is available currently.

3.1.1.3 Skin Temperature field

The presence of the Skin Temperature field is indicated by the corresponding bit in the flag field. It represents the current skin temperature, which may be measured along the core body temperature by a device implementing the Core Body Temperature Service.

3.1.1.4 Core Reserved field

The presence of the Core Reserved field is indicated by the corresponding bit in the flag field.

3.1.1.5 Quality and State field

The presence of the Quality and State field is indicated by the corresponding bit in the flag field. It may be used to indicate the quality or trust level of the current measurement values (bit 0-3).

Bit Number	Description	Value
0-3	Data Quality	Bit 2-0: Bits set to 000 – Invalid Bits set to 001 – Poor Bits set to 010 – Fair Bits set to 011 – Good Bits set to 100 – excellent Bits set to 111 – N/A (<i>Data Quality is not available</i>) Bit 3 – <i>reserved, shall be set to 0</i>
4-7	State	Bit 5-4: Bit set to 00 – Pairing with heart rate not supported Bit set to 01 – Heart rate supported, not receiving Heart Rate signal Bit set to 10 – Heart rate supported, receiving Heart Rate signal Bit set to 11 – N/A (<i>State of HRM is not available</i>) Bits 7-6 – <i>reserved, shall be set to 0</i>

Table 4 Bit Definitions for the optional Quality and State field of the Core Body Temperature Characteristic

3.2 CoreTemp Control Point

A core body temperature sensor may expose the CoreTemp Control Point. For example, if it can pair with a heart-rate monitor (HRM), the Client can write the ID of the HRM to the device. If the core body temperature device supports pairing with a heart rate monitor, it will then implement a procedure to attempt to connect to the heart rate monitor after processing this command.

The format of the CoreTemp Control Point characteristic is defined in Table 5. The Op Codes, Parameters and requirements for the Core Control Point are defined in Section 3.2.1 below.

	LSO	MSO
	OpCode	Parameter Value
Octet Order	N/A	LSO...MSO
Data type	UINT8	Variable
Size	1 octet	0 to 6 Octets
Units	None	None

Table 5 CoreTemp Control Point characteristic

3.2.1 Characteristic Behavior

The UUID for this characteristic shall be set to UUID 00002102-5B1E-4347-B07C-97B514DAE121.

The *Client Characteristic Configuration* descriptor shall be configured for indication for the CoreTemp Control Point characteristic to indicate the result of a control procedure back to the client. The procedures are further explained in the sections below.

3.2.1.1 CoreTemp Control Point Procedures

A client shall use the *GATT Write Characteristic Value* sub-procedure to initiate a sub-procedure defined in Table 6. A special OpCode (0x80) will be used by the Peripheral to indicate the result of a sub-procedure back to the Client.

If the operation results in an error condition where the CoreTemp Control Point cannot be indicated, the error handling as defined in CSS Part B [1] applies. The two cases of interest are described in the next paragraphs.

If an Op Code is written to the CoreTemp Control Point characteristic while the Server is performing a previously triggered CoreTemp 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.

If an Op Code is written to the CoreTemp Control Point characteristic and the Client Characteristic Configuration descriptor of the CoreTemp 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.

