ANT+ Device Profile

Shifting

Copyright Information and Usage Notice

This information disclosed herein is the exclusive property of Dynastream Innovations Inc. The recipient and user of this document must be an ANT+ Adopter pursuant to the ANT+ Adopter's Agreement and must use the information in this document according to the terms and conditions of the Adopter's Agreement and the following:

a) You agree that any products or applications that you create using the ANT+ Documents and ANT+ Design Tools will comply with the minimum requirements for interoperability as defined in the ANT+ Documents and will not deviate from the standards described therein.

b) You agree not to modify in any way the ANT+ Documents provided to you under this Agreement.

c) You agree not to distribute, transfer, or provide any part of the ANT+ Documents or ANT+ Design Tools to any person or entity other than employees of your organization with a need to know.

d) You agree to not claim any intellectual property rights or other rights in or to the ANT+ Documents, ANT+ Design Tools, or any other associated documentation and source code provided to you under this Agreement. Dynastream retains all right, title and interest in and to the ANT+ Documents, ANT+ Design Tools, associated documentation, and source code and you are not granted any rights in or to any of the foregoing except as expressly set forth in this Agreement.

e) DYNASTREAM MAKES NO CONDITIONS, WARRANTIES OR REPRESENTATIONS ABOUT THE SUITABILITY, RELIABILITY, USABILITY, SECURITY, QUALITY, CAPACITY, PERFORMANCE, AVAILABILITY, TIMELINESS OR ACCURACY OF THE ANT+ DOCUMENTS, ANT+ DESIGN TOOLS OR ANY OTHER PRODUCTS OR SERVICES SUPPLIED UNDER THIS AGREEMENT OR THE NETWORKS OF THIRD PARTIES. DYNASTREAM EXPRESSLY DISCLAIMS ALL CONDITIONS, WARRANTIES AND REPRESENTATIONS, EXPRESS, IMPLIED OR STATUTORY INCLUDING, BUT NOT LIMITED TO, IMPLIED CONDITIONS OR WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, DURABILITY, TITLE AND NON-INFRINGEMENT, WHETHER ARISING BY USAGE OF TRADE, COURSE OF DEALING, COURSE OF PERFORMANCE OR OTHERWISE.

f) You agree to indemnify and hold harmless Dynastream for claims, whether arising in tort or contract, against Dynastream, including legal fees, expenses, settlement amounts, and costs, arising out of the application, use or sale of your designs and/or products that use ANT, ANT+, ANT+ Documents, ANT+ Design Tools, or any other products or services supplied under this Agreement.

If you are not an ANT+ Adopter, please visit our website at www.thisisant.com to become an ANT+ Adopter. Otherwise you must destroy this document immediately and have no right to use this document or any information included in this document.

The information contained in this document is subject to change without notice and should not be construed as a commitment by Dynastream Innovations Inc.

Products sold by DYNASTREAM are not designed for use in life support and/or safety equipment where malfunction of the Product can reasonably be expected to result in injury or death. You use or sell such products for use in life support and/or safety applications at your own risk and agree to defend, indemnify and hold harmless DYNASTREAM from any and all damages, claims, suits or expense resulting from such use.

Revision History

Revision	Effective Date	Description
1.0	November 2016	Creation of document

Table of Contents

List of Tables

List of Figures

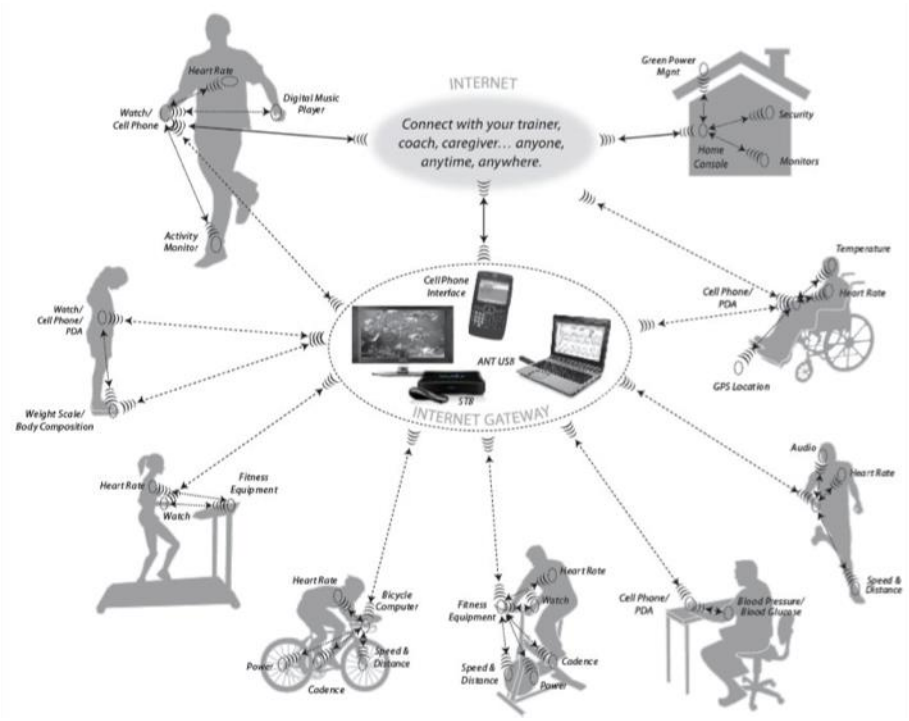
1 Overview of ANT+

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. Flexible and Interoperable Data Transfer (FIT) Protocol
4. FIT File Types

