ANT+ Device Profile

Heart Rate

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Revision History

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1.0	Feb 14, 2006	Creation of document
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1.4	Nov 27, 2006	Added future page note
1.5	Jan 15, 2007	Added measurement count value to data packet
1.6	Oct 2, 2007	Clarified page identification
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1.10	May 2, 2008	Official Customer release
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1.13	Jan 28, 2011	Edited 'Copyright Information and Usage Notice'
2.0	Feb 23, 2016	Added data pages 5, 6, 7, 70, 76 Added manufacturer specific page range Added Minimum requirements section
2.1	Nov 11, 2016	Added verification tests, requirement markers Added 'Using This Document' section

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1   Overview of ANT+

The ANT+ Managed Network is comprised of a group of devices that use the ANT radio protocol and ANT+ Device Profiles to determine and standardize wireless communication between individual devices. This management of device communication characteristics provides interoperability between devices in the ANT+ network.

Developed specifically for ultra low power applications, the ANT radio protocol provides an optimal balance of RF performance, data throughput and power consumption.

ANT+ Device Profiles have been developed for devices used in personal area networks and can include, but are not limited to, devices that are used in sport, fitness, wellness, and health applications. Wirelessly transferred data that adheres to a given device profile will have the ability to interoperate with different devices from different manufacturers that also adhere to the same standard. Within each device profile, a minimum standard of compliance is defined. Each device adhering to the ANT+ Device Profiles must achieve this minimum standard to ensure interoperability with other devices.
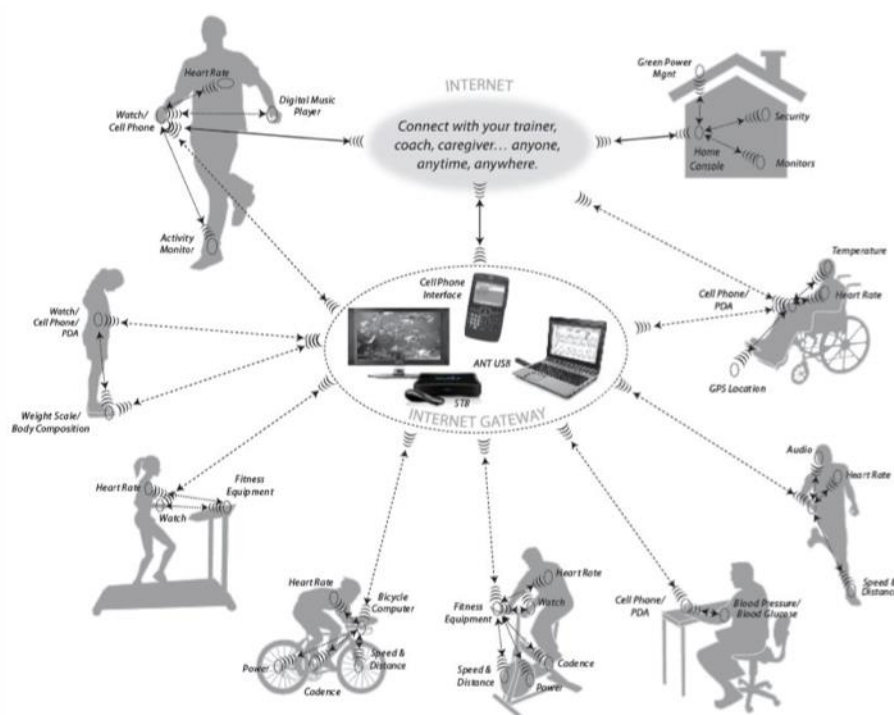
Figure 1-1. ANT+ Device Ecosystem

This document details the wireless communication between devices adhering to this ANT+ Device Profile. The typical use case of the device(s), wireless channel configuration, data format(s), minimum compliance for interoperability, and implementation guidelines are also detailed.

IMPORTANT:

If you have received this document you have agreed to the terms and conditions of the Adopter's Agreement and have downloaded the ANT+ Managed network key. By accepting the Adopter's Agreement and receiving the ANT+ device profiles you agree to:

- **Implement and test your product to this specification in its entirety**

- **To implement only ANT+ defined messages on the ANT+ managed network**

2   Related Documents

Refer to current versions of the listed documents. To ensure you are using the current versions, check the ANT+ website at www.thisisant.com or contact your ANT+ representative.

1. ANT Message Protocol and Usage

2. ANT+ Common Data Pages

3. ANT+ Fitness Equipment Device Profile

4. SimulANT+ User Guide

5. SimulANT+ Profile Verification Suite User Guide

3   Using This Document

This profile document defines the requirements, recommendations, best practices, and allowances for certified ANT+ products. As a developer, use the document to identify requirements that need to be met to make your product ANT+ compliant. Use the SimulANT+ Profile Verification Suite with the certification requirement markers (Figure 3-1) in this document to test that requirements are met before submitting your product for ANT+ certification.

**Figure 3-1. ANT+ Certification
Requirement Marker**

Each requirement in the profile is marked with a test number in bold square brackets **[XX_XXXX]**. Profile verification tests for master (sensor) devices are prefixed with '**MD_**' whereas slave (display) devices are marked as '**SD_**'. As you run the tests on SimulANT+, you can check back to the requirements in this document to understand and fix test failures. Section 10 outlines the tests that you can run using SimulANT+ to verify your product's ANT+ compliance, and points to the sections in the document that explain the individual requirements covered in each test. Requirements marked as **[self-verify]** do not have a related SimulANT+ Profile Verification Test and must be verified manually.

4   Overview of Heart Rate Monitor Use Case

ANT+ heart rate monitors are primarily used to measure the user's heart rate (beats per minute – bpm) during a given activity in real-time. Heart rate monitors are typically body worn sensors that utilize a variety of technologies to measure the heart rate of the user. The duration of activity for measuring the user's heart rate varies greatly as does the type of activities a heart rate monitor can be used for.

Heart rate monitors are becoming increasingly popular for training purposes and monitoring the user's activity when competing in events. Events such as a triathlon requires the heart rate monitor to behave differently based on what stage of the race the user is in. Swimming is a unique activity in that the heart rate monitor is often underwater thus preventing wireless communication with the display device. For the best user experience the heart rate monitor can store heart rate data when submerged in water and transfer that saved data at a later time. Training in a pool often involves the swimmer resting at specific intervals. Should the user stand up during their rest, the heart rate monitor is no longer in the water so the user can view their display device for useful heart rate statistics such as average/max heart rates for that interval they just completed.

4.1   ANT+ Heart Rate Monitor

An ANT+ heart rate monitor (HRM) broadcasts the user's heart rate to an ANT+ compatible receiver. The heart rate monitor may also transmit other data in addition to the user's heart rate that provides more detailed information about the user's heart rate, as well as data about the heart rate monitor's make and model.

Most heart rate monitors are worn around the chest and transmit heart rate data to watches or other display devices. However other types of monitors such as finger sensors, earlobe sensors, wrist sensors, or the hand contact sensors on fitness machines may also use this device profile to transmit heart rate data.

Note that many heart rate monitors sleep when they are not in use to conserve power, and only transmit data when worn by the user.

4.2   ANT+ Heart Rate Display Device

Most ANT+ heart rate display devices are personal display devices that are worn or placed close the user. These displays show the user's heart rate as received from the heart rate monitor in real-time and they may also store this data for later download and analysis. These displays are usually watches, cell phones, bike computers, PDAs, etc.

