ANT+ Device Profile

BLOOD PRESSURE

ANT+ Managed Network Document
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Copyright Information and Usage Notice

Revision History

Revision	Effective Date	Description
Beta	May 2010	Initial Release
1.0	January 28, 2011	Edited "Copyright Information and Usage Notice" 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.

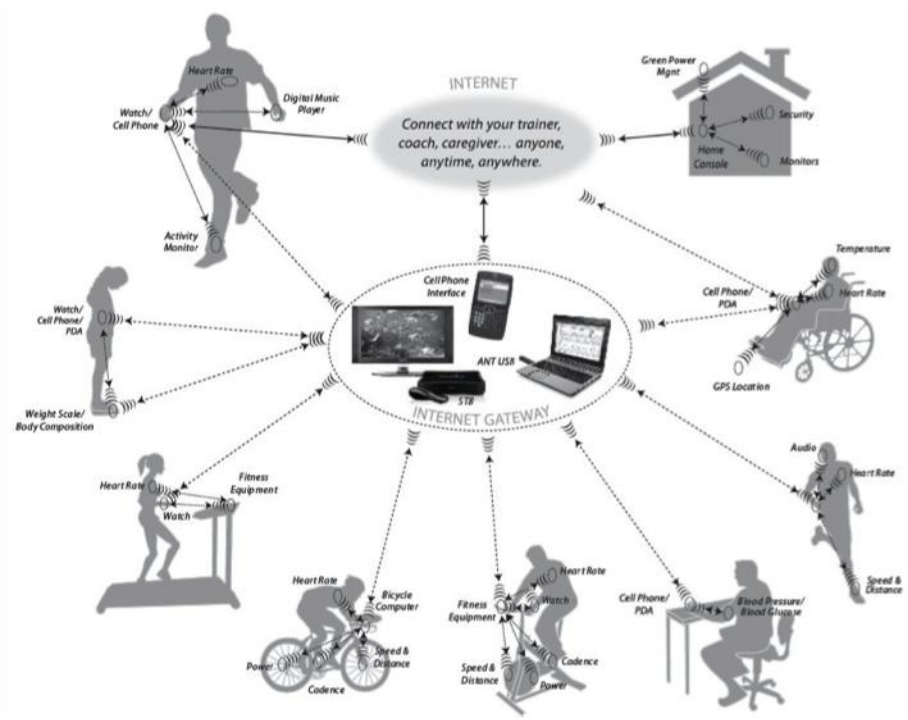

Figure 1-1. ANT+ Device Ecosystem

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, and signed, the ANT+ Managed Network license agreement and have received the ANT+ Managed Network Key. By signing the license 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 Pages
3. ANT-FS Technical Specification
4. ANT-FS Reference Design User Manual
5. Flexible and Interoperable Data Transfer (FIT) Protocol
6. FIT File Types

3 Overview of Blood Pressure Device Use Case

All blood pressure (BP) monitors are designed to take the user's blood pressure. This is usually accomplished using a sphygmomanometer cuff, which is placed around the user's upper arm at approximately the same height as the heart. The cuff is inflated until the flow of blood in the brachial artery is momentarily stopped, and then the cuff is deflated until blood flow returns and the arterial pressure is recorded. Electronic BP monitors usually have the ability to display the measured arterial pressure values, as well as other measured and calculated data, such as heart rate and the detection of any pulse irregularities.

Blood pressure monitors are used in a variety of settings, ranging from a clinical setting where a health professional will use the device for a given patient, to a home setting where the patient will use the device directly without help or supervision. While all BP monitors have the ability to measure blood pressure, some devices have the ability to store recorded data, and some devices are capable of storing data for different users of the same device.

3.1 Typical Use of an ANT+ Blood Pressure Device

An ANT+ blood pressure device will have the ability to store recorded data, and forward this information to another device when required. The blood pressure monitor will have the minimum capabilities to take and record blood pressure measurements made by the device.

Some blood pressure devices may have the ability to store multiple measurements from multiple users. The ANT+ Blood Pressure Device Profile will allow for devices to have the necessary scalability to handle multiple users and their associated user profiles. This user information can be stored and transferred, along with the measurements, from the blood pressure device to the collection device.

The collection device will store, display and possibly track the data received from the blood pressure device. The collection device can be a device such as a cell phone or laptop computer that may have direct internet access; or it may be a device like a PDA or wrist top computer that will act as a transfer device for the received data.

Ultimately the blood pressure measurements will be stored in a data base application, for example an online health data base or at a health professional's office. The information may be transmitted from the blood pressure device to a collection device and then over the internet to a data base for storage and possibly further analysis (Figure 3-1).

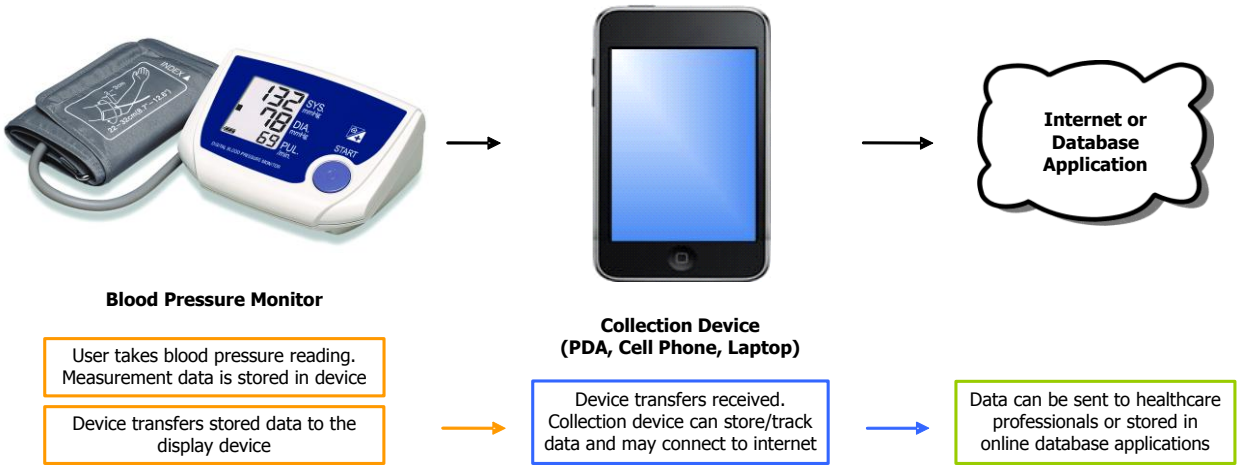

Figure 3-1. Typical Use Case with Intermediary Display Device

A blood pressure monitor's typical use in the home environment will be a 2 minute, once a day measurement per user. In the clinical setting, use will be more frequent and could easily be estimated to 50 times a day, for two minutes per use.