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 ANT+ Shifting Use Case

The ANT+ Shifting Device Profile defines interoperable wireless communication between electronic gear-shifting systems (shifting devices) and portable displays (displays). Primarily, it enables a shifting device to broadcast its current gear status to the display. Messaging for supplementary information and notifications such as invalid shifting requests, shifting failures, component battery statuses, and system information (including manufacturer and product information) are also defined. Section 6 defines the broadcast transmission pattern and messaging data formats for the ANT+ Shifting Device Profile.

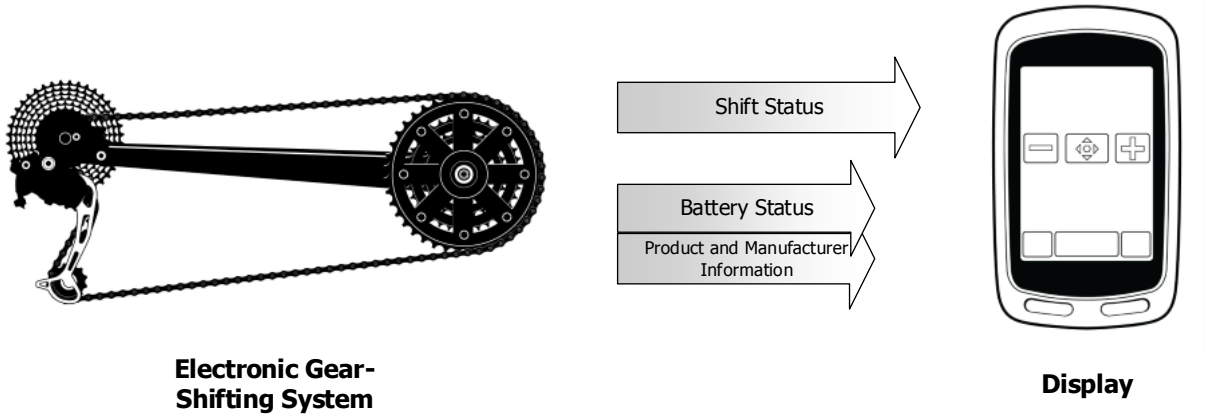


Figure 4-1. ANT+ Shifting Device Profile Use Case

In addition to defining broadcast data messaging for shifting devices, the ANT+ Shifting Device Profile also defines a standard storage format for storing shifting data on display devices using the Flexible and Interoperable Data Transfer (FIT) protocol. Section 7 defines the FIT storage format for the ANT+ Shifting Device Profile.

5 Channel Configuration

The channel configuration parameters of the ANT+ shifting device 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 Master Channel Configuration

The ANT+ shifting device **shall [MD_0001] [MD_0002] [MD_0003]** configure its ANT channel as shown in Table 5-1.

Table 5-1. ANT Channel Configuration for ANT+ Shifting Device (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+ shifting device.
Transmission Type	Set MSN to 0 (0x0) or MSN of extended device number. Set LSN to 5 (0x5)	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	34 (0x22)	An ANT+ shifting device **shall [MD_0001]** transmit its device type as 0x22. 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+ shifting device. 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	8192 counts	Data is transmitted every 8192/32768 seconds (4 Hz).

5.1.1 Channel Type

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

5.1.2 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.

5.1.3 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 ID; ensure that the device has a set serial number.

The device number of the ANT+ shifting device **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.

5.2 Slave Channel Configuration

The device expected to receive data from an ANT+ shifting device **shall [SD_0001]** configure an ANT channel with its channel parameters set as listed in Table 5-2.

Table 5-2. ANT Channel Configuration for ANT+ Shifting Display Device (i.e. Slave)

Parameter	Value	Comment
Channel Type	Slave (0x00)	The ANT+ shifting device 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+ shifting device.
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	34 (0x22)	34 (0x22) – indicates search for an ANT+ shifting device. 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	8192 counts	Data is transmitted from the ANT+ shifting device every 8192/32768 seconds (4 Hz) and must be received at this rate.
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.

5.2.1 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+ shifting device that it is searching for.

5.2.2 Channel Period

The channel period is set such that the display device **shall [SD_0003]** receive data at the full message rate (4 Hz). Since the display may send status change messages on any given channel period, the display device must be configured to receive all messages transmitted.

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 profile specific data.