ANT+ personal display devices are typically meant to be used with a single heart rate monitor at a time and record and display only a single user's heart rate information. Display devices define a user interaction that allows the device to pair with new heart rate monitors. See section 5 for more details on pairing heart rate monitors to display devices.

4.3   Wireless Network Topology

The ANT+ heart rate monitor is designed to work as a broadcast sensor. This type of sensor reduces network complexity, simplifies the user interaction with the device, and reduces the battery requirements.

A broadcast sensor utilizes a one-to-many network topology. This allows multiple display devices to potentially receive heart rate data from the same heart rate monitor. To accomplish this each display device must be configured to receive from the heart rate monitor. Refer to section 5 for details on channel configurations of ANT+ heart rate monitors and display devices.

4.4   Messages Transmitted from an ANT+ Heart Rate Monitor

It is important to note that all of the ANT+ heart rate monitor's data pages, both main data pages and background data pages; transmit the user's current heart rate, current heart beat count, and the most recent heart beat event time. This message format ensures that the most recent critical heart rate information is sent with every message. This format also ensures that new heart rate monitors and receivers are backwards compatible with existing ANT+ heart rate monitors and receivers, which adhere to older versions of the ANT+ specifications.

A heart rate monitor must transmit data page 0, or data page 4, as the main data page. Main data pages are sent at a rate of approximately 4 Hz. The choice of main data page and how often each main data page is sent are selected by the manufacturer, though there are some limitations as described in section 6.2.1. Refer to section 6.6 for a more detailed description of main data pages.

There are five background data pages that the heart rate monitor can transmit. Two of these pages are manufacturer information and are required to be sent by each heart rate monitor. A background page is sent every 65th message. A further discussion of background data pages is found in sections 6.2.2 and 6.5.

Figure 4-1 shows the different main data pages and background data pages that can be sent from the heart rate monitor.
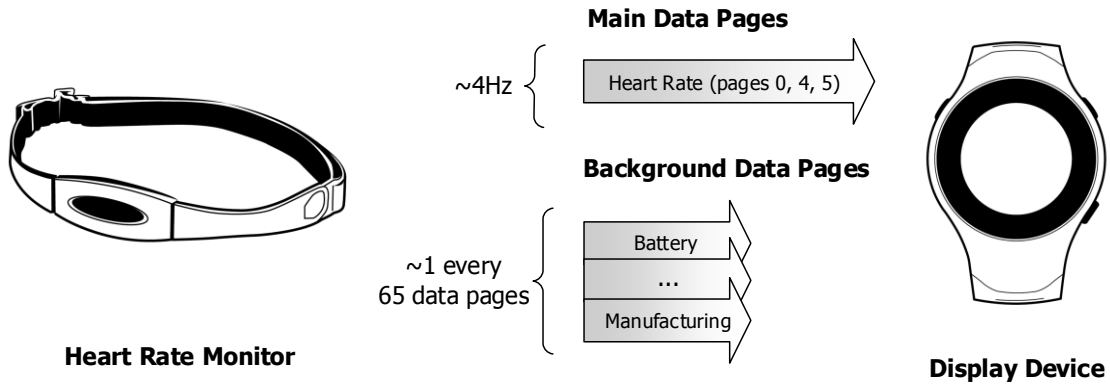
Figure 4-1. ANT+ Heart Rate Use Case and Message Timing

5   Channel Configuration

The channel configuration parameters of the ANT+ heart rate monitor and all other ANT-enabled devices are defined by the ANT protocol. Refer to the ANT Message Protocol and Usage document for more details.

5.1   Slave Channel Configuration

The device expected to receive data from an ANT+ heart rate monitor **shall [SD_0001]** configure an ANT channel with its channel parameters set as listed in Table 5-1.

Table 5-1. ANT Channel Configuration for an ANT+ Heart Rate Display (i.e. Slave)

Parameter	Value	Comment
Channel Type	Slave (0x00)	The ANT+ heart rate monitor is a master device; therefore, the display device must be configured as the slave. Bidirectional communication is required.
Network Key	ANT+ Managed Network Key	The ANT+ Managed Network Key is governed by the ANT+ Managed Network licensing agreement.
RF Channel Frequency	57 (0x39)	RF Channel 57 (2457MHz) is used for the ANT+ heart rate monitor.
Transmission Type	0 for pairing	The transmission type must be set to 0 for a pairing search. Once the transmission type is learned, **the receiving device should remember the type for future searches.** To be future compatible, any returned transmission type is valid. Future versions of this spec may allow additional bits to be set in the transmission type.
Device Type	120	120 (0x78) – indicates search for an ANT+ heart rate monitor. Please see the ANT Message Protocol and Usage document for more details.
Device Number	1 – 65535 0 for searching	Set the Device Number parameter to zero to allow wildcard matching. Once the device number is learned, the receiving device should remember the number for future searches. Please see the ANT Message Protocol and Usage document for more details.
Channel Period	8070 counts	Data is transmitted from the ANT+ heart rate monitor every 8070/32768 seconds (4.06 Hz) however the receive rate may be set lower if desired (section 5.1.2).
Search Timeout	(Default = 30 seconds)	The default search timeout is set to 30 seconds in the receiver. This timeout is implementation specific and can be set by the designer to the appropriate value for the system.

5.1.1   Transmission Type

The most significant nibble of the transmission type may optionally be used to extend the device number from 16 bits to 20 bits. In this case, the most significant nibble of the transmission type becomes the most significant nibble of the extended 20 bit device number. Therefore a wildcard pairing scheme **shall [SD_0002]** always be used by a display that does not know the transmission type of the ANT+ heart rate monitor that it is searching for.

5.1.2   Channel Period

The channel period is set such that the display device **shall [SD_0003]** receive data at the full message rate (4.06 Hz) or at one half or one quarter of this rate; data can be received four times per second, twice per second, or once per second. The developer sets the channel period count to receive data at one of the allowable receive rates:

- 8070 counts (~4.06 Hz, 4 messages/second)

- 16140 counts (~2.03 Hz, 2 messages/second)

- 32280 counts (~1.02 Hz, 1 message/second)

The minimum receive rate allowed is 32280 counts (~1.02 Hz).

The longer the count (i.e. lower receive rate) the more power is conserved by the receiver but a trade off is made for the latency of the data as it is being updated at a slower rate. The implementation of the receiving message rate by the display device is chosen by the developer.

As heart rates are typically greater than 1 Hz (60bpm), the most robust solution to receive every heart beat timestamp for receiver applications that require R-R interval timing is to receive at 8070 counts (~4.06 Hz). For applications on the receiver that display only the computed heart rate (see Table 6-3) a receive rate of 32280 counts (~1.02 Hz) may be sufficient.

5.2   Master Channel Configuration

The ANT+ heart rate monitor **shall [MD_0001] [MD_0002] [MD_0003]** establish its ANT channel as shown in Table 5-2.