OpCode	Requirement	Definition	Parameter Value
0x00		<i>Reserved for future use (RFU)</i>	
0x01	M	Clear list of paired heart rate monitors	N/A
0x02	C.1	Add ANT+ heart rate monitor to list of paired devices	The 2 least significant bytes (LSB) of the Heart Rate Monitor ID. Use 3 Bytes for 20bit ANT ID, set 4 MSBs to 0. <div style="display: flex; align-items: center;"> <div style="margin-right: 10px;">16bit ANT ID</div> <div style="border: 1px solid black; padding: 2px; text-align: center;"> <div style="display: flex; justify-content: space-between; font-size: 0.8em;"> LS0MS0 </div> <div style="border-top: 1px solid black; height: 10px; width: 100%;"></div> <div style="text-align: center; font-size: 0.8em;">2 Bytes</div> </div> </div> <div style="display: flex; align-items: center; margin-top: 5px;"> <div style="margin-right: 10px;">20bit ANT ID</div> <div style="border: 1px solid black; padding: 2px; text-align: center;"> <div style="display: flex; justify-content: space-between; font-size: 0.8em;"> LS0MS0 </div> <div style="border-top: 1px solid black; height: 10px; width: 100%;"></div> <div style="display: flex; justify-content: space-between; font-size: 0.8em;"> 2.5 Bytes0x0 </div> </div> </div>
0x03	C.1	Remove ANT+ heart rate monitor from list of paired devices	The 2 least significant bytes (LSB) of the Heart Rate Monitor ID. Use 3 Bytes for 20bit ANT ID, set 4 MSBs to 0. <div style="display: flex; align-items: center;"> <div style="margin-right: 10px;">16bit ANT ID</div> <div style="border: 1px solid black; padding: 2px; text-align: center;"> <div style="display: flex; justify-content: space-between; font-size: 0.8em;"> LS0MS0 </div> <div style="border-top: 1px solid black; height: 10px; width: 100%;"></div> <div style="text-align: center; font-size: 0.8em;">2 Bytes</div> </div> </div> <div style="display: flex; align-items: center; margin-top: 5px;"> <div style="margin-right: 10px;">20bit ANT ID</div> <div style="border: 1px solid black; padding: 2px; text-align: center;"> <div style="display: flex; justify-content: space-between; font-size: 0.8em;"> LS0MS0 </div> <div style="border-top: 1px solid black; height: 10px; width: 100%;"></div> <div style="display: flex; justify-content: space-between; font-size: 0.8em;"> 2.5 Bytes0x0 </div> </div> </div>
0x04	C.1	Get total number of paired ANT+ heart rate monitors	N/A
0x05	C.1	Get ID of ANT+ heart rate monitor at index i.	Index i, in range(0, total number of ANT+ HRMs). Details for the response parameter, see 3.2.1.2.
0x06	C.2	Add BLE heart rate monitor to list of paired devices	The full Bluetooth Address (6 bytes) of the heart Rate Monitor. <div style="display: flex; align-items: center;"> <div style="margin-right: 10px;"></div> <div style="border: 1px solid black; padding: 2px; text-align: center;"> <div style="display: flex; justify-content: space-between; font-size: 0.8em;"> LS0MS0 </div> <div style="border-top: 1px solid black; height: 10px; width: 100%;"></div> <div style="text-align: center; font-size: 0.8em;">6 Bytes</div> </div> </div>
0x07	C.2	Remove BLE heart rate monitor from list of paired devices	The full Bluetooth Address (6 bytes) of the heart Rate Monitor. <div style="display: flex; align-items: center;"> <div style="margin-right: 10px;"></div> <div style="border: 1px solid black; padding: 2px; text-align: center;"> <div style="display: flex; justify-content: space-between; font-size: 0.8em;"> LS0MS0 </div> <div style="border-top: 1px solid black; height: 10px; width: 100%;"></div> <div style="text-align: center; font-size: 0.8em;">6 Bytes</div> </div> </div>
0x08	C.2	Get Total number of paired BLE heart rate monitors	N/A
0x09	C.2	Get ID of BLE heart rate monitor at index i	Index i in range(0, total number of BLE HRMs). Details for the response parameter, see 3.2.1.3
0x0A	C.1	Scan for available ANT+ heart rate monitors and read list of found heart rate monitors.	Details for the request and response parameter, see 3.2.1.4.
0x0B	C.2	Scan for available BLE heart rate monitors and read list of found heart rate monitors.	Details for the request and response parameter, see 3.2.1.5.
0x0C-0x7F		<i>Reserved for future use (RFU)</i>	
0x80	M	Used to identify the response to this Control Point.	Response Code, see section 3.2.1.2
0x81-0xFF		<i>Reserved for future use (RFU)</i>	

C.1: If the core body temperature sensor supports pairing ANT+ Heart Rate Monitors.

C.2: If the core body temperature sensor supports pairing BLE Heart Rate Monitors.

Table 6 CoreTemp Control Point Procedure description.

3.2.1.2 Control Point ANT+ HRM Id Procedure (Op Code 0x05)

When the 'get ID of ANT+ heart rate monitor' procedure is written to the CoreTemp Control Point and the Result Code is 'Success', i. e. the heart rate monitor at index 'i' is present, the Server shall include the id of the heart rate monitor and the state in the response parameter as stated in Table 7 below.