Table 6-1. ANT+ General Message Format

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

6.2 Data Page Types

6.2.1 Main Data Page

The Shift System Status data page (data page 1) is the only required main data page and **shall [MD_0008]** be transmitted from the shifting device by default. On shift events, the Shift System Status data page **shall [MD_0008]** be transmitted in 4 consecutive messages with the updated status information.

6.2.1.1 Request Data Page

To request specific data pages like the Battery Status page, the Request data page (data page 70) may be used.

6.2.2 Background Data Pages

Background data pages contain slow changing or constant data and are interleaved in the regular transmission pattern at a slow rate (minimum: once every 65 seconds). All background pages defined in this device profile are common pages:

- Multi-component System Manufacturer's Identification Page (data page 78)
- Multi-component System Product Information Page (data page 79)
- Battery Status Page (data page 82)

6.3 Transmission Patterns

The ANT+ shifting device transmits at a rate of 4 data pages every second. The main data page and the required background data pages must be included in the regular broadcast transmission pattern for a shifting device.

Refer to section 9.1 for the minimum transmission requirements for each required data page.

6.4 Data Page 1 – Shift System Status (0x01)

Data page 1 is the main data page broadcast from an ANT+ shifting device. All devices **shall [MD_0008]** send this data page at a minimum 1 Hz rate. After a shift event (valid or invalid shift on the electronic shifting system), this data page **shall [MD_0008]** be transmitter four times consecutively with updated shifting status information. All fields in this message **shall [MD_0010]** be set as described in Table 6-2.

Table 6-2. Data Page 1 Format – Shift System Status

Byte	Description	Length	Value	Units	Range or Rollover
0	Data Page Number	1 Byte	Data Page Number = 1 (0x01)	N/A	N/A
1	Event Count	1 Byte	Event counter increments with each shift event.	N/A	256 (Rollover)
2	Reserved	1 Byte	Reserved: 0xFF	N/A	N/A
3	Current Gear – Rear	5 Bits (0:4)	Current gear of rear derailleur. 31 = Unknown Current Gear / Error	N/A	0-30
	Current Gear – Front	3 Bits (5:7)	Current gear of front derailleur. 7 = Unknown Current Gear / Error	N/A	0-6
4	Total Number of Gears – Rear	5 Bits (0:4)	Total number of gears in front derailleur. 0 = Unknown Gear Count / Error	Gears	1-31
	Total Number of Gears – Front	3 Bits (5:7)	Total number of gears in rear derailleur. 0 = Unknown Gear Count / Error	Gears	1-7
5	Invalid Inboard Shift Count – Rear	4 Bits (0:3)	Rear Derailleur Over Inboard Shift Count	N/A	16 (Rollover)
	Invalid Outboard Shift Count – Rear	4 Bits (4:7)	Rear Derailleur Over Outboard Shift Count	N/A	16 (Rollover)
6	Invalid Inboard Shift Count – Front	4 Bits (0:3)	Front Derailleur Over Inboard Shift Count	N/A	16 (Rollover)
	Invalid Outboard Shift Count – Front	4 Bits (4:7)	Front Derailleur Over Outboard Shift Count	N/A	16 (Rollover)
7	Shift Failure Count – Rear	4 Bits (0:3)	Rear Derailleur Shift Failure Count	N/A	16 (Rollover)
	Shift Failure Count – Front	4 Bits (4:7)	Front Derailleur Shift Failure Count	N/A	16 (Rollover)

6.4.1 Update Event Count

The update event count field is incremented each time the information in the message is updated (valid or invalid shift event). There are no invalid values for update event count. This field rolls over at 255 (0xFF).

6.4.2 Current Gear - Rear/Front

The front and rear derailleur current gear fields indicate the current gear of the front and rear derailleurs in the electronic shifting system. This field is 0 based, where 0 refers to the innermost gear of the respective derailleur.

6.4.3 Number of Gears - Rear/Front

Total number of gears in the installed shifting system's rear and front derailleurs.

6.4.4 Invalid Inboard Shift Count - Rear/Front

The front and rear derailleur invalid shift count field **shall [MD_0011]** indicate the number of invalid shift events that have occurred.

Invalid Inboard Shift: When a rider attempts an inboard shift while already in the innermost gear of a derailleur.

6.4.5 Invalid Outboard Shift Count - Rear/Front

The front and rear derailleur invalid shift count field **shall [MD_0011]** indicate the number of invalid shift events that have occurred.

Invalid Outboard Shift: When a rider attempts an outboard shift while already in outermost gear of a derailleur.

6.4.6 Shift Failure Count - Rear/Front

Count of valid shift commands that could not be executed by the ANT+ shifting device due to mechanical system failure.

6.5 Data Pages 2-63: Reserved for Future Use

Data pages 2 - 63 are reserved for future data page definitions. These pages **shall [MD_0007]** not be transmitted.

6.6 Required Common Pages

Common pages are pages that can be sent/received from any ANT+ device that has its channel configured to send/receive them. This is indicated via the transmission type channel parameter. See the ANT+ Common Pages document for details of all common data pages.