Table 5-2. ANT Channel Configuration for an ANT+ Heart Rate Monitor (i.e. Master)

Parameter	Value	Comment
Channel Type	Master (0x10)	Within the ANT protocol the master channel (0x10) allows for bi-directional communication channels and utilizes the interference avoidance techniques and other features inherent to the ANT protocol.
Network Key	ANT+ Managed Network Key	The ANT+ Managed Network Key is governed by the ANT+ Managed Network licensing agreement.
RF Channel Frequency	57 (0x39)	RF Channel 57 (2457MHz) is used for the ANT+ heart rate monitor.
Transmission Type	Set MSN to 0 (0x0) or MSN of extended device number. Set LSN to 1 (0x1)	ANT+ devices follow the transmission type definition as outlined in the ANT protocol. This transmission type cannot use a shared channel address and must be compliant with the global data messages defined in the ANT protocol
Device Type	120 (0x78)	An ANT+ heart rate monitor **shall [MD_0001]** transmit its device type as 0x78 Please see the ANT Message Protocol and Usage document for more details.
Device Number	1-65535	This is a two byte field that allows for unique identification of a given ANT+ heart rate monitor. It is imperative that the implementation allow for a unique device number to be assigned to a given device. NOTE: The device number for the transmitting sensor **shall [self-verify]** not be 0x0000.
Channel Period	8070 counts	Data is transmitted every 8070/32768 seconds (4.06 Hz).

5.2.1   Channel Type

As communication in two directions is required, the channel type **shall [MD_0004]** be set to bidirectional master (0x10). The bidirectional master channel is also used to enable the interference avoidance features inherent to the ANT protocol.

5.2.2   Transmission Type

The most significant nibble of the transmission type may optionally be used to extend the device number from 16 bits to 20 bits. In this case, the most significant nibble of the transmission type becomes the most significant nibble of the 20 bit device number.

5.2.3   Device Number

The device number needs to be as unique as possible across production units. An example of achieving this specification is to use the lowest two bytes of the serial number of the device for the device number of the ANT channel parameter; ensure that the device has a unique serial number.

The device number of the heart rate monitor **shall [self-verify]** not be 0x0000. Care should be taken if the device number is derived from the lower 16-bits of a larger serial number. In this case, ensure that serial numbers that are multiples of 0x10000 (65536) are handled correctly such that the device number is not set to 0.

Data page 2 has been created specifically to allow for the resolution of a four byte serial number. This data page provides the upper two bytes of the serial number and assumes the lower two bytes are used as the device number in the ANT channel parameters. Please refer to section 6.6.3 for details.

6   Message Payload Format

6.1   ANT+ Message Data Formats

All ANT messages have an 8 byte payload. For ANT+ messages, the first byte contains the data page number and the remaining 7 bytes are used for sensor-specific data.

Table 6-1. ANT+ General Message Format

Parameter	Value	Comment
0	Data Page Number	1 Bytes
1-7	Sensor Specific Data	7 Bytes

Note that some older heart rate monitors may not implement data pages. Refer to section 6.4 for details.

6.2   Data Page Types

The data pages that are supported in the ANT+ Heart Rate Device Profile are divided into distinct types of pages. The first type is main information that is sent for most of the data transmissions. Main data pages contain data that either change quickly or is needed frequently and needs to be monitored. Background information pages contain data that is meant to be sent at a slower update rate. Background pages should be requestable. Command pages are sent from the display to the heart rate monitor to change mode, and Common pages are pages that are common between different ANT+ profiles.

Table 6-2. ANT+ Heart Rate Monitor Data Pages

Data Page	Description	Data Page Type	Direction
0	Default Data Page	Main (optional)	HRM → Display
1	Cumulative Operating Time	Background (optional)	
2	Manufacturer Information: Manufacturer ID, Serial Number	Background (required)	
3	Product Information: Hardware and Software Version, Model Number	Background (required)	
4	Previous Heart Beat Event Time for R-R Interval	Main (optional)	
5	Swim Interval Summary	Main (swim mode)	
6	Capabilities	Background (sports mode)	
7	Battery Status	Background (optional)	
70	Request Data Page	Common (all modes)	Display → HRM
76	Mode Settings Command: run, swim, and cycle modes	Common (sports mode)	

6.2.1   Main Data Pages

The main data pages include data pages 0, 2, 4 and 5. Main pages are sent continuously from the heart rate monitor as the default data page (except when background pages are sent). The choice of main data page is left to the discretion of the developer to implement with some restrictions. Data page 5 **shall [MD_HRM_003]** only be transmitted as the main page if the HRM is in swim mode (see section 6.6.6 for more details).

6.2.2   Background Data Pages

The background data pages include pages 1, 2, 3, 6, and 7. Background data pages 2 and 3 **shall [MD_0006]** be implemented. Pages 1, 6, and 7 are not required and their transmission is left to the discretion of the manufacturer.

As a minimum requirement a background message **shall [MD_0008]** be sent every 65th message. However, it is highly recommended that 4 background messages are sent after every 64 main data pages when transmitting at ~4.06 Hz so that all pages are received by a ~1.02 Hz receiver, see section 6.5 for more details.

6.2.3   Common Data Pages

Common pages that are supported in the HRM profile include pages 70 and 76. In the ANT+ Heart Rate Profile, common pages are sent from a display to a heart rate monitor. Implementation of common pages is optional for both displays and heart rate monitors, though displays and HRMs that intend to support sports modes must implement both pages.

6.3   Receiving Data Pages

An ANT+ receiver compatible with the ANT+ Heart Rate Device Profile should implement all defined data pages for maximum interoperability. **In addition, the receiver shall [SD_0005] interpret bytes 4 – 7 regardless of the page number.**

6.4   Current and Legacy Data Page Formats

The ANT+ Heart Rate Device Profile was the first device profile defined, and does not use the standard ANT+ data page numbered message format. Legacy heart rate monitors do not transmit paged data, and transmit a single message format containing undefined data in bytes 0-3. Bytes 4-7 are set as defined in page 0.

Current heart rate monitors use a 'toggle bit' to indicate the use of paged data. In order to use page numbering and maintain backwards compatibility, the following special rules apply:

1. The most significant bit of the data page number is reserved for a page change toggle bit. This bit must be seen to toggle before the rest of the data page number can be interpreted.

2. Bytes 1 – 3 are the only bytes that change definition in a page.

3. Bytes 4 – 7 have the same definition for every data page. This is the only data that can be interpreted before the page change toggle bit is seen to change.

6.4.1   Page Change Toggle Bit

The first byte of the paged heart rate data format comprises two data fields. Bits 0–6 determine the page number being used and identify the definition of the following three bytes.

Bit 7 or most significant bit (msb) is used for the page change toggle bit. The transmitter **shall [MD_0005]** toggle the state of this bit every fourth message (~1 Hz). This allows the receiving/display unit to receive data from a heart rate sensor at a slower rate than 4 Hz and still be able to observe the page change toggle bit to know that other data page formats are being used.