The download of data from the blood pressure device will vary between use cases. A health care professional may download data after every use for storage in the database application, whereas a home user may only download their data on a weekly or monthly basis.

Data will be stored according to the Flexible and Interoperable Data Transfer (FIT) Protocol and as defined by the Blood Pressure Device Profile. FIT file formats can be transferred using any file transfer mechanism; however, the Blood Pressure Device Profile stipulates that FIT file transfers between the blood pressure monitor and collector device will use the wireless ANT File Share (ANT-FS) protocol.

4 ANT+ Interoperability Icons

Each ANT+ device profile has an associated icon. Devices that are compliant with their ANT+ profiles are able to use these icons on the device packaging and documentation. This will allow the end user to know which devices will interoperate and what performance to expect from a given device.

The ANT+ Blood Pressure Device Profile has defined one icon that can be used for devices in compliance with this device profile.

Devices bearing this icon will represent to the end user the ability to transmit or receive ANT+ Blood Pressure data.

See section 8 for a detailed description of the minimum data set that must be maintained by either transmitting or receving devices in order to use this icon. Devices must be tested for compliance prior to using this icon.

5 Channel Configuration

Measured blood pressure data will be stored on the blood pressure monitoring device, and later forwarded to the collector device when desired. Blood pressure, and possibly other related data will be stored according to the Flexible & Interoperable Data Transfer (FIT) Protocol, and as defined by the Blood Pressure Device Profile. The blood pressure monitor and collector device will transfer FIT files between them using the wireless ANT File Share (ANT-FS) protocol. Please note, the **ANT-FS Technical Specification must be implemented in its entirety in order to be compliant with this profile.**

For more information on the ANT-FS protocol, please refer to the ANT-FS technical specification and Reference Design User Manual documents.

5.1 ANT-FS Client – Blood Pressure Monitor

The blood pressure monitor shall act as the ANT-FS client as it contains data for download to another device. Also the BP monitor will usually have more stringent battery requirements than the collection device in most of the ANT+ blood pressure systems.

The BP monitor's ANT-FS client channel shall be established as outlined in the ANT-FS technical specification and Table 5-1.

Table 5-1. ANT Channel Configuration for a Blood Pressure Monitor (ANT-FS Client Device)

Parameter	Value	Comment
Channel Type	Master (0x10)	The blood pressure monitor shall be the ANT-FS client and transmits an ANT-FS beacon. The client must be configured as the ANT master
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 (2457 MHz) is used for the initial link layer of ANT+ devices
Transmission Type	5 (0x05)	This indicates that the device will use common pages
Device Type	18 (0x12)	Denotes ANT+ Blood Pressure device
Device Number	1 – 65535	This is a two byte field that allows for a unique identification of a given blood pressure monitor. It is imperative that the implementation allows for a unique device number to be assigned to any given device NOTE: The device number shall not be 0x0000 for the ANT-FS client.
Beacon Channel Period	8192 or 4096 counts	The blood pressure monitor shall beacon at one of two rates while in the link layer depending on the power modes available: **high power mode (default):** beacon continuously at 4Hz. **low power mode (optional):** beacon at 8Hz for at least 1s every 10s.

5.1.1 RF Channel Frequency

Both the BP monitor and collector devices will operate at an RF Channel Frequency of 2457MHz whilst in the unconnected link state. The host shall change this operational frequency once the devices progress into the authentication and transport states as detailed in the ANT-FS Technical Specification document, and discussed in best practices (section 6.4).

5.1.2 Device Type

The monitor's device type parameter will indicate that it is an ANT+ Blood Pressure Monitor device. The beacon's payload will also include the ANT+ Blood Pressure Monitor device type (see section 6.1.1).

5.1.3 Device Number

The device number needs to be as unique as possible across production units. One example is to set the device number parameter to the lowest two bytes of a device's serial number.

The device number of the blood pressure monitor shall not be 0 (0x0000). If the device number is derived from the lower 16-bits of a larger serial number, ensure that multiples of 65536 (0x10000) do not cause the device number to be set to 0.

5.1.4 Beacon Channel Period

The initial beacon channel period used by the blood pressure monitor whilst in the unconnected link layer depends on the available power mode(s):

- Single or High Power Mode: 4Hz continuously (default)
- Low Power Mode: 8Hz for at least 1 second every 10 seconds (optional) or the default continuous 4Hz

If only a single power mode is available, the monitor shall continuously beacon at a rate of 4 Hz. If high and low power states are available, the monitor should beacon continuously at 4Hz in high power mode, and may beacon intermittently at 8Hz for at least one second every 10 seconds while in low power mode. This will ensure a rapid acquisition time while also maintaining low power consumption on the client device.

The collection device can alter the client's beacon rate while in authentication or transport layers, as outlined in section 6.1.2, and in accordance with the ANT-FS Technical Specification.

5.2 ANT-FS Host – Collection Device

The ANT-FS host channel shall be established as outlined in the ANT-FS technical specification and as shown in Table 5-2.