	LSO	MSO
	ANT id	State
Octet Order	LSO...MSO	N/A
Data type	Variable	N/A
Size	2 Octets	1 Octet
Details	The 2 least significant bytes (LSB) of the Heart Rate Monitor ID. Use 3 Bytes for 20bit ANT ID, set 4 MSBs to 0.	Bit 0-3: Most Significant Nibble(MSN) of 20-bit device ID (0 if 16-bit IDs are used) Bit 4-5: Bit set to 00 – HRM state is “Closed” Bit set to 01 – HRM state is “Searching” Bit set to 10 – HRM state is “Synchronized” Bit set to 11 – HRM state is “Reserved” Bit 6-7 Reserved for future use (RFU), set to 0
	<div> <div>LSO</div> <div>MSO</div> <div> <div>Byte 1</div> <div>Byte 2</div> <div>Byte 3</div> </div> <div> <div>ANT ID</div> <div>ANT ID</div> <div>(MSN of 20bit ID)</div> <div>0x(State)</div> </div> </div>	

Table 7 Result Parameter for Result of OpCode 0x05 (id of ANT+ HRM at index).

3.2.1.3 Control Point BLE HRM Id Procedure (Op Code 0x09)

When the ‘get ID of ANT+ heart rate monitor’ procedure is written to the CoreTemp Control Point and the Result Code is ‘Success’, i. e. the heart rate monitor at index ‘i’ is present, the Server shall include the id of the heart rate monitor and the state in the response parameter as stated in Table 8 below.

	LSO	MSO
	BLE id	State
Octet Order	LSO...MSO	N/A
Data type	Variable	N/A
Size	6 Octets	1 Octet
Details	The full Bluetooth Address (6 bytes) of the heart Rate Monitor. <div> <div>LSO</div> <div>MSO</div> <div>6 Bytes</div> </div>	Bit 0-1: Bit set to 00 – HRM state is “disconnected” Bit set to 01 – HRM state is “Connecting” Bit set to 10 – HRM state is “Connected” Bit set to 11 – HRM state is “Disconnecting”

Table 8 Result Parameter for result of OpCode 0x09 (id of BLE HRM at index).

3.2.1.4 Control Point ANT+ HRM Scan Procedure (OpCode 0x0A)

When the ‘Scan for available ANT+ heart rate monitors’ procedure is written to the CoreTemp Control Point, the Server shall perform the respective procedure as stated below in Table 9, depending on the request parameters.

After the ‘Scan for available ANT+ heart rate monitors’-procedure is finished, the ‘CoreTemp Control Point Complete’-procedure (defined in 3.2.1.6) shall be indicated by the server using the response parameter defined in Table 10. The delay between writing the OpCode 0x0A to the server and the indication of the result may be several seconds, depending on the duration of the scan. Any command written to the CoreTemp Control Point during the scan time may be silently ignored.

OpCode	Request Parameter	Definition of the procedure
0x0A	0xFF	Start scan for ANT+ HRMs on the peripheral. This shall invalidate the old / cached list from a previous scan. <i>The response parameter shall contain the HRM at index 0.</i>
0x0A	0xFE	Start scan and do proximity pairing, i. e. automatically add the HRM with the best signal strength to the list of paired devices. This shall also invalidate the old / cached list from a previous scan and only save the id of the HRM with the best signal strength in the list of scanned devices. Note: command will fail with 'operation failed' if no HRM could be found during the scan or if the list of paired HRMs is full.
0x0A	0x00...0xFD	Return id of HRM at index i in range(0, total number of ANT+ HRMs in the list of found HRMs.). Note: command will fail with 'invalid parameter' if the Request Parameter exceeds this range.

Table 9 Request parameter for OpCode 0x0A (scan for list of available ANT+ HRMs).

LSO			MSO
	Number of devices found	Index	Device id
Octet Order	N/A	N/A	LSO...MSO
Data type	UINT8	UINT8	N/A
Size	1 Octet	1 Octet	3 Octets
Details	Number of ANT+ HRMs in the list.	Index i or 0 if no HRM was found.	ANT+ id of HRM at index i in the list of devices that were found during the scan. 16bit ANT+ id: <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;"> LSO MSO <div style="border: 1px solid black; padding: 2px; display: inline-block;">1 byte</div> <div style="border: 1px solid black; padding: 2px; display: inline-block;">1 byte</div> <div style="border: 1px solid black; padding: 2px; display: inline-block;">0x00</div> </div> <div style="text-align: center;"> LSO MSO <div style="border: 1px solid black; padding: 2px; display: inline-block;">1 byte</div> <div style="border: 1px solid black; padding: 2px; display: inline-block;">1 byte</div> <div style="border: 1px solid black; padding: 2px; display: inline-block;">0x(MSN)0</div> </div> </div> <div style="display: flex; justify-content: space-around; margin-top: 5px;"> 16bit id 20bit id </div> or (0x00)-(0x00)-(0x00) if no HRM was found

Table 10 Response parameter for OpCode 0x0A.