Multi-component electronic shifting systems may use common pages to provide information about a specific system component or for the system as a whole. Table 6-3 indicates the identifier values for specific components of electronic shifting systems used in the common pages.

Table 6-3. ANT+ Shifting System Component Identifiers

Identifier	Value
0	System
1	Front Derailleur
2	Rear Derailleur
3	Left Shifter
4	Right Shifter
5	Shifter
6	Left Extension Shifter
7	Right Extension Shifter
8	Extension Shifter 1
9	Left Extension Shifter 2
10	Right Extension Shifter 2
11	Extension Shifter 2
15	Unknown/Identified

6.6.1 Common Page 78 – Multi-component System Manufacturer's Information (0x4E)

This common data page allows for a manufacturer to transmit a hardware revision, manufacturer ID and a model number.

Table 6-4. Common Page 78 Format – Multi-component System Manufacturer's Information

Byte	Description	Length	Value	Units
0	Data Page Number	1 Byte	78 (0x4E) – Multi-component System Manufacturer's Information	N/A
1	Reserved	1 Byte	Value = 0xFF	N/A
2	Component Identifier	1 Byte	Identifies the component in the system to which this Manufacturer's Information pertains and specifies how many separate components are available in the system. Bits 0 – 3: Number of Components Bits 4 – 7: Component Identifier(Refer to Table 6-3) Set to 0xFF if not used.	N/A
3	HW Revision	1 Byte	To be set by the manufacturer.	N/A
4	Manufacturer ID LSB	2 Bytes	Refer to the FIT SDK for a current list of manufacturer IDs	N/A
5	Manufacturer ID MSB			
6	Model Number LSB	2 Bytes	To be set by the manufacturer.	N/A
7	Model Number MSB			

6.6.1.1 Component Identifier

The component identifier is used by systems that are made up of components and report manufacturer's information for components separately. The upper nibble of this field is used identify the component in the system to which this message pertains while the lower nibble is used to indicate the total number of components in the system.

Identifier: Identifies component in system to which this message pertains. Refer to Table 6-3.
Number of components: Total number of components in the system reporting manufacturer's information.

When reporting the manufacturer's information for a system with multiple components, it is recommended the shifting system alternate and cycle through the Manufacturer's Information data page for each individual component before repeating. When multiple components are in the system, the transmission frequency of this data page may be increased as long as the minimum transmission pattern requirements listed in Section 9.1 are met. The display may request the Manufacturer's Information data page for a specific component using the Request data page, specifying the requested component identifier value in the Descriptor Byte 1 field. If this field is not used its value should be set to 0xFF.

6.6.1.2 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). The ID corresponding to the manufacturer **shall [MD_0009]** be transmitted. 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 (0x00FF) has been reserved as a development ID and may be used by manufacturers that have not yet been assigned a value.

6.6.2 Common Page 79 – Multi-component System Product Information (0x4F)

Common data page 0x4E is similar to the multi-component manufacturer's information page (0x4F). This page allots two bytes for software revision number as well as the ability to transmit the lowest four bytes of the device's serial number.

Table 6-5. Common Page 79 Format – Multi-component System Product Information

Byte	Description	Length	Value	Units
0	Data Page Number	1 Byte	79 (0x4F) – Multi-component System Product Information	N/A
1	Component Identifier	1 Byte	Identifies the component in the system to which this Manufacturer's Information pertains and specifies how many separate components are available in the system. Bits 0 – 3: Number of Components Bits 4 – 7: Component Identifier(Refer to Table 6-3) Set to 0xFF if not used.	N/A
2	SW Revision (Supplemental)	1 Byte	Supplemental SW Revision (Invalid = 0xFF)	N/A
3	SW Revision (Main)	1 Byte	Main SW Revision defined by manufacturer OR: SW version defined by manufacturer if byte 2 is set to 0xFF.	N/A
4	Serial Number (Bits 0 – 7)	4 Bytes	The lowest 32 bits of the serial number. Value 0xFFFFFFFF to be used for devices without serial numbers	N/A
5	Serial Number (Bits 8 – 15)			
6	Serial Number (Bits 16 – 23)			
7	Serial Number (Bits 24 – 31)			

6.6.2.1 Component Identifier

The component identifier is used by systems that are made up of components and report product information for components separately. The upper nibble of this field is used identify the component in the system to which this message pertains while the lower nibble is used to indicate the total number of components in the system.

Identifier: Identifies component in system to which this message pertains. Refer to Table 6-3.
Number of components: Total number of components in the system reporting manufacturer's information.

When reporting the product information for a system with multiple components, it is recommended the shifting system alternate and cycle through the Product Information data page for each individual component before repeating. When multiple components are in the system, the transmission frequency of this data page may be increased as long as the minimum transmission pattern requirements listed in Section 9.1 are met. The display may request the Product Information data page for a specific component using the Request data page, specifying the requested component identifier value in the Descriptor Byte 1 field. If this field is not used its value should be set to 0xFF.