Table 5-2. ANT Channel Configuration for a Blood Pressure Collection Device (ANT-FS Host Device)

Parameter	Value	Comment
Channel Type	Slave (0x00)	The collection device shall act as the ANT-FS Host device and shall be configured as an ANT slave to receive ANT-FS beacons from the blood pressure monitor
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 (2457 MHz) is used for the initial link layer of ANT+ devices
Transmission Type	0 (0x00) for searching	The transmission type must be set to 0 for a pairing search. 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	18 (0x12)	Allows the ANT-FS host device to find an ANT+ Blood Pressure Monitor beacon device
Device Number	0 (0x0000) for searching	The device number will be defined by the blood pressure monitor. Once the device is found, and appropriate pairing established, this value should be remembered for future searches
Channel Period	8192 counts	Data shall be received by the collection device at a rate of 4Hz (8192)

5.2.1 RF Channel Frequency

Both the BP monitor and collector devices will operate at an RF Channel Frequency of 2457MHz whilst in the unconnected link state. To avoid interfering with other ANT+ broadcasting devices during file transfer, the host shall change this operational frequency once the devices progress into the authentication and transport states as detailed in the ANT-FS Technical Specification document, and discussed in best practices (section 6.4).

5.2.2 Device Type

The collector will search for an ANT+ Blood Pressure Monitor beaconing device (i.e. Device Type = 0x12). The monitor's beacon payload will also include the ANT+ Blood Pressure Monitor device type (see section 6.1.1).

5.2.3 Device Number

The device number is used to identify specific blood pressure devices. This device number will be as unique as possible. Initially this value will be unknown and a value of 0 (0x0000) can be used for pairing. Unlike standard ANT+ broadcast sensors, an ANT-FS system has higher level pairing mechanisms that are performed at the application level. These higher level pairing schemes are discussed in detail in the ANT-FS Technical Specification and summarized in section 6.2.

Once a blood pressure device has been uniquely identified, and it has been determined that pairing should be established, the host device should remember the channel ID, and any other relevant parameters (such as serial number, passkey, manufacturing ID , etc), for future connections.

5.2.4 Channel period

The client will beacon in the link state at 4 Hz or 8Hz depending on the available power mode(s). The host is set to receive at 4Hz, supporting both defined client beacon rates. The host may check the client's beacon and alter its channel period to that of the client, OR the host may define the channel period of communication in subsequent ANT-FS states (i.e. authentication and transport states). For more details refer to the ANT-FS specifications.

6 ANT-FS Implementation Details

The ANT+ Blood Pressure Device Profile uses the ANT File Share (ANT-FS) system of establishing and authenticating the wireless link. Please note, the **ANT-FS Technical Specification must be implemented in its entirety in order to be compliant with this profile.** This section provides an overview, only, of how the ANT+ Blood Pressure monitor and collection device shall behave as defined by ANT-FS.

6.1 Link State

6.1.1 Blood Pressure Monitor Link Beacon

When the blood pressure monitor has data to transmit to a collection device, the BP monitor shall enter the unconnected ANT-FS link state. In this state, the blood pressure monitor shall transmit a link beacon at a rate of no less than 4Hz (8192 counts). The format of the link beacon is described in Table 6-1.

For details on the state machine associated with an ANT-FS client device in link state, please refer to the ANT-FS Technical Specification document and the associated help files and reference code.

Table 6-1. ANT+ Blood Pressure Link Beacon

Byte	Description	Length	Value
0	ANT-FS Beacon ID	1 Byte	67 (0x43) – Identifies page as an ANT-FS Beacon
1	Bit field – Status Byte 1	1 Byte	Refer to ANT-FS Technical Specification for details.
2	Bit field – Status Byte 2	1 Byte	Refer to ANT-FS Technical Specification for details.
3	Authentication	1 Byte	Refer to ANT-FS Technical Specification for details.
4	Device Type (LSB)	2 Bytes	18 (0x0012) - Client device type is an ANT+ BP monitor
5	Device Type (MSB)		
6	Manufacturer ID (LSB)	2 Bytes	Assigned by ANT+ to all manufacturers. Contact ANT+ to obtain a manufacturer ID. Most significant bit (i.e. bit 15) should be set to 1 to indicate the device type is ANT+ managed.
7	Manufacturer ID (MSB)		

6.1.1.1 Status Byte 1

The status byte 1 fields should be set according to the ANT-FS Technical Specification. The Blood Pressure Device Profile further defines the following:

Data Available: This bit shall be set to indicate the BP monitor has data available for download.

Pairing Enabled: A BP monitor will use pairing or passkey methods of authentication only. Pass-through is not supported. The negotiation of the pairing mechanism may be transacted via the ANT-FS beacon and command interchange between devices.

Beacon Channel Period: The BP monitor's initial beacon message rate depends on the power mode(s) available. If the client device only supports a single power mode, the initial beacon rate is 4Hz. If the BP monitor supports dual mode, the initial beacon period in high power mode is also 4Hz, whereas in low power mode the BP monitor shall beacon at 8Hz for 1 second every 10 seconds.

The channel period whilst in the authentication and transport states can then be negotiated per system requirements.

6.1.1.2 Status Byte 2

The status byte 2 fields should be set according to the ANT-FS Technical Specification. The Blood Pressure Device Profile further defines:

Client Device State: The BP monitor shall stay in the unconnected link state until it receives the link command from the collection device. Until this time bits 3 – 0 of status byte 2 shall be set as 0000 to indicate the BP monitor is in the unconnected link state.

6.1.1.3 Authentication

This field shall be set according to the desired authentication mechanism. Only pairing and passkey authentication types are permitted for use in the ANT+ blood pressure system. Best practices for the collections device's authentication handling are covered in section 6.2.4.

6.1.1.4 Device Type

The ANT-FS device type is managed by ANT+ and shall be set to 18 (0x12) indicating that the client device contains BP data. This information along with the channel ID will help to uniquely identify the device that is transmitting the ANT-FS beacon.

6.1.1.5 Manufacturer ID

The manufacturer's ID is assigned by ANT+. To obtain a manufacturer's ID please contact ANTAlliance@thisisant.com. **The most significant bit (i.e. bit 15) of the manufacturer ID field shall be set to 1**. This indicates that the device type field is managed by ANT+.

6.1.2 Collection Device Link Command

When a collection device receives a beacon from the BP monitor, it can use the information in the beacon payload to determine if it wants to initiate an ANT-FS session. The collection device can send an ANT-FS link command to move both client and host devices into the authentication state. The link command is described in Table 6-2.