3.2.1.5 Control Point BLE HRM Scan Procedure (OpCode 0x0B)

When the 'Scan for available BLE heart rate monitors' procedure is written to the CoreTemp Control Point, the Server shall perform the respective procedure as stated below in Table 11, depending on the request parameters.

After the 'Scan for available BLE heart rate monitors'-procedure is finished, the 'CoreTemp Control Point Complete'-procedure (defined in 3.2.1.6) shall be indicated by the server using the response parameter defined in Table 12. The delay between writing the OpCode 0x0B to the server and the indication of the result may be several seconds, depending on the duration of the scan. Any command written to the CoreTemp Control Point during the scan time may be silently ignored.

OpCode	Request Parameter	Definition of the procedure
0x0A	0xFF	Start scan for BLE HRMs on the peripheral. This shall invalidate the old / cached list from a previous scan. <i>The response parameter shall contain the HRM at index 0.</i>
0x0A	0xFE	Start scan and do proximity pairing, i. e. automatically add the HRM with the best signal strength to the list of paired devices. This shall also invalidate the old / cached list from a previous scan and only save the id of the HRM with the best signal strength in the list of scanned devices. Note: command will fail with 'operation failed' if no HRM could be found during the scan or if the list of paired HRMs is full.
0x0A	0x00...0xFD	Return id of HRM at index i in range(0, total number of BLE HRMs in the list of found HRMs.). Note: command will fail with 'invalid parameter' if the Request Parameter exceeds this range.

Table 11 Request parameter for OpCode 0x0B (scan for list of available BLE HRMs).

LSO			MSO
	Number of devices found	Index	Device id
Octet Order	N/A	N/A	LSO...MSO
Data type	UINT8	UINT8	N/A
Size	1 Octet	1 Octet	6 Octets
Details	Number of ANT+ HRMs in the list.	Index i or 0 if no HRM was found.	BLE id of HRM at index i in the list of devices that were found during the scan. or (0x00)-(0x00)-(0x00)-(0x00)-(0x00)-(0x00) if no HRM was found

Table 12 Response parameter for OpCode 0x0B.

3.2.1.6 CoreTemp Control Point Procedure Complete

When any of the procedures described in 3.2.1 have been executed by the server or if the procedure generated an error as defined below in this section, the server shall indicate the Core Control Point characteristic to the client. The format of the indication is defined in Table 13. The Client should implement appropriate logic to not send another command until the result of the last command has not been indicated.

LSO			MSO	
	Response OpCode (0x80)	Parameter Value		
		Request OpCode	Result Code	Response Parameter (if present)
Octet Order	N/A	N/A	N/A	LSO...MSO
Data type	UINT8	UINT8	UINT8	various
Size	1 octet	1 octet	1 octet	0 to 17 ¹ octets

Table 13 Format of the response indication for the Core Control Point characteristic.

Table 14 defines the result code for the Core Control Point characteristic.

¹ This is because the characteristic response should fit in a PDU smaller or equal MTU size (20 Bytes)

Result Code	Definition	Request Op Code	Response Parameter
0x00	<i>Reserved for future use (RFU)</i>	N/A	N/A
0x01	Success	All Op Codes defined in Table 6	various
0x02	Op Code not supported	All codes defined in Table 6 as reserved for future use, or all Op Codes that are not supported by the server.	None
0x03	Invalid Parameter	All Op Codes defined in Table 6	None
0x04	Operation Failed	All Op codes defined in Table 6	None

Table 14 Result Codes for Core Control Point characteristic.

If an Op Code is written to the CoreTemp Control Point that results in a successful operation, the Server shall indicate the CoreTemp Control Point with the Response Code Op Code, the Request Op Code, and the Result Code set to "Success".

If the 'add HRM' Op Code is written to the CoreTemp Control Point that results in an error condition (e.g., the peripheral's buffer for HRM's is already full), the Server, after sending a Write Response, shall indicate the CoreTemp Control Point with the Response Code Op Code, the Request Op Code, and the Result Code set to "Operation Failed".