Figure 6-1 below shows how the toggle bit changes every fourth message. The receiver **shall [SD_0004]** only decode bytes 1-3 of the data page once the toggle bit behavior has been observed. If the toggle bit state does not change, the receiver **shall [SD_0004]** decode data according to the legacy data format (page 0).

```
[00][FF][FF][FF][41][1E][D5][56]
[00][FF][FF][FF][61][3D][D6][56]
[00][FF][FF][FF][61][3D][D6][56]
[00][FF][FF][FF][61][3D][D6][56]
[80][FF][FF][FF][27][3E][D7][56]
[80][FF][FF][FF][27][3E][D7][56]
[80][FF][FF][FF][27][3E][D7][56]
[80][FF][FF][FF][27][3E][D7][56]
[00][FF][FF][FF][FA][3E][D8][56]
[00][FF][FF][FF][FA][3E][D8][56]
.
```

The receiver receives one of the messages in this set of four messages with the toggle bit set high. Now the new data pages can be decoded.
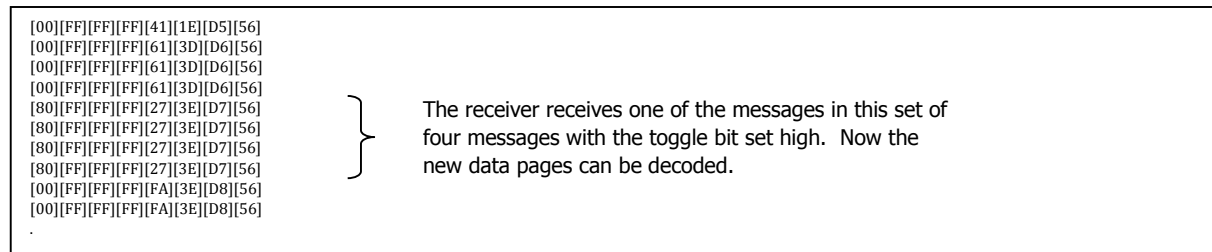
Figure 6-1. Example of Page Change Toggle Bit

6.5   Transmission Patterns

The ANT+ heart rate monitor transmits at a rate of 4 data pages every second. The main data pages and the required background data pages **shall [MD_0008]** be included in the regular broadcast transmission pattern.

As a minimum requirement a background message **shall [MD_0008]** be sent every 65th message, however it is recommended that a background page is sent 4 times consecutively after every 64 main data pages. For example, to transmit required background pages 2 and 3, and optional background page 1, use the transmission pattern illustrated in Figure 6-2. If fewer pages are used, then it is recommended that the same pattern is used, and the individual background pages be sent more often.
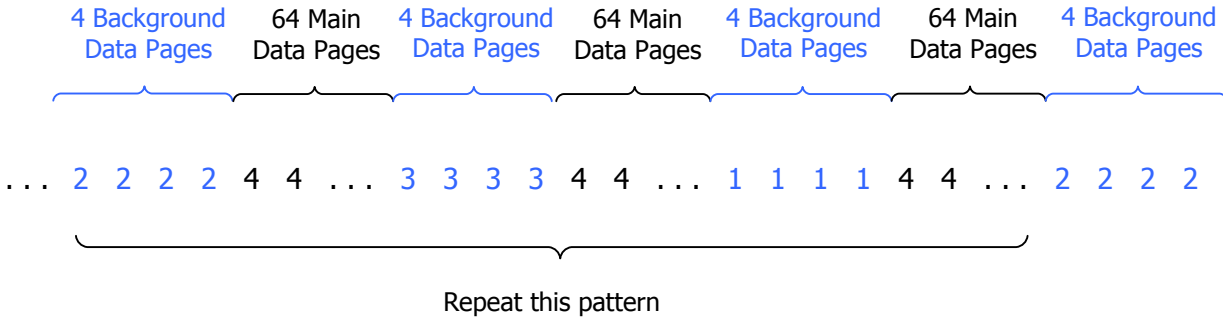
Figure 6-2. Regular Broadcast Transmission Pattern with Optional Data Pages

Figure 6-2 shows the transmission pattern for an ANT+ heart rate monitor implementing three different background pages (pages 2, 3, and 1). Four background pages are interleaved after every 64 main data pages.

6.6   Main and Background Data Pages

All data pages sent from a heart rate monitor **shall [MD_0010]** take the format specified in Table 6-3.

Table 6-3. Heart Rate Monitor General Data Page Format

Byte	Description	Length	Value	Units	Range or Rollover
0	Data Page Number	7 Bits (bits 0:6)	Data Page Number	N/A	N/A
0	Page Change Toggle	1 Bit (bit 7)	The transmitter **shall [MD_0005]** toggle this bit every 4th message. Refer to section 6.4.1.	N/A	N/A
1 2 3	Page Specific	3 Bytes	Interpret as specified in sections below.	N/A	N/A
4	Heart Beat Event Time LSB	2 Bytes	Represents the time of the last valid heart beat event.	1/1024 second	63.999
5	Heart Beat Event Time MSB				
6	Heart Beat Count	1 Byte	A single byte value which increments with each heart beat event.	N/A	256 counts
7	Computed Heart Rate	1 Byte	Instantaneous heart rate. This value is intended to be displayed by the display device without further interpretation. If Invalid set to 0x00	bpm	1-255

Note that a valid Computed Heart Rate **shall [self-verify]** be sent in every page transmitted from a heart rate monitor. Invalid computed heart rate should only be sent when the heart beat event count is not changing, though the last reported heart rate may also be transmitted in this case. The display **shall [SD_0006]** display changing heart rate values.

6.6.1 Data Page 0 – Default or Unknown Data Page (0x00)

Data page 0 is one of the main data pages broadcast from an ANT+ heart rate monitor. All fields in this message **shall [MD_0010]** be set as described in Table 6-3 and Table 6-4.

Table 6-4. Data Page 0 Format – Unknown Data Page

Byte	Description	Length	Value	Units	Range or Rollover
1	Reserved		Reserved. Set to 0xFFFFFF. The receiver **shall [self-verify]** not interpret this data.	N/A	N/A
2	Reserved	3 Bytes			
3	Reserved				

6.6.1.1 Transmission Requirements

Data page 0 is a main data page. Refer to section 6.2.1 and 6.5 for more details on transmission patterns.

6.6.2   Data Page 1 – Cumulative Operating Time (0x01)

Data page 1 allows the receiver to determine the total time that the heart rate monitor has been active since the last battery change. The operating time increments by one count every two seconds, providing a maximum total time between rollovers of 33554432 seconds (9320 hours), which is greater than typical battery life. The operating time is reset when the battery is replaced. All fields in this message **shall [MD_0010]** be set as described in Table 6-3 and Table 6-5.

Table 6-5. Data Page 1 Format – Background Data Page

Byte	Description	Length	Value	Units	Range or Rollover
1	Cumulative Operating Time LSB	3 Bytes	Increments every 2 seconds and is reset on battery replacement.	2 s	33554430s
2	Cumulative Operating Time				
3	Cumulative Operating Time MSB				

6.6.2.1   Transmission Requirements

Data page 1 is a background data page. Refer to section 6.2.2 and 6.5 for more details on transmission patterns. The transmission of data page 1 is optional.

6.6.3   Data Page 2 – Manufacturer Information (0x02)

Data page 2 allows the manufacturer to uniquely identify the heart rate monitor on the ANT+ network by setting the manufacturer identification field and by populating the serial number. Although the serial number allows for only two bytes of data, if it is used in conjunction with the device number a four byte serial number can be resolved. The manufacturer ID, serial number, and device number together uniquely identify a device. All fields in this message **shall [MD_0009] [MD_0010]** be set as described in Table 6-3 and Table 6-6.

Table 6-6. Data Page 2 Format – Background Data Page

Byte	Description	Length	Value	Units	Range or Rollover
1	Manufacturer ID LSB	1 Byte	Refer to FIT SDK for a current list of all manufacturer IDs.	N/A	N/A
2	Serial Number LSB	2 Bytes	This is the upper 16 bits of the 4 byte serial number. Refer to section 5.2.3.	N/A	N/A
3	Serial Number MSB				

6.6.3.1   Manufacturer ID

The current list of manufacturer ID values can be found in the FIT.xls profile (available within the FIT SDK at www.thisisant.com). New manufacturers are required to be members of the ANT+ Alliance in order to be added to this list; please contact the ANT+ Alliance at antalliance@thisisant.com for details. The value 255 (0xFF) has been reserved as a development ID and may be used by manufacturers that have not yet been assigned a value.