For details on the state machine associated with an ANT-FS host device in link state please refer to the ANT-FS Technical Specification document and associated help files and reference code.

Table 6-2. ANT+ Blood Pressure Link Command

Byte	Description	Length	Value
0	ANT-FS Command/Response	1 Byte	68 (0x44) – Identifies ANT-FS command/response message
1	Command/Response ID	1 Byte	2 (0x02) – Identifies link command message
2	Channel Frequency	1 Byte	Refer to ANT-FS Technical Specification for details.
3	Channel period	1 Byte	Refer to ANT-FS Technical Specification for details.
4	Host Serial Number (LSB)	4 Bytes	The serial number of the host (i.e. collection device)
5	Host Serial Number		
6	Host Serial Number		
7	Host Serial Number (MSB)		

6.1.2.1 RF Channel Frequency

Note that while both devices should operate at an RF Channel Frequency of 2457MHz while in the unconnected link layer, a collection device shall request a change in RF channel frequency for subsequent ANT-FS communication states. As transferring files utilizes a significant amount of bursting, changing the RF channel frequency to something other than 2457MHz will allow the devices to transfer files without creating interference to other, neighboring ANT+ devices.

When the BP monitor receives the link command it will change its RF channel frequency to the value specified in this data field. Please refer to the ANT-FS Technical Specifications document for more details.

6.1.2.2 Channel period

The collection device also has the ability to request that the ANT channel change its channel period. When the BP monitor receives this command it will change its message rate to that specified in this data field. The channel period options require

the same mapping as status byte 1 of the link beacon, with bits 7 – 3 reserved and set to '0', and bits 2 – 0 defining the channel period.

6.1.2.3 Host Serial Number

The collection device shall put its serial number into the final four bytes of the link command. This will allow the BP monitor to determine which collection device sent the link command. Once received, the BP monitor will place the collection device's serial number in subsequent authentication and transport beacons (explained in sections 6.2 and 6.3). The collection device shall then only interact to a BP monitor's authentication and transport beacons that have its own serial number contained in those beacons.

6.2 Authentication State

The Authentication State of the ANT-FS connection is determined by the blood pressure monitor. Collection devices shall implement the full ANT-FS technical specification and shall be able to accommodate different blood pressure monitors that may have different authentication and pairing requirements.

The following sections will outline the format and structure of the Authentication State's beacons, commands, and responses. For details on the individual data fields and the different authentication methods, please refer to the ANT-FS Technical Specification document.

6.2.1 BP Monitor Authentication Beacon

Once the blood pressure monitor has received the link command from the collection device, the ANT-FS system will be moved into the Authentication state. The blood pressure monitor shall set the RF channel frequency and the channel period according to the received link command.

The authentication and transport states use the same beacon structure, which is similar to that of the link state beacon except that bytes 4 – 7 now contain the serial number of the collection device that sent the link command (Table 6-3).

Table 6-3. ANT+ Blood Pressure Authentication Beacon

Byte	Description	Length	Value
0	ANT-FS Beacon ID	1 Byte	67 (0x43) – Identifies ANT-FS Beacon
1	Bit field – Status Byte 1	1 Byte	Refer to ANT-FS Technical Specification for details.
2	Bit field – Status Byte 2	1 Byte	Refer to ANT-FS Technical Specification for details.
3	Authentication	1 Byte	Refer to ANT-FS Technical Specification for details.
4	Host Device Serial Number (LSB)	4 Bytes	Serial number of the collection device is transmitted here.
5	Host Device Serial Number		
6	Host Device Serial Number		
7	Host Device Serial Number (MSB)		

6.2.1.1 Status Byte 1

The status byte 1 fields should be set according to the ANT-FS Technical Specification. The Blood Pressure Device Profile further defines the following:

Data Available: This bit should be set to indicate that the BP monitor has data available for download.

Pairing Enabled: A BP monitor will use pairing or passkey methods of authentication only. Pass-through is not supported. The negotiation of the pairing mechanism may be transacted via the ANT-FS beacon and command interchange between devices.

Beacon Channel Period: The beacon message rate shall be set as specified by the channel period field in the collection device's link command. For more details refer to the ANT-FS Technical Specification document.

6.2.1.2 Status Byte 2

The status byte 2 fields should be set according to the ANT-FS Technical Specification. The Blood Pressure Device Profile further defines:

Client Device State: The blood pressure monitor shall reflect its state as defined in the ANT-FS Technical Specification document, and with bits 3:0 as summarized below:

- Authentication State: shall be set to 0001 (or 0011 if busy)
- Transport State: shall be set to 0010 (or 0011 if busy)

6.2.1.3 Authentication

The authentication string contains the passkey. This field shall be set according to the desired authentication mechanism. Only pairing and passkey authentication types are permitted for use in the ANT+ blood pressure system. Best practices for the collections device's authentication handling are covered in section 6.2.4.

6.2.1.4 Host Serial Number

Bytes 4 – 7 of the authentication (and transport) state's beacon shall be used to transmit the serial number of the collection device, as was received by the BP monitor in the link command.

6.2.2 Collection Device Authenticate Command

The collection device will transmit the authenticate command after receiving an authentication beacon from the blood pressure monitor. This command starts the authentication process requested by the blood pressure monitor.

Table 6-4. ANT+ Blood Pressure Authenticate Command

Byte	Description	Length	Value
0	ANT-FS Command/Response	1 Byte	68 (0x44) – Identifies ANT-FS Command/Response
1	Command/Response ID	1 Byte	4 (0x04) – Identifies the Authenticate Command
2	Command Type	1 Byte	Refer to ANT-FS Technical Specification for details.
3	Authentication String Length	1 Byte	Refer to ANT-FS Technical Specification for details.
4	Host Serial Number (LSB)	4 Bytes	Serial number of the collection device is transmitted here.
5	Host Serial Number		
6	Host Serial Number		
7	Host Serial Number (MSB)		

6.2.2.1 Command Type

The command type shall mirror what has been requested by the authentication beacon in the authentication data field. The collection device implements the full ANT-FS specification and shall be able to handle the following authentication command types in order to be fully interoperable with all ANT+ blood pressure monitors:

- Request client serial number (0x01)
- Request client pairing operation (0x02)
- Passkey exchange (0x03)

6.2.2.2 Authentication String Length

The authentication string contains the passkey. The authentication string length can also be the friendly name, sent along with the pairing request. For details on how to implement this data field see the ANT-FS Technical Specification.