6.6.2.2 SW Revision

The SW revision is managed by the manufacturer and specifies the version of the software running on the transmitting device. If bytes 2 and 3 are both valid, then these fields **shall [self-verify]** be interpreted as the main and supplemental software versions.

For example, if a manufacturer uses a SW Revision format:

SW Revision = 1.380 where '1.3' is the Main SW Revision and '80' is the Supplemental SW Revision

This would be encoded as follows:

Main SW Revision = 13 (as only integer values may be sent in this field)

Supplemental SW Revision = 80

If only the Main SW Revision field is used then its value is defined by the manufacturer. In this case the Supplemental SW Revision field **shall [self-verify]** be set to 0xFF.

6.6.3 Common Page 82 – Battery Status (0x52)

This page is sent to allow the battery voltage and status of device to be transmitted. Bytes 3 – 5 allow for an hour meter to be defined allowing a device to transmit the amount of time that it has been running on a given battery. This is a required field for this data page.

Devices with advanced circuitry can utilize byte 6 to give the fractional voltage and byte 7 to use the descriptive bit field that gives the coarse battery voltage, the battery status, and the units of the hour meter.

Table 6-6. Common Page 82 Format – Battery Status

Byte	Description	Length	Value	Units	Rollover
0	Data Page Number	1 Byte	82 (0x52) – Battery Status	N/A	N/A
1	Reserved	1 Byte	Value = 0xFF	N/A	N/A
2	Battery Identifier	1 Byte	Identifies the battery in system to which this battery status pertains and specifies how many batteries are available in the system. Bits 0 – 3: Number of Batteries Bits 4 – 7: Battery Identifier(Refer to Table 6-3) Set to 0xFF if not used.	N/A	N/A
3	Cumulative Operating Time (bits 0 – 7)	3 Bytes	This will give the cumulative operating time of the device and should be reset on insertion of a new battery. Range = 0 – 16777215 ticks	2 seconds 16 seconds	1.1 years 8.5 years
4	Cumulative Operating Time (bits 8 – 15)				
5	Cumulative Operating Time (bits 16 - 23)				
6	Fractional Battery Voltage	1 Byte	Value = 0 – 255 (0x00 – 0xFF)	1/256 (V)	N/A
7	Descriptive Bit Field	1 Byte	Battery Status, Cumulative Operating Time Resolution, and Coarse Battery Voltage See Table 6-7 for more details.	Binary	N/A

6.6.3.1 Battery Identifier

The battery identifier is used by systems that are made up of components and have a need to report battery status information from multiple batteries. The upper nibble of this field is used identify the battery in the system to which this message pertains while the lower nibble is used to indicate the total number of batteries in the system.

Identifier: Identifies battery in system to which this message pertains. Refer to Table 6-3.
Number of batteries: Total number of batteries in the system needing to report battery status.

Only the battery with the lowest battery level should be broadcast in the regular common page transmission pattern. This ensures that display devices that do not support the device identifier field still show a consistent and meaningful value. The display may request battery information of all other devices individually using the Request Data Page (Common Page 70), and setting the Descriptor Byte 1 field to the value of the desired identifier. If this field is not used its value should be set to 0xFF.

6.6.3.2 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 6-7. Battery Voltage Descriptive Bit Field

Bits	Value	Description
0 – 3	0 – 14 Volts 0xF (15): Invalid	Coarse Battery Voltage Use bit mask of 0x0F
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)	Battery Status = Charging
	7 (0x07)	Invalid
7	0 – 16 second resolution 1 – 2 second resolution	The resolution used for the cumulative operating time

6.6.3.3 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) does not indicate that the voltage data field is invalid. This can only be determined by the value in the descriptive bit field.

6.6.3.4 Example of Battery Voltage Page Data

The 8 byte packet of battery voltage is shown in Figure 6-1. Starting at byte 7 with the descriptive bit field = 0x32 = 00110010. The lowest four bits indicate the value of the coarse battery voltage = 0010 = 2 Volts. The next three bits indicate the battery status = 011 = 3, which is interpreted to be 'Ok'.

```
ANT Serial Data = [52][FF][FF][1A][2C][03][8B][32]
```

Figure 6-1. Example of Battery Voltage Data

The highest bit of the descriptive bit field denotes what resolution the hour meter is updating at. With this bit = 0 it is interpreted that the hour meter is using a 16 second resolution. Therefore the cumulative operating time is found to be = 0x32C1A * 16s = 3118470s / 3600s/hr = 923.99 hours.

Byte 6 of this message gives the fractional battery voltage = 0x8B = 139 / 256V = 0.543V. Adding this to the coarse voltage of 2V the battery voltage is determined to be 2.543V.