If an Op Code is written to the CoreTemp Control Point characteristic that is unsupported by the Server (e.g., an Op Code that is Reserved for Future Use), the Server, after sending a Write Response, shall indicate the CoreTemp Control Point with a Response Code Op Code, the Request Op Code, and Result Code set to "Op Code Not Supported".

If a Parameter is written to the CoreTemp Control Point characteristic that is invalid (e.g., the Client writes the 'Get ID of HRM at index I' Op Code with an index that is out of range) the Server, after sending a Write Response, shall indicate the CoreTemp Control Point with a Response Code Op Code, the Request Op Code, and Result Code set to "Invalid Parameter".

If the operation results in an error condition that cannot be reported to the Client using the CoreTemp Control Point (e.g., the CoreTemp Control Point cannot be indicated), see Section 3.2.1.1 for details on handling this condition.

4 Glossary

Term	Requirement
BLE	Bluetooth Low Energy
LSO	Least significant octet
HRM	Heart Rate Monitor
MSO	Most significant octet
RFU	Reserved for future use.
UUID	Universally Unique Identifier
Server	<i>Also: The Peripheral. In the context of this Specification: The CoreTemp device that sends data to the Client.</i>
Client	<i>Also: The Central. In the context of this Specification: The display device such as mobile phone app or a smartwatch.</i>

5 References

[1] Supplement to the Bluetooth Core Specification, v10 or later

Appendix A: Complementary Services

1. Health Thermometer Service

The core body temperature sensor may optionally implement the health thermometer service (16bit UUID: 0x1809) to make the temperature readings available for clients adopting only the standardized BLE service.

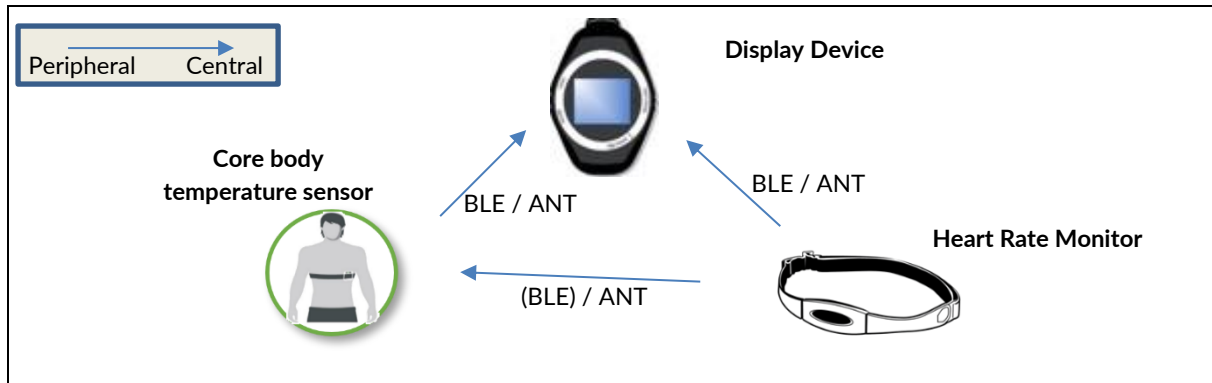
2. Device Information Service

The core body temperature sensor may optionally implement the Device Information service (16bit UUID: 0x180A) to be compliant with the Health Thermometer Profile.

3. Battery Service

The core body temperature sensor may optionally implement the battery service (16bit UUID: 0x180F) as a complementary service.

Appendix B: Scenarios Heart Rate Pairing



Scenario 1	<p>Display device wants to get a list of the paired HRMs</p> <ul style="list-style-type: none"> • Display device sends OpCode 0x04 to get total number of paired HRMs • Then, it sends OpCode 0x05 with payload index i, for all i in range(0, total number of HRMs) • From the response to this command, the Display Device can tell which HRMs are paired with the core body temperature sensor and whether they are currently connected to the core body temperature sensor.
Scenario 2	<p>Assume the Peripheral Phone app wants to change the list of Heart Rate Monitors the Peripheral should listen to = try to establish a connection to receive a heart rate signal</p> <ul style="list-style-type: none"> • Central will get the list of currently "paired" heart rate monitors = list of HRM devices as described in <i>Scenario 1</i>. • Central will then send command to add / remove / remove all HRM devices from the Peripheral. • Note: Peripheral will then attempt to connect to one of the HRMs, cycling through the list.