6.6.3.2   Serial Number Determination

The 16 bit device number allows for sufficient differentiation of devices in the RF domain for most scenarios, but cannot uniquely identify all manufactured heart rate monitors. When used in combination with the Manufacturer ID and the upper 16 bits of the serial number transmitted in this message, a unique identification of the heart rate monitor can be made.

The 32-bit serial number comprised of the upper serial number (most significant 16 bits) and the device number (least significant 16 bits) provides more than 4 billion serial numbers for each manufacturer ID. The manufacturer must ensure that this data is unique for each heart rate monitor produced. Therefore, the manufacturer ID and serial number together identifies a unique device across all ANT+ devices.

It is important to note that the device ID must never be 0, therefore serial numbers that are integer multiples of 65536 must not be used. See section 5.2.3 for more details.

6.6.3.3   Transmission Requirements

Data page 2 is a background data page. Refer to section 6.2.2 and 6.5 for more details on transmission patterns. The transmission of data page 2 is required by all manufacturers of ANT+ heart rate monitors.

6.6.4   Data Page 3 – Product Information (0x03)

Data page 3 is one of the background data pages broadcast from an ANT+ heart rate monitor. This page indicates the hardware and software version and the model number of the device. All fields in this message **shall [self-verify]** be set as described in Table 6-3 and Table 6-7.

Table 6-7. Data Page 3 Format – Product Information

Byte	Description	Length	Value	Units	Range or Rollover
1	Hardware Version	1 Byte	To be set by the manufacturer	N/A	N/A
2	Software Version	1 Byte	To be set by the manufacturer	N/A	N/A
3	Model Number	1 Byte	To be set by the manufacturer	N/A	N/A

6.6.4.1   Transmission Requirements

Data page 3 is a background data page. Refer to section 6.2.2 and 6.5 for more details on transmission patterns. The transmission of data page 3 is required by all manufacturers of ANT+ heart rate monitors.

6.6.5   Data Page 4 – Previous Heart Beat (0x04)

Data page 4 is one of the main data pages broadcast from an ANT+ heart rate monitor. This page allows the heart rate monitor to transmit the measured time of the previously measured heartbeat. This format provides a level of redundancy in the transmitted data stream and allows for a more robust form of calculating R-R intervals. All fields in this message **shall [MD_0010]** be set as described in Table 6-3 and Table 6-8.

Table 6-8. Data Page 4 Format – Previous Heart Beat

Byte	Description	Length	Value	Units	Range or Rollover
1	Manufacturer Specific	1 Byte	Set to 0xFF if not used. The receiver **shall [self-verify]** not interpret this data unless custom behaviour is defined for a specific manufacturer.	N/A	N/A
2	Previous Heart Beat Event Time LSB	2 Bytes	Represents the time of the previous valid heart beat event.	1/1024 second	63.999s
3	Previous Heart Beat Event Time MSB				

6.6.5.1   Manufacturer Specific

This field allows manufacturers to add 1 byte of data to this data page. The field is not interpreted by the receiver and can be used for any purpose required by the manufacturer.

6.6.5.2   Previous Heart Beat Event Time

The previous heart beat event time **shall [MD_HRM_002]** hold the exact value reported as the heart beat event time (bytes 4-5) in when the heart beat event count was one less than the current, accounting for rollovers.

6.6.5.3   Transmission Requirements

Data page 4 is a main data page. Refer to section 6.2.1 and 6.5 for more details on transmission patterns.

6.6.6　Data Page 5 – Swim Interval Summary (0x05)

Data page 5 allows the heart rate monitor to transmit heart rate statistics over swim sessions and intervals. This format allows swimmers to see summaries of their heart rate in real-time when the heart rate monitor is not submerged in water. All fields in this message **shall [MD_0010] [MD_HRM_003]** be set as described in Table 6-3 and Table 6-9. This data page **shall [MD_HRM_003]** only be transmitted when the heart rate monitor is in swim mode. For details on switching into swim mode see section 6.7.2.

Table 6-9. Data Page 5 Format – Interval Summary

Byte	Description	Length	Value	Units	Range or Rollover
1	Interval Average Heart Rate	1 Byte	Invalid = 0x00 Valid Value = 1 – 255bpm. This value is intended to be displayed by the display device without further interpretation.	bpm	N/A
2	Interval Maximum Heart Rate	1 Byte	Invalid = 0x00 Valid Value = 1 – 255bpm. This value is intended to be displayed by the display device without further interpretation.	bpm	N/A
3	Session Average Heart Rate	1 Byte	Invalid = 0x00 Valid Value = 1 – 255bpm. This value is intended to be displayed by the display device without further interpretation.	bpm	N/A

6.6.6.1　Interval Average Heart Rate

Average heart rate over the current interval in progress (if active) or the most recently completed interval (if resting). An interval is a segment of the athletic workout.

6.6.6.2　Interval Maximum Heart Rate

Maximum heart rate over the current interval in progress (if active) or the most recently completed interval (if resting). An interval is a segment of the athletic workout.

6.6.6.3　Session Average Heart Rate

Average heart rate over the current session in progress. A session spans over the entire activity and may contain multiple intervals.

6.6.6.4　Transmission Requirements

Data page 5 is a main data page and its implementation is optional. Refer to section 6.2.1 and 6.5 for more details on transmission patterns.

If the heart rate monitor supports the swimming extended feature (specified in Bit 2 of 'Features Supported' in Table 6-10) then data page 5 must be implemented.

This page **shall [MD_HRM_003]** be transmitted as the main page when swimming mode is enabled (specified in Bit 2 of 'Features Enabled' in Table 6-10) Note: This page is swimming specific and **shall [MD_HRM_003]** only be transmitted when the device is in swimming mode (specified in Bit 2 of 'Features Enabled' in Table 6-10).

6.6.7 Data Page 6 – Capabilities (0x06)

Data page 6 allows the heart rate monitor to transmit information about extended features that it supports or is capable of enabling. Such features may include additional data specific to running, cycling or swimming. This page **shall [MD_HRM_003]** be sent upon request from the display. All fields in this message **shall [MD_0010]** be set as described in Table 6-3 and Table 6-10.

Table 6-10. Data Page 6 Format - Capabilities

Byte	Description	Length	Value	Units	Rollover
1	Reserved	1 Byte	The transmitter **shall [MD_0010]** set this value = 0xFF. The receiver **shall [SD_0007]** not interpret this field at this time.	N/A	N/A
2	Features Supported	8 bits	Bit field to indicate which features are supported by the heart rate monitor. If the bit is set to 1, the feature is supported. Bit 0: Extended Running Features Supported Bit 1: Extended Cycling Features Supported Bit 2: Extended Swimming Features Supported Bits 3 – 5: Reserved. Set to 0 Bits 6 – 7: Manufacturer-Specific Features	Binary	N/A
3	Features Enabled	8 bits	Bit field to indicate which features are enabled by the heart rate monitor. If the bit is set to 1, the feature is enabled. The feature must be supported to be enabled. Bit 0: Extended Running Features Enabled Bit 1: Extended Cycling Features Enabled Bit 2: Extended Swimming Features Enabled Bits 3 – 5: Reserved. Set to 0 Bits 6 – 7: Manufacturer-Specific Features	Binary	N/A

6.6.7.1 Features Supported

If the heart rate monitor is capable of supporting extended features such as running, cycling, or swimming, the corresponding bits in this field **shall [MD_HRM_003]** be set to 1. The display **shall [self-verify]** receive page 6 (and check that the extended feature is supported) before attempting to switch the heart rate monitor into running, cycling, and swimming modes. For details on switching sport modes see section 6.7.2.