6.2.2.3 Host Serial Number

The collection device's serial number is included in the authenticate command.

6.2.3 Blood Pressure Monitor Authenticate Response

Once the blood pressure monitor receives the appropriate authenticate command from the collection device, it will transmit the authenticate response as outlined in Table 6-5.

Table 6-5. ANT+ Blood Pressure Authenticate Response

Byte	Description	Length	Value
0	ANT-FS Command/Response	1 Byte	68 (0x44) – Identifies ANT-FS Command/Response
1	Command/Response ID	1 Byte	132 (0x84) – Identifies the Authenticate Response
2	Response Type	1 Byte	0: N/A (response for serial number request) 1: Accept 2: Reject Refer to ANT-FS Technical Specification for details.
3	Authentication String Length	1 Byte	Refer to ANT-FS Technical Specification for details.
4	Client Serial Number (LSB)	4 Bytes	Serial number of the blood pressure monitor
5	Client Serial Number		
6	Client Serial Number		
7	Client Serial Number (MSB)		

6.2.3.1 Response Type

The blood pressure monitor can accept or reject the authenticate command of the collection device. If a serial number is requested, this field will be set to 0. For details on this data field refer to the ANT-FS Technical Specification document.

6.2.3.2 Authentication String Length

For details on how to implement this data field see the ANT-FS Technical Specification document.

6.2.3.3 Client Serial Number

The blood pressure monitor's serial number is included in the authenticate response.

6.2.4 Authentication Handler

The BP collection device's authentication handler is shown in Figure 6-2. Once a link command has sent, the BP collection device will receive the BP monitor's authentication beacon indicating that it has moved into the authentication state. The beacon will also contain the collection device's serial number.

6.2.4.1 Request Serial Number

The collection device shall then use the authenticate command as described in Table 6-4 to request the BP monitor's serial number. The BP monitor will send the serial number in the authenticate response which is sent as a burst transfer consisting of the beacon and serial number as described in Table 6-3 and Table 6-5. The client may also send an optional friendly name in the burst transfer.

6.2.4.2 Pairing

On receiving the BP monitor's serial number, the collection device should check to see if a passkey already exists for that BP device. If no pass key is known, then the collection device shall request pairing using the authenticate command. If a friendly name is included, this command will be burst to the BP monitor. If no friendly name is included, the authenticate command is sent as a standard acknowledged message.

The BP monitor will accept or reject the pairing request with an authenticate response. If pairing is rejected, both devices will move back into the unconnected link state. If pairing is accepted, the BP monitor shall also send the passkey (i.e. authentication string) in the authenticate response. This will be a burst transfer of varying length depending on the size of the passkey. Once the pairing has been accepted and passkey sent, the BP monitor moves into the transport state and will

transmit the transport beacon. The collection device should store the BP monitor's serial number and passkey combination for future connections.

6.2.4.3 Passkey

If the collection device receives the serial number, and a passkey is already stored for that BP monitor, the collection device should request a passkey exchange using the authenticate command. The command will be sent as a burst transfer to the BP monitor and includes the passkey authentication string.

The BP monitor will accept or reject the passkey exchange using a 2 packet burst transfer containing the authentication beacon and response message. If the passkey exchange is rejected, both devices will return to the unconnected link layer. If the passkey exchange is accepted, the BP monitor will send the transport beacon, indicating it has moved into the transport layer.

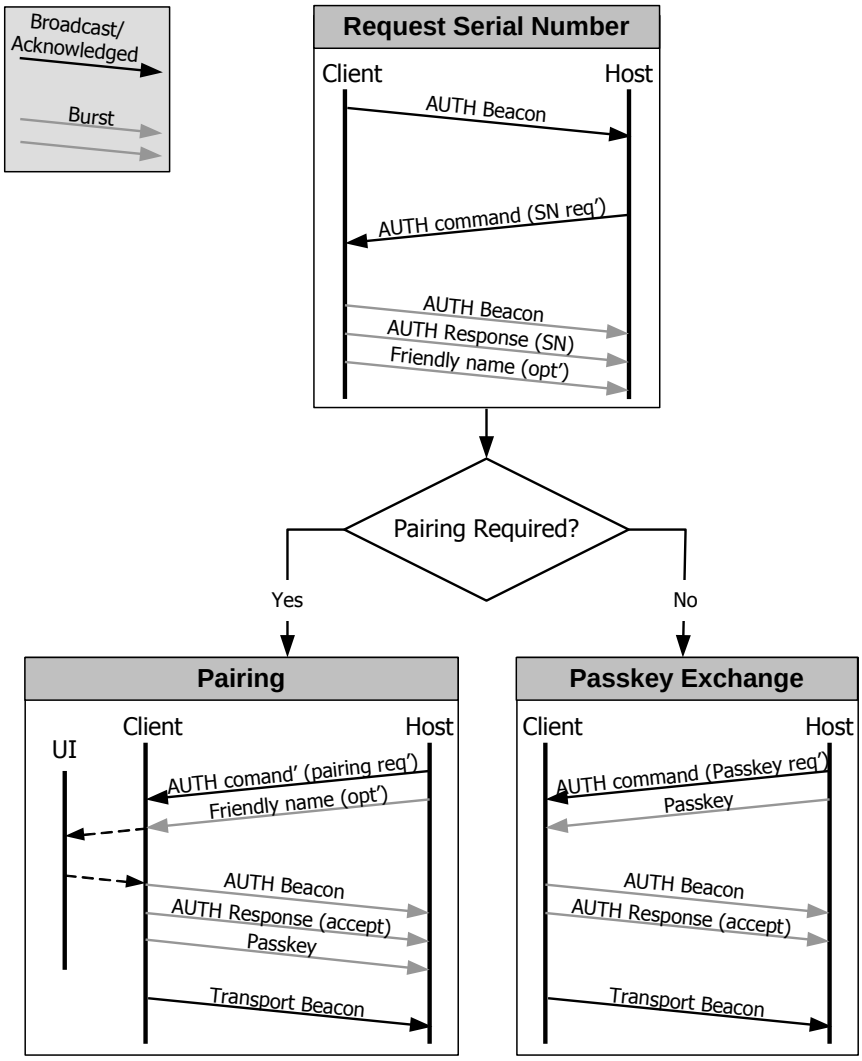

Figure 6-1. Host Authentication Handler

Although both BP monitors and collection devices shall implement the full ANT-FS technical specification, no ANT+ BP monitor shall request pass-through authentication.