6.6.4 Common Page 70 – Request Data Page (0x46)

Common Data Page 70 allows an ANT+ device to request a data page from another ANT+ device; in this case, it allows the display to request the Shifting System data page from the ANT+ shifting device. The request data page **shall [self-verify]** be sent using an acknowledged message by the display and **shall [self-verify]** be formatted as shown in Table 6-8.

Table 6-8. Common Page 70 Format – Request Data Page

Byte	Description	Length	Value	Units
0	Command ID	1 Byte	70 (0x46) – Data Page Request	N/A
1	Reserved	1 Byte	Value = 0xFF	N/A
2	Reserved	1 Byte	Value = 0xFF	N/A
3	Descriptor Byte 1	1 Byte	Allows subpages to be requested within the requested data page. Valid Values: 0 – 254 Invalid: 255 (0xFF)	N/A
4	Descriptor Byte 2	1 Byte	Allows subpages to be requested within the requested data page. Valid Values: 0 – 254 Invalid: 255 (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

6.6.4.1 Descriptor Bytes 1 & 2

When requesting the Shifting System data page both of these fields **shall [self-verify]** be set to invalid.

If requesting common data pages (Manufacturer's Information, Product Information, Battery Status) from a system with multiple components, the Descriptor Byte 1 field **shall [self-verify]** be used to identify the requested component identifier (Refer to Table 6-3).

6.6.4.2 Requested Transmission Response

The shifting device **shall [MD_0013]** be able to support all requested transmission response types; however, the ANT+ Shifting Device Profile further stipulates that the display **shall [self-verify]** only request broadcast messages from the shifting device.

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

7 Using Accumulated Values

The ANT+ data page definitions make use of accumulated values to maintain accuracy in the event of packet loss. This section explains how to properly transmit and receive accumulated data:

- Transmitters: **shall [MD_0011]** add only positive values to message fields that are accumulated.
- Receivers: **shall [SD_0008]** reconstruct accumulated values from rollover fields using either modulo operations (if unsigned values are used) or as described in section 7.1.1.
- Receivers: Use average values to properly calculate and store data after RF reception loss.

7.1 Transmitting Data in Accumulated Values

Instantaneous values from the sensor, such as revolution count, are calculated during each update period and added to a running sum. The update event count and the accumulated sum are then transmitted in the next broadcast message. For example, during update event *N* the data field would be accumulated as in Equation 7-1. Example of Accumulating a Value.

$$AccumulatedValue_N = AccumulatedValue_{N-1} + CurrentValue$$

Equation 7-1. Example of Accumulating a Value

Each message field has a maximum value, after which the running sum rolls over, as shown in Figure 7-1. Note that a rollover makes it possible for the Accumulated Value N to be less than it was in the previous message.

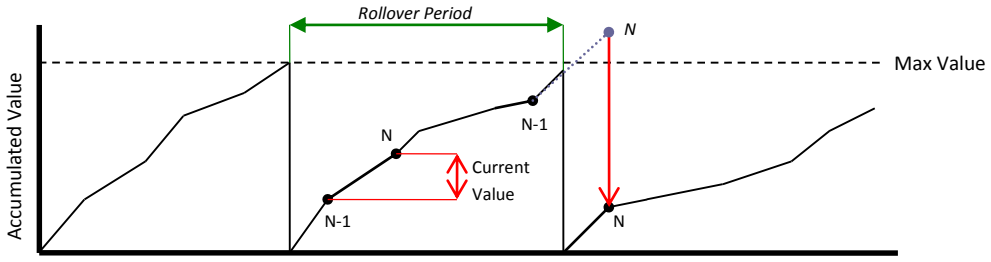


Figure 7-1. Accumulating Values

NOTE: All accumulating message fields must use only positive values.

A decrease in an accumulated value is interpreted by the receiver as a rollover event. For this reason, negative values cannot be added to accumulated fields as they will be incorrectly calculated at the receive side.

The expected amount of time separating rollover events is called the rollover period. This is the maximum amount of time that accuracy in calculations can be maintained during an interruption of RF reception. Rollover periods vary by application and are described in the data page sections.

7.1.1 Receiving and Calculating Data from Accumulated Values

When messages are received by the display, the current value can be determined by subtracting the data from the previous message, and dividing by the difference in update event counts between the two messages.

NOTE: The following calculations assume signed numbers are used.

To properly span rollovers, the calculations on the receiver side must first reconstruct the accumulated value and the event count from the received values, as shown:

1. Initialize AccumulatedValue to 0; initialize PreviousReceivedValue to the value received in the first data message.
2. For each subsequent data message:
    a. AccumulatedValue += ReceivedValue – PreviousReceivedValue
    b. If PreviousReceivedValue > ReceivedValue
        { AccumulatedValue += 256 }
    c. PreviousReceivedValue = ReceivedValue

Note that the event count is reconstructed in exactly the same way as the accumulated value. The current value can then be calculated from the reconstructed accumulated value and the reconstructed event count as shown in Equation 7-2. In the following, *N* refers to the most recently calculated value, and *N-1* refers to the calculation immediately preceding *N*.

$$CurrentValue = \frac{(AccumulatedValue_N - AccumulatedValue_{N-1})}{(AccumulatedEventCount_N - AccumulatedEventCount_{N-1})}$$

Equation 7-2. Calculating a Value from Two Messages

During normal RF conditions, every message is received and the calculated value is equal to the instantaneous value.