6.6.7.2 Features Enabled

This field indicates which extended feature the heart rate monitor currently has enabled. The heart rate sensor should only have one sport mode enabled at a time and should never enable a feature that is not supported.

6.6.7.2.1   *Extended Swimming Features Enabled*

If the heart rate monitor has swimming enabled (set to 1), it **shall [MD_HRM_003]** transmit data page 5 as its main data page.

6.6.7.3   Transmission Requirements

Page 6 is a background data page. Refer to section 6.2.2 and 6.5 for more details on transmission patterns. The implementation of data page 6 is optional. If the heart rate monitor supports extended features for any sport, this page must be implemented and sent as a background page and upon request from display (see section 6.7.1 for page requests).

6.6.8 Data Page 7 – Battery Status (0x07)

Page 7 allows the receiver to determine the battery status of the heart rate monitor. All fields in this message **shall [MD_0010]** be set as described in Table 6-3 and Table 6-11.

Table 6-11. Data Page 7 Format – Battery Status

Byte	Description	Length	Value	Units	Range or Rollover
1	Battery Level	1 Byte	Battery Level Percentage Reserved Values: 0x65 − 0xFE Set to 0xFF if not used.	%	0-100%
2	Fractional Battery Voltage	1 Byte	Value = 0 − 255 (0x00 − 0xFF)	1/256 (V)	N/A
3	Descriptive Bit Field	1 Byte	Battery Status and Coarse Battery Voltage. See Table 6-12 for more details.	Binary	N/A

6.6.8.1 Battery Level

The battery level is used by the heart rate monitor to report the current remaining percentage of battery level. The percentage value **shall [MD_0010]** not be set to greater than 100%. Values 0x65 − 0xFE should not be used.

If this field is not used its value should be set to 0xFF.

6.6.8.2 Descriptive Bit Field

The coarse battery voltage can be found easily by using the bit mask of 0x0F on byte 7 as it requires no bit shifting.

Table 6-12. Battery Voltage Descriptive Bit Field

Bits	Value	Description
0 − 3	0 − 14 Volts 0xF (15): Invalid	Coarse Battery Voltage
4 − 6	0 (0x00)	Reserved for future use
	1 (0x01)	Battery Status = New
	2 (0x02)	Battery Status = Good
	3 (0x03)	Battery Status = OK
	4 (0x04)	Battery Status = Low
	5 (0x05)	Battery Status = Critical
	6 (0x06)	Reserved for future use
	7 (0x07)	Invalid
7	Reserved (0x00)	Receiver will not interpret this value at this time.

6.6.8.3 Invalid Battery Voltage

If the battery voltage is unable to be measured and transmitted by the device a value of 15 (0x0F) **shall [self-verify]** be used in bits 0 − 3 of the descriptive bit field and a value of 255 (0xFF) **shall [self-verify]** be used in the fractional battery voltage data field.

However, a value of 255 (0xFF) in the fractional field does not indicate that the voltage data field is invalid. This can only be determined by the value in the descriptive bit field.

6.6.8.4   Transmission Requirements

Data page 7 is a background data page. Refer to section 6.2.2 and 6.5 for more details on transmission patterns. The implementation of data page 7 is optional. If page 7 is implemented, it is recommended that page 7 also be sent upon request from the display.

6.7

6.7   Common Data Pages

ANT+ heart rate monitors have the lower nibble of their transmission type set to 1, and **shall [MD_0002] not send ANT+ common pages.** Only the data pages described in this ANT+ Heart Rate Device Profile may be transmitted. This is critical to ensuring backwards compatibility with legacy display devices. However, displays may send ANT+ common pages 70 and 76 to an ANT+ heart rate monitor, for example, common page 70 – Request Data Page. This can be useful when first connecting to a new device, as it allows the display to obtain manufacturer and product information more quickly in order describe the device to the user. It is highly recommended that the heart rate monitor responds to all data page requests from the display.

6.7.1   *Common Page 70 (0x46): Request Data Page*

Common Data Page 70 allows an ANT+ device to request a specific data page from another ANT+ device; in this case, it allows the display to request a specific data page from the ANT+ heart rate monitor. The request data page should be sent using an acknowledged message by the display and **shall [self-verify]** be formatted as shown in Table 6-13. It is recommended that if the requested page (data page 6 for example) is not received within 5 request attempts, the display **shall [SD_HRM_001]** stop sending request attempts and assume that the heart rate monitor does not support the requested data page.

Table 6-13. Common Data Page 70

Byte	Description	Length	Value	Units
0	Command ID	1 Byte	70 (0x46) – Data Page Request	N/A
1	Reserved	1 Byte	Set to 0xFF	N/A
2	Reserved	1 Byte	Set to 0xFF	N/A
3	Descriptor Byte 1	1 Byte	Set to 0xFF	N/A
4	Descriptor Byte 2	1 Byte	Set to 0xFF	N/A
5	Requested Transmission Response	1 Byte	Describes transmission characteristics of the data requested. Bit 0-6: Number of times to transmit requested page. Bit 7: Setting the MSB means the device replies using acknowledged messages if possible. Special Values: 0x80 - Transmit until a successful acknowledge is received. 0x00 – Invalid	N/A
6	Requested Page Number	1 Byte	Page number to transmit.	N/A
7	Command Type	1 Byte	Value = 1 (0x01) for Request Data Page	N/A

6.7.1.1   Requested Transmission Response

The heart rate monitor should be able to support all requested transmission response types; however, the ANT+ Heart Rate Profile further stipulates that the display shall [self-verify] only request broadcast messages from a heart rate sensor.

Note that some Heart Rate Monitors do not support sending acknowledged messages and will instead respond with broadcast messages regardless of the response type requested.

Refer to the ANT+ Common Pages document for more details on the request data page and possible requested transmission response types.

6.7.2   Common Page 76 (0x4C): Mode Settings Page

Common Page 76 is sent from the display to the heart rate monitor to switch between different sport modes, allowing the heart rate monitor to change its extended functionality to better correspond with how the user is exercising. **This page shall [SD_HRM_002] [SD_HRM_003] only be sent after data page 6 (Capabilities) has been received from the heart rate monitor (indicating that the sport mode is supported).** Refer to Figure 6-4 for an example on the sequence of events required to switch sport modes.