6.3 Transport State

The transport state of the ANT-FS connection allows files to be selected and transferred between devices. These files can be sent from the blood pressure monitor to the collection device, as well as from the collection device to the blood pressure monitor (Figure 6-2).

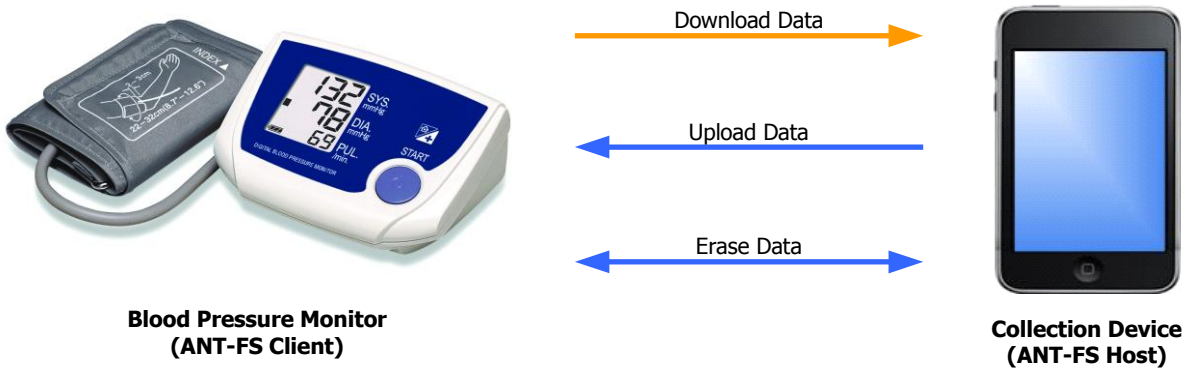

Figure 6-2. ANT+ Blood Pressure File Transfer

6.3.1 BP Monitor Transport Beacon

The blood pressure monitor will transmit the transport beacon once the ANT-FS state machine has progressed to the transport state. The transport beacon has the same structure as the authentication beacon detailed in Table 6-3, with the exception of Status Byte 2 (Client Device State); which will change to indicate that the blood pressure monitor is now in the transport state, as defined in the ANT-FS Technical Specification document.

6.3.2 Transport State Commands/Responses

Once the client's beacon indicates it is in the transport state, the host device can request data upload, download, or erase operations. The BP monitor will store the data in a FIT BP file. As described in the ANT-FS Technical Specification document, this file is allocated an index number indicating where it is stored in the device's memory. Upload, download and erase commands all reference the file's index number. The first step a collection device shall perform is a download request of the BP monitor's directory structure, which is located at file index 0.

The following sections outline a collection device's download request, followed by a BP monitor's download response. For other commands such as data upload and erase, please refer to the ANT-FS Technical Specification and ANT-FS Reference Design User Manual documents.

The Blood Pressure Device Profile may be expanded to include the use of ANT-FS command pipe messages for time synchronization or other purposes.

6.3.2.1 Collection Device Download Request

The download request is sent as a burst transmission as it comprises of two data pages from the collection device when the blood pressure monitor has indicated that there is data available for download.

The two download request data packets are outlined in Table 6-6 and Table 6-7. Refer to the ANT-FS Technical Specification document for a description of these fields. Refer to the ANT-FS reference code to see how the download request is implemented.

Table 6-6. Download Request Data Packet 1 of 2

Byte	Description	Length	Value
0	ANT-FS Command/Response	1 Byte	68 (0x44) – Identifies this as an ANT-FS Command/Response
1	Command/Response ID	1 Byte	9 (0x09) – Identifies the Download Request
2	Data File Index (LSB)	2 Byte	Refer to ANT-FS Technical Specification for details.
3	Data File Index (MSB)		
4	Data Offset (LSB)	4 Bytes	Refer to ANT-FS Technical Specification for details.
5	Data Offset		
6	Data Offset		
7	Data Offset (MSB)		

Table 6-7. Download Request Data Packet 2 of 2

Byte	Description	Length	Value
0	Reserved	1 Byte	0 (0x00)
1	Initial Request	1 Byte	Refer to ANT-FS Technical Specification for details.
2	CRC Seed (LSB)	2 Byte	Refer to ANT-FS Technical Specification for details.
3	CRC Seed (MSB)		
4	Maximum Block Size (LSB)	4 Bytes	Refer to ANT-FS Technical Specification for details.
5	Maximum Block Size		
6	Maximum Block Size		
7	Maximum Block Size (MSB)		

6.3.2.2 Blood Pressure Monitor Download Response

After receiving the appropriate download request from the collection device, the blood pressure monitor will send the download response, which is sent as a burst data transmission from the blood pressure monitor.

The transport beacon is discussed in section 6.3.1. The two download response data packets are shown in Table 6-8 and Table 6-9 respectively.

Table 6-8. ANT+ Blood Pressure Download Response Data Packet 1 of 2

Byte	Description	Length	Value
0	ANT-FS Command/Response	1 Byte	68 (0x44) – Identifies this as an ANT-FS Command/Response
1	Command/Response ID	1 Byte	137 (0x89) – Identifies the Download Response
2	Response	1 Byte	Refer to ANT-FS Technical Specification for details.
3	Reserved	1 Byte	0 (0x00)
4	Remaining Data Length (LSB)	4 Bytes	Refer to ANT-FS Technical Specification for details.
5	Remaining Data Length		
6	Remaining Data Length		
7	Remaining Data Length (MSB)		

Table 6-9. ANT+ Blood Pressure Download Response Data Packet 2 of 2

Byte	Description	Length	Value
0	Reserved	4 Bytes	Refer to ANT-FS Technical Specification for details.
1	Initial Request		
2	CRC Seed (LSB)		
3	CRC Seed (MSB)		
4	Maximum Block Size (LSB)	4 Bytes	Refer to ANT-FS Technical Specification for details.
5	Maximum Block Size		
6	Maximum Block Size		
7	Maximum Block Size (MSB)		

The ANT+ Blood Pressure file is overviewed in section 7. Refer to the FIT File Types document for details. The footer data packet is shown in Table 6-10.