When RF reception is compromised, the calculated value is the average value over the period of the RF outage.

8 FIT Data

Shifting data may be stored on an ANT+ display device using the FIT Protocol. Displays using the FIT protocol to store shifting data shall use an Activity FIT file. System information shall be stored in a Settings FIT file.

8.1 Activity FIT File

Recorded shifting data is stored in a FIT activity file. The activity file shall contain the FIT file_id, activity, session, lap and event messages and device messages as described in the FIT File Types document and outlined in Table 8-1 below.

Table 8-1. Activity FIT File Messages and Fields

FIT Message	FIT Fields	Required	Type	Description
file_id (Required)	type	Y	file (enum)	Activity file (=4)
	manufacturer	Y	manufacturer (UINT16)	Refer to SDK
	product	Y	UINT16	Managed by manufacturer
	serial_number	Y	UINT32z	Managed by manufacturer
	time_created	Y	date_time (UINT32)	File creation time
	number	N*	uint16	File identifier
Activity (Required)	timestamp	Y	date_time (UINT32)	Seconds since UTC 00:00 Dec 31 1989 If <0x10000000 = system time
	local_timestamp	N	local_date_time (UINT32)	Local time.
	num_sessions	Y	uint16	Indicates total number of sessions included in the activity file
	type	Y	activity (enum)	Refer to SDK
Session (Required)	timestamp	Y	date_time (UINT32)	Seconds since UTC 00:00 Dec 31 1989 If <0x10000000 = system time
	start_time	Y	date_time (UINT32)	Seconds since UTC 00:00 Dec 31 1989 If <0x10000000 = system time
	total_elapsed_time	Y	UINT32	Total number of msec since timer started (includes pauses)
	sport	Y	sport (enum)	Set to generic if sport type is unknown
	front_gear_shift_count	N	UINT16	Total number of gear changes in the front derailleur.
	rear_gear_shift_count	N	UINT16	Total number of gear changes in the rear derailleur.
Lap (Required)	timestamp	Y	date_time (UINT32)	Seconds since UTC 00:00 Dec 31 1989 If <0x10000000 = system time
	event	Y	event (enum)	front_gear_change or rear_gear_change
	event_type	Y	event_type (enum)	Refer to SDK

FIT Message	FIT Fields	Required	Type	Description
	front_gear_shift_count	N	UINT16	Total number of gear changes in the front derailleur.
	rear_gear_shift_count	N	UINT16	Total number of gear changes in the rear derailleur.
Event (Required)	timestamp	Y	date_time (UINT32)	Seconds since UTC 00:00 Dec 31 1989 If <0x10000000 = system time
	event	Y	event(enum)	(gear_change) Other event messages are permitted as desired. Refer to SDK.
	event_type	Y	event(enum)	(marker) Refer to SDK.
	gear_change_data	N	UINT32	front_gear_num(UINT8) current gear front derailleur, front_gear(UINT8) number of teeth in current front derailleur gear, rear_gear_num(UINT8)) current gear rear derailleur, rear_gear(UINT8)) number of teeth in current rear derailleur gear
	gear_change_data[3]	N	UINT8	Front_gear (optional). Number of teeth in current front derailleur gear. 0 if unknown.
	gear_change_data[2]	N	UINT8	Front_gear_num
	gear_change_data[1]	N	UINT8	Rear_gear (optional). Number of teeth in current rear derailleur. 0 if unknown.
	gear_change_data[0]	N	UINT8	Rear_gear_num
device_info	timestamp	Y*	date_time (UINT32)	Seconds since UTC 00:00 Dec 31 1989 If <0x10000000 = system time
	device_type	N	device_type (UINT8)	34 (0x22) for ANT+ shifting device
	manufacturer	N	manufacturer (UINT16)	Managed by ANT+.
	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
	descriptor	N	string	Used to describe the sensor or location.
	battery_status	N	battery_status (UINT8)	new/good/ok/low/critical

* Only required if optional message included

8.2 Settings FIT File

System information is stored in a FIT settings file. The settings file shall contain the FIT bike_profile message as described in the FIT File Types document and outlined in Table 8-2 below.

Table 8-2. Settings FIT File Message and Fields

FIT Message	FIT Fields	Required	Type	Description
bike_profile	message_index	Y	UINT16	Provides an index such that other FIT messages in the file can be related to this user
	name	Y	string	User name
	front_gear_num	N	UINT8z	Number of gears available in front derailleur.
	front_gear	N	UINT8z[N]	Number of gear teeth in front derailleur gear N. [0] refers to innermost gear.
	rear_gear_num	N	UINT8z	Number of gears available in rear derailleur.
	rear_gear	N	UINT8z[N]	Number of gear teeth in rear derailleur gear N. [0] refers to innermost gear.