Table 6-14. Common Data Page 76

Byte	Description	Length	Value	Units
0	Data Page Number	1 Byte	76 (0x4C) – Mode Settings Page	N/A
1	Reserved	1 Byte	Reserved: Set to 0xFF	N/A
2	Reserved	1 Byte	Reserved: Set to 0xFF	N/A
3	Reserved	1 Byte	Reserved: Set to 0xFF	N/A
4	Reserved	1 Byte	Reserved: Set to 0xFF	N/A
5	Reserved	1 Byte	Reserved: Set to 0xFF	N/A
6	Reserved	1 Byte	Reserved: Set to 0xFF	N/A
7	Sport Mode	1 Byte	0x01: Running 0x02: Cycling 0x05: Swimming Refer to FIT SDK for 'Sport' enum	N/A

6.7.2.1   Sport Mode

If the heart rate monitor supports any number of sport modes, it should enable the extended features specific to the received sport mode and disable features specific to all other sport modes. In addition, the heart rate monitor **shall [MD_HRM_003]** update the appropriate Features Enabled fields in data page 6 (Table 6-10) when switching sport modes.

6.7.2.1.1   Running (0x01)

Sport Mode of value 0x01 (Running) is manufacturer specific and the heart rate monitor can transmit main data pages 0 or 4 at the manufacturer's discretion.

6.7.2.1.2   Cycling (0x02)

Sport Mode of value 0x02 (Cycling), is manufacturer specific and the heart rate monitor can transmit main data pages 0 or 4 at the manufacturer's discretion.

6.7.2.1.3   Swimming (0x05)

When the heart rate monitor receives a Sport Mode of value 0x05 (Swimming), the heart rate monitor **shall [MD_HRM_003]** send page 5 as the default main data page at a ~4.06 Hz rate.

Note: Data page 5 **shall [MD_HRM_003]** only be sent when the heart rate sensor is in sport mode swimming. Transmission of main data page 5 must stop when the heart rate monitor exits out of sport mode swimming as indicated in Bit 2 of 'Features Enabled' in Table 6-10.

broadcast →

← acknowledged →

ANT+ Display

ANT+ Heart Rate Monitor

Page 4

⋮

Page 4

Heart Rate Data at ~4.06Hz

User switches into swimming mode on display

Page 70 (Requested Page=0x06)

Received Capabilities
The display checks to see if the HRM supports swimming mode and what mode is enabled before sending page 76

Page 6

Page 76 (Sport Mode=Swimming)

Received Sport Mode Swimming
-HRM sets fields in page 6 (swimming set to enabled, all other sports set to disabled)
-HRM sets page 5 as its main page

Page 5

⋮

Page 5

Swim Heart Rate Data at ~4.06Hz

User switches into cycling mode on display

Page 70 (Requested Page=0x06)

Received Capabilities
The display checks to see if the HRM supports cycling mode and what mode is enabled before sending page 76

Page 6

Page 76 (Sport Mode=Cycling)

Received Sport Mode Cycling
-HRM sets fields in page 6 (cycling set to enabled, all other sports set to disabled)
-HRM **removes** page 5 as its main page

Page 4

⋮

Page 4

Heart Rate Data at ~4.06Hz

Figure 6-4. Changing Sport Modes on the Heart Rate Monitor

6.8   Other Pages

6.8.1   Page 8-61, & 94-111 – Reserved Range

These pages are reserved for future use. These pages **shall [MD_0007]** not be transmitted.

6.8.2   Page 112-127 – Manufacturer Specific Range

Manufacturer specific pages sent from an HRM **shall [self-verify]** be defined as specified in Table 6-3 and Table 6-4.

Table 6-15. Manufacturer Specific Page Format

Byte	Description	Length	Value	Units	Rollover
1	Manufacturer Specific	1 Byte	Manufacturer Specific Value	N/A	N/A
2	Manufacturer Specific	1 Byte	Manufacturer Specific Value	N/A	N/A
3	Manufacturer Specific	1 Byte	Manufacturer Specific Value	N/A	N/A

6.8.2.1   Manufacturer Specific

These fields allow manufacturers to add 3 bytes of data to each data page. The fields are not interpreted by the receiver and can be used for any purpose required by the manufacturer.

6.8.2.2   Transmission Requirements

Manufacturer specific data page pages should be sent with the same transmission requirements as background pages. Refer to section 6.2.2 and 6.5 for more detail.

7   R-R Interval Measurements

7.1   Handling Rollovers

The Heart Beat Event Time and Heart Beat Count values that are transmitted in all data pages (Table 6-3) are subject to rollover. This means that a transmitter **shall [MD_0011]** continue to increase the value of the field until the maximum is hit, at which point the value is rolled-over. Note that a rollover makes it possible for the Heart Beat Event Time or Heart Beat Count to be less than it was in the previous message.

To properly span rollovers, calculations on the receiver side **shall [SD_0008]** first reconstruct the value from the received values, as shown in Figure 7-1. It is important to note that the Heart Beat Event Time is a bit string of size 16 and the Heart Beat Count is a bit string of size 8 as the reconstruction will vary based on the bit string size.

$$\text{If } Value_{N-1} > Value_N \qquad\qquad 255 > 1 \ \checkmark \ \text{Rollover Occurred}$$

$$\frac{\begin{array}{r} Value_N \\ + \quad 2^{\text{Size of Bitstring}} \end{array}}{Value_N \text{ Rollover Correction}} \qquad\qquad \frac{\begin{array}{r} 1 \\ + \ 2^8 \end{array}}{257}$$

$$\frac{\begin{array}{r} Value_N \text{ Rollover Correction} \\ - \qquad\qquad Value_{N-1} \end{array}}{Value \text{ Difference}} \qquad\qquad \frac{\begin{array}{r} 257 \\ - \ 255 \end{array}}{2}$$

Figure 7-1. Sample Calculation of Rollover Correction for Heart Beat Count (bit string size 8)

7.2   Using Data Page 4 for R-R Interval Measurements

It is recommended that whenever possible, page 4 be used to compute R-R intervals. Data page 4 has both the heart beat event time and the previous heart beat event time. This allows for the R-R interval to be computed from a single page. See Figure 7-2 for how to calculate the R-R interval using only one data page 4.

ANT Data Message Payload: [0x04][0xFF][0x88][0x06][0xDD][0x07][0x83][0xB4]

$$\frac{\begin{array}{r} HeartBeatEventTime \ (byte\ 4|5) \\ - PreviousHeartBeatEventTime \ (byte\ 2|3) \end{array}}{RR\ Interval} \qquad\qquad \frac{\begin{array}{r} 2013 \\ - \ 1672 \end{array}}{341 \ \ _{1/1024\ (s)}}$$

$$\frac{\begin{array}{r} RR\ Interval \\ \mathbf{x}\ 1000 \\ \div\ 1024 \end{array}}{RR\ Interval\ in\ ms} \qquad\qquad \frac{\begin{array}{r} 341 \\ x\ 1000 \\ \div\ 1024 \end{array}}{333 \ \ _{(ms)}}$$

Figure 7-2. Sample R-R Interval Calculation using Data Page 4

7.3　Using Any Two Data Pages for R-R Interval Measurements

If data page 4 is unavailable, it is still possible to calculate R-R intervals. R-R intervals can be calculated using any of the data pages transmitted from the heart rate monitor provided you have received two data pages with successive heart beat counts. See Figure 7-3 on how to calculate the R-R interval. This method should only be used if data page 4 is unavailable.

Figure 7-3. Sample Calculation using two data page 0 messages

Figure 7-3 shows how the R-R interval is calculated from two successive data page 0 ANT Data payload messages. However, this method can be applied to any combination of data pages, as long as their beat count is consecutive (the difference equals 1).