Table 6-10. ANT+ Blood Pressure Download Response Footer Packet

Byte	Description	Length	Value
0	Reserved	1 Byte	0 (0x00)
1	Reserved	1 Byte	0 (0x00)
2	Reserved	1 Byte	0 (0x00)
3	Reserved	1 Byte	0 (0x00)
4	Reserved	1 Byte	0 (0x00)
5	Reserved	1 Byte	0 (0x00)
6	CRC (LSB)	2 Bytes	Refer to ANT-FS Technical Specification for details.
7	CRC (MSB)		

Figure 6-3 illustrates the sequence of commands for the complete transfer of data from a BP monitor to collection device.

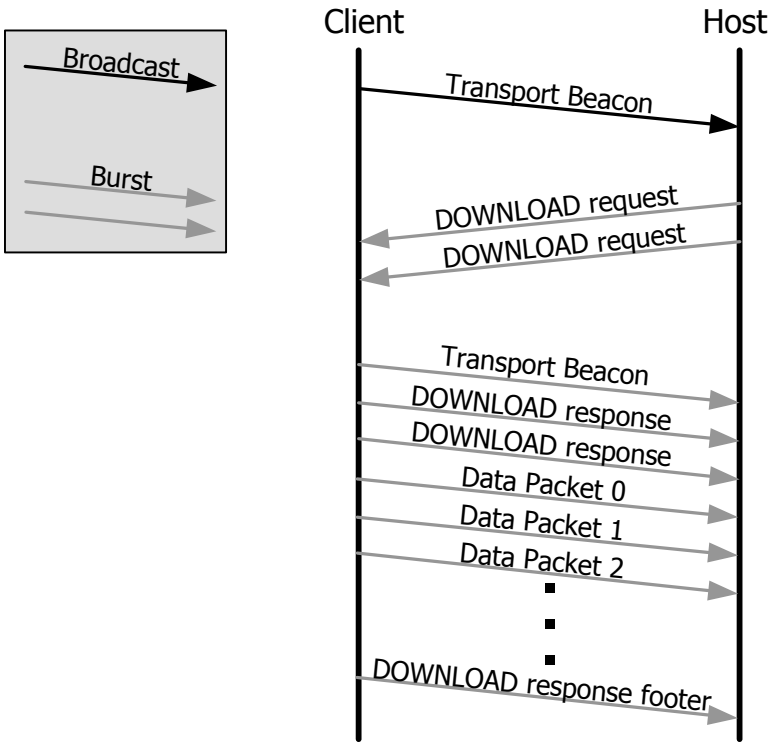

Figure 6-3. Download Sequence

After the successful completion of the BP file transfer, the blood pressure monitor shall remain in the transport state for an application-specific amount of time (e.g. 1 minute). This will allow the collection device to issue any further requests, and for the blood pressure monitor to respond appropriately. After sending the transport beacon without any response from the collection device within the specified amount of time, the blood pressure monitor may turn off its ANT-FS beacon (i.e. close the ANT channel) until new data is stored and ready for transfer.

6.4 Best Practices

The ANT-FS Technical Specification must be implemented in its entirety in both the BP monitor and collector device in order to be compliant with this profile.

Once the BP monitor takes a measurement, it will add the data to a FIT BP file (described in section 7 and FIT File Types document). The BP monitor shall only beacon once data is available for download.

The developer will design the BP collector device to open an ANT channel and initiate a search for an ANT+ BP device (ANT channel device type = 0x12). Once an ANT-FS beacon is found, the collector shall check the contents of the beacon, specifically that the manufacturer ID indicates that it is an ANT+ managed device, and that the corresponding Device Type is a blood pressure monitor (beacon payload device type = 0x0012).

Once a BP monitor's link beacon is detected, the collector can send the link command. The collector device shall specify a new RF channel frequency (mandatory) and may also change the channel period (optional) for subsequent communication. The link command will also include the collector's serial number.

On receiving the link command, the BP monitor will change its RF channel frequency and channel period to match that specified in the link command. It will progress to the authentication state and start transmitting the authentication beacon, which will include the collector's serial number.

On receiving the authentication beacon, the collector shall check that its own serial number is contained in the authentication beacon's payload. If the serial number does not match that of the collector, it shall remain in the unconnected link state; however, if the serial number matches that of the collector, then the collector will progress into the authentication state.

Authentication will be handled as described in section 6.2.4. If pairing was used, the collector device shall store the BP monitor's serial number and passkey for future connections.

The collector shall then download the BP monitor's directory from file index 0 and search for the FIT Blood Pressure File subdirectory type. The collector shall then request a download of the BP file.

Once the files have been downloaded from the BP monitoring device, the data should be erased, or a user interface provided to user-select a file erase.

The BP device profile may be expanded to include user profile uploads, and allow for ANT-FS pipeline commands.

7 ANT+ Blood Pressure FIT File Format

All data is transferred between a blood pressure monitor and collection device using the FIT Protocol. Please read the Flexible & Interoperable Data Transfer (FIT) Protocol and FIT File Types documents for details.

Blood pressure data is stored in the BP monitoring file type. The BP monitoring file must contain the FIT file_id and blood_pressure messages as described in Table 7-1. It may also, optionally contain the user_profile and device_info messages.