8.3 Other FIT Files

Refer to the FIT File Types document for details on other FIT files that may be useful for ANT+ shifting applications.

9 Minimum Requirements

9.1 Minimum Data Page Requirements

An ANT+ shifting device shall behave as described in this document. In summary, the data pages defined in this device profile **shall [MD_0008]** comply with the transmission requirements listed in Table 9-1. All fields are required for these data pages unless specifically marked as optional in the data page descriptions.

Table 9-1. Minimum Transmission Requirements for ANT+ Shifting Devices

Required Data Page	Transmission Requirements
Data Page 1 – Shift Status	Broadcast at 1 Hz. Must be transmitted for four consecutive messages on a shift event.
Common Page 78 – Multi-component System Manufacturer's Information	Minimum: Interleave once every 65 seconds (260 messages) for each component. A common page should be interleaved at least once every 65 messages.
Common Page 79 – Multi-component System Product Information	Minimum: Interleave once every 65 seconds (260 messages) for each component. A common page should be interleaved at least once every 65 messages.
Common Page 82 – Battery Voltage	Minimum: Interleave once every 65 seconds (260 messages) for each component. A common page should be interleaved at least once every 65 messages.
Common Page 70 – Request Data Page	Receive and Decode

An ANT+ shifting display **shall [SD_0008]** comply with the data page requirements listed in Table 9-2.

Table 9-2. Minimum Transmission Requirements for ANT+ Shifting Displays

Required Data Page	Transmission Requirements
Data Page 1 – Shift Status	Receive, decode, and display changing Shift data.
Common Page 78 – Multi-component System Manufacturer's Information	Receive and decode.
Common Page 79 – Multi-component System Product Information	Receive and decode.
Common Page 82 – Battery Voltage	Receive and decode.
Common Page 70 – Request Data Page	Transmitted as an acknowledged message.

9.2 Additional Requirements

In addition to the requirements outlined in section 9.1, the following general requirements apply:

- A shifting device **shall [MD_0006]** only send broadcast messages to the display, and **shall [MD_0006]** never send acknowledged or burst messages. However 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 shifting device, and **shall [SD_0009]** handle this situation gracefully.
- A display **shall [SD_0007]** not decode reserved bytes in received data pages.
- A display **shall [SD_0005]** be able to gracefully handle the receipt of undefined data pages.
- 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.

9.3 ANT+ Shifting 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 ANT+ Shifting information, and that it is interoperable with other devices that carry the same icon.

An ANT+ shifting system 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+ Shifting Interoperability Icon

10 Profile Verification Tests

Table 10-1. Profile Verification Tests for the Shifting Sensor

☑	Certification Test	Relevant Document Sections
	MD_0001 ANT Channel Parameter Test	5.1 Master Channel Configuration
	MD_0002 Transmission Type	5.1 Master Channel Configuration
	MD_0003 Channel Period	5.1 Master Channel Configuration
	MD_0004 Channel Type	5.1 Master Channel Configuration
	MD_0006 Tx Required Data Page	9.2 Additional Requirements
	MD_0007 Tx Invalid Data Page	6.5 Data Pages 2-63: Reserved for Future Use
	MD_0008 Transmission Pattern	9.1 Minimum Data Page Requirements
	MD_0009 Manufacturer ID	6.6.1.2 Manufacturer ID
	MD_0010 Page Format	6 Message Payload Format
	MD_0011 Rollover	7 Using Accumulated Values 6.4.4 Invalid Inboard Shift Count - Rear/Front 6.4.5 Invalid Outboard Shift Count - Rear/Front
	MD_0013 Request Data Page	6.6.4 Common Page 70 – Request Data Page (0x46)
	MD_0014 Network Traffic	9.2 Additional Requirements
	Self-verify	5.1 Master Channel Configuration 6.6.2 Common Page 79 – Multi-component System Product Information (0x4F) 6.6.3 Common Page 82 – Battery Status (0x52)

Table 10-2. Profile Verification Tests for the Shifting Display

☑	Certification Test	Relevant Document Sections
	SD_0001 ANT Channel Parameter Test	5.2 Slave Channel Configuration
	SD_0002 Transmission Type	5.2 Slave Channel Configuration
	SD_0003 Channel Period	5.2 Slave Channel Configuration
	SD_0005 Rx Undefined Data Page	9.2 Additional Requirements
	SD_0007 Rx Reserved Fields	9.2 Additional Requirements
	SD_0008 Rollover	7 Using Accumulated Values 9.1 Minimum Data Page Requirements
	SD_0009 Ignore Burst	9.2 Additional Requirements
	SD_0010 Rx Ack	9.2 Additional Requirements
	Self-verify	6.6.2 Common Page 79 – Multi-component System Product Information (0x4F) 6.6.4 Common Page 70 – Request Data Page (0x46)