8   Minimum Requirements

An ANT+ heart rate monitor shall behave as described in this document. In summary, the pages marked as required in Table 8-1 **shall [MD_0006] [MD_0008]** be transmitted and comply with the transmission requirements. Should the heart rate monitor support extended features for any sport mode, then the pages marked as required in Table 8-2 **shall [MD_0008]** be transmitted and comply with the transmission requirements. The pages marked as optional must also meet the specified transmission requirements if they are included. All fields are required for all messages unless they are specifically marked as optional in the data page descriptions.

8.1   Broadcast

8.1.1   Minimum Transmission Timing Requirements

An ANT+ heart rate monitor **shall [MD_HRM_003]** support the transmission patterns described in section 6 and its subsections.

8.1.2   Minimum Data Page Requirements

Table 8-1. Required Data Elements of the Heart Rate Monitor

Required Data Pages	Transmission Requirements
Data Page 0 or Data Page 4	Sent as main data page at ~4.06 Hz. Refer to section 6.2.1 and 6.5.
Data Page 2	Placed in background page rotation. Refer to section 6.2.2 and 6.5.
Data Page 3	Placed in background page rotation. Refer to section 6.2.2 and 6.5.

Table 8-2. Required Data Elements of the Heart Rate Monitor with Extended Features

Required Data Pages	Transmission Requirements
Data Page 0 or Data Page 4	Sent as main data page at ~4.06 Hz. Refer to section 6.2.1 and 6.5.
Data Page 2	Placed in background page rotation. Refer to section 6.2.2 and 6.5.
Data Page 3	Placed in background page rotation. Refer to section 6.2.2 and 6.5.
Data Page 6	Sent as background page (Refer to section 6.2.2 and 6.5) and **shall [MD_HRM_003]** respond to requests.
Data Page 70	Receive and respond to requests for pages.
Data Page 76	Receive and update heart rate monitor extended features
Optional Data Pages	**Transmission Requirements**
Data Page 5 (Required if swimming is a supported feature)	Sent as main data page at ~4.06 Hz when heart rate monitor is in swimming mode and only when in swimming mode.

8.2   Additional Requirements

The following general requirements also apply:

- A sensor **shall [MD_0006]** only send broadcast messages to the display, and **shall [MD_0006]** never send acknowledged or burst messages unless specified otherwise by request from the display. A display **shall [SD_0010]** decode (and display) data sent as acknowledged messages from the sensor.

- A display **shall [SD_0009]** not decode any unexpected burst messages that are sent from the sensor, and **shall [SD_0009]** handle this situation gracefully.

- A display **shall [SD_0007]** not decode reserved bytes in received data pages.

- The display **shall [SD_0005]** handle the receipt of undefined data pages gracefully.

- If the display requires a data page from the heart rate monitor, the display **shall [self-verify]** only request broadcast messages.

- The display **shall [SD_0015]** handle invalid data gracefully.

- A sensor **shall [MD_0014]** not open any other master channel on the ANT+ Network Key except that the channel conforms to an ANT+ Device Profile.

9 ANT+ Interoperability Icons

9.1 Heart Rate Interoperability Icon

The ANT+ interoperability icons inform the end user of the product's capabilities. This icon indicates to the user that this specific device will transmit/receive heart rate information, and that it is interoperable with other devices that carry the same icon.

An ANT+ heart rate monitor or display that meets the minimum compliance specifications and has been certified may use the icon shown in Figure 9-1 on packaging, documentation, and marketing material.

Figure 9-1. ANT+ Heart Rate Interoperability Icon

9.2 Link Here Logo

The 'Link Here' logo is used to indicate to the user that the fitness equipment is interoperable with both ANT+ heart rate monitors and ANT+ personal displays and can pair to these devices based on proximity. The logo also indicates the optimal location for proximity pairing.

Figure 9-2. ANT+ Link Here Logo

10 Profile Verification Tests

Table 10-1. Profile Verification Tests for the Heart Rate Sensor

☑	Certification Test	Relevant Document Sections
	MD_0001 ANT Channel Parameter Test	5.2 Master Channel Configuration
	MD_0002 Transmission Type	5.2 Master Channel Configuration 6.7 Common Data Pages
	MD_0003 Channel Period	5.2 Master Channel Configuration
	MD_0004 Channel Type	5.2.1 Channel Type
	MD_0005 Toggle Bit	6.4.1 Page Change Toggle Bit 6.6 Main and Background Data Pages
	MD_0006 Tx Required Data Page	6.2 Data Page Types 8 Minimum Requirements 8.2 Additional Requirements
	MD_0007 Tx Invalid Data Page	6.8.1 Page 8-61, & 94-111 – Reserved Range
	MD_0008 Transmission Pattern	6.2.2 Background Data Pages 6.5 Transmission Patterns 8 Minimum Requirements
	MD_0009 Manufacturer ID	6.6.3 Data Page 2 – Manufacturer Information (0x02)
	MD_0010 Page Format	6.6 Main and Background Data Pages
	MD_0011 Rollover	7.1 Handling Rollovers
	MD_0013 Request Data Page	6.6.7 Data Page 6 – Capabilities (0x06)
	MD_0014 Network Traffic	8.2 Additional Requirements
	MD_HRM_002 Previous Timestamp	6.6.5 Data Page 4 – Previous Heart Beat (0x04)
	MD_HRM_003 Sports Mode	6.2.1 Main Data Pages 6.6.6 Data Page 5 – Swim Interval Summary (0x05) 6.6.7.2.1 Extended Swimming Features Enabled 6.7.2 Common Page 76 (0x4C): Mode Settings Page 8.1.1 Minimum Transmission Timing Requirements
	Self-verify	5.2 Master Channel Configuration 5.2.3 Device Number 6.6 Main and Background Data Pages 6.6.4 Data Page 3 – Product Information (0x03) 6.6.7.1 Features Supported 6.6.8.3 Invalid Battery Voltage 6.8.2 Page 112-127 – Manufacturer Specific Range

Table 10-2. Profile Verification Tests for the Heart Rate Display

☑	Certification Test	Relevant Document Sections
	SD_0001 ANT Channel Parameter Test	5.1 Slave Channel Configuration
	SD_0002 Transmission Type	5.1.1 Transmission Type
	SD_0003 Channel Period	5.1.2 Channel Period
	SD_0004 Toggle Bit	6.4.1 Page Change Toggle Bit
	SD_0005 Rx Undefined Data Page	6.3 Receiving Data Pages 8.1.2 Minimum Data Page Requirements 8.2 Additional Requirements
	SD_0006 Sweep	6.6 Main and Background Data Pages
	SD_0007 Rx Reserved Fields	6.6.7 Data Page 6 – Capabilities (0x06) 8.2 Additional Requirements
	SD_0008 Rollover	7.1 Handling Rollovers
	SD_0009 Ignore Burst	8.2 Additional Requirements
	SD_0010 Rx Ack	8.2 Additional Requirements
	SD_0015 Valid Data Displayed	8.2 Additional Requirements
	SD_HRM_001 No Request Response from HRM	6.7 Common Data Pages
	SD_HRM_002 HRM has no Sports Mode	6.7.2 Common Page 76 (0x4C): Mode Settings Page
	SD_HRM_003 Sports Mode	6.7.2 Common Page 76 (0x4C): Mode Settings Page
	Self-verify	6.6.5 Data Page 4 – Previous Heart Beat (0x04) 6.7.1 Common Page 70 (0x46): Request Data Page 8.2 Additional Requirements