Table 7-1. FIT messages contained in BP Monitoring File

FIT Message	FIT Fields	Required	Type	Value/Units
file_id (files from device)	type	Y	file (enum)	BP file
	manufacturer	Y	Manufacturer (UINT16)	ANT+ managed. Please contact antalliance@thisisant.com for details
	product	Y	UINT16	Managed by manufacturer
	serial_number	Y	UINT32z	Managed by manufacturer
file_id (files to device)	type	Y	file (enum)	BP Monitoring file
user_profile	message_index	Y*	UINT16	Provides an index such that other FIT messages can be related to this user
	local_id	N	UINT16	BP monitor's local user ID
	friendly_name	N	String	
	gender	N	Gender (enum)	Male/female
	age	N	UINT8	Years
	height	N	UINT8	1/100 m
	weight	N	UINT16	1/10 kg
	resting_heart_rate	N	UINT8	bpm
blood_pressure	timestamp	Y	Date_time (UINT32)	Seconds since UTC 00:00 Dec 31 1989 If <0x10000000 = system time
	user_profile_index	N	UINT16	Provides a link to the user_profile message. e.g. user_profile_index = 1 relates to the user_profile message with message_index = 1
	systolic_pressure	Y	mmHg (UINT16)	
	diastolic_pressure	Y	mmHg (UINT16)	
	mean_arterial_pressure	N	mmHg (UINT16)	
	heart_rate	Y	bpm (UINT8)	
	map_3_sample_mean	N	mmHg (UINT16)	
	map_morning_values	N	mmHg (UINT16)	
	map_evening_values	N	mmHg (UINT16)	
	heart_rate_type	N	hr_type (enum)	normal, irregular

device_info	timestamp	Y*	Date_time (UINT32)	Seconds since UTC 00:00 Dec 31 1989 If <0x10000000 = system time
	device_index	N	device_index (UINT8)	
	device_type	N	device_type (UINT8)	18 (0x12) for ANT+ BP monitor
	manufacturer	N	manufacturer (UINT16)	managed by ANT+ msb (i.e. bit 15) must be set to 1
	serial_number	N	UINT32z	Managed by manufacturer
	product	N	UINT16	Managed by manufacturer
	software_version	N	UINT16	Managed by manufacturer
	hardware_version	N	UINT8	Managed by manufacturer
	cum_operating_time	N	UINT32	s
	battery_voltage	N	UINT16	1/256 V
	battery_status	N	battery_status (enum)	new/good/ok/low/critical

* Field is only required if the optional FIT message is recorded

As indicated in the "Required" column, not all of the listed fields shall be included in the BP file. At a minimum, the following is required:

- file_id message must be included to indicate the file type
- blood_pressure message containing systolic pressure, diastolic pressure and pulse (i.e. heart_rate)
- *If the optional user_profile message is included, then it must contain the message_index field in order to link the respective blood_pressure data to each user. The file shall contain a user_profile message with a matching message_index defined for each user_profile_index used. If this message is not recorded, it is implied that user ID's are not supported on any level
- *If the optional device_info message is included, then it must contain the timestamp field in order to link each device_info message to its respective blood_pressure message

Refer to the FIT File Types documents for details and examples of blood pressure files.

8 Blood Pressure Monitor Minimum Compliance

The ANT+ BP monitor that is compliant with the BP icon shall transmit its beacon and progress through the ANT-FS states as described in section 6. Although many ANT-FS details, specifically those related to BP, are described in this document, the **ANT-FS Technical Specification must be implemented in its entirety in order to be compliant with this profile.** Once an ANT-FS session has been established, the collector device will transmit a FIT blood pressure file. The FIT file shall include the minimum FIT messages and fields outlined in (Table 8-1).

Table 8-1. Minimum FIT BP File messages and fields

FIT Message	FIT Fields	Required	Type	Value/Units
file_id (files from device)	type	Y	file (enum)	BP file
	manufacturer	Y	Manufacturer (UINT16)	ANT+ managed. Please contact
	product	Y	UINT16	Managed by manufacturer
	serial_number	Y	UINT32z	Managed by manufacturer
blood_pressure	Timestamp	Y	Date_time (UINT32)	Seconds since UTC 00:00 Dec 31 1989 If <0x10000000 = system time
	systolic_pressure	Y	mmHg (UINT16)	
	diastolic_pressure	Y	mmHg (UINT16)	
	heart_rate	Y	bpm (UINT8)	

These messages should be recorded in the file as illustrated in Figure 8-1. Note, illustrated are the minimum FIT fields only. Refer to the FIT File Types document for complete details of the BP File Type.

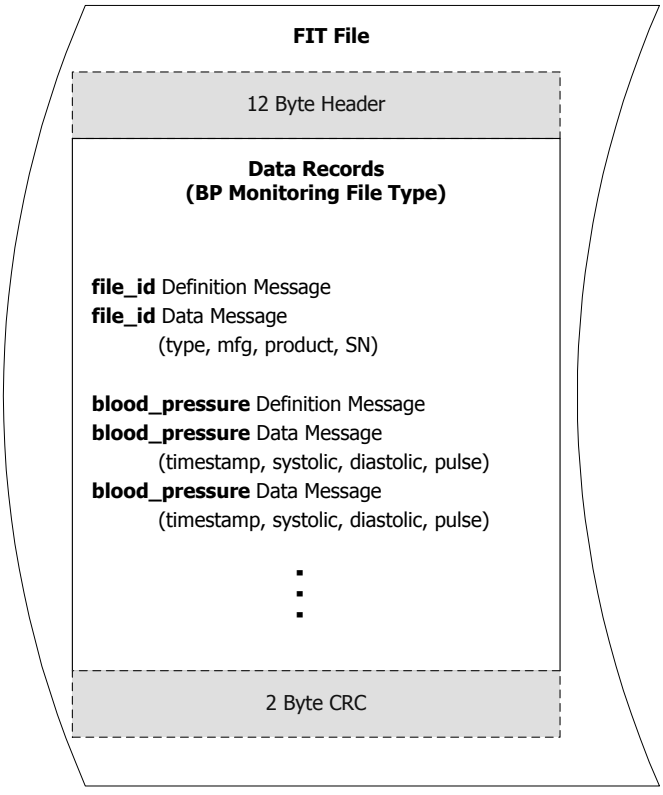

Figure 8-1. Minimum FIT BP file requirements