ANT+ Device Profile

Bike Lights

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Revision History

Revision	Effective Date	Description
1.0_M.001	April 2015	First Member Early Release.
2.0_M.001	February 2016	• Added channel period decimation command. • Number of maximum secondary lights changed to 63. • Added Bike Radar support indicator to data Page 1. • Number of maximum sub-lights changed from 6 to 4. • Added beam focus and granular beam intensity control (data pages 1, 2, 34). • Clarified sub-light index value when addressing all sub-lights (sections 7.18.3, 7.18.2, 7.18.3, Figure 7-9). • Removed requirement for Hazard Lights mode to be supported by ANT+ Bike Lights configured as Signal Lights (section 5.3). • Data page 6 now required for all ANT+ Bike Lights that support sub-lights (section 5.3, 7.9, Table 8-1 and Table 8-2). • Updated Data Page 34 to include new fields Sub-Light Index Flag and Beam Focus (decision tree figure also updated) (section 7.18) • Defined limit for Requested Transmission Response field for A.NT+ Bike Lights (Table 7-45 and section 7.22.3.3).

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1 Overview of ANT+

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

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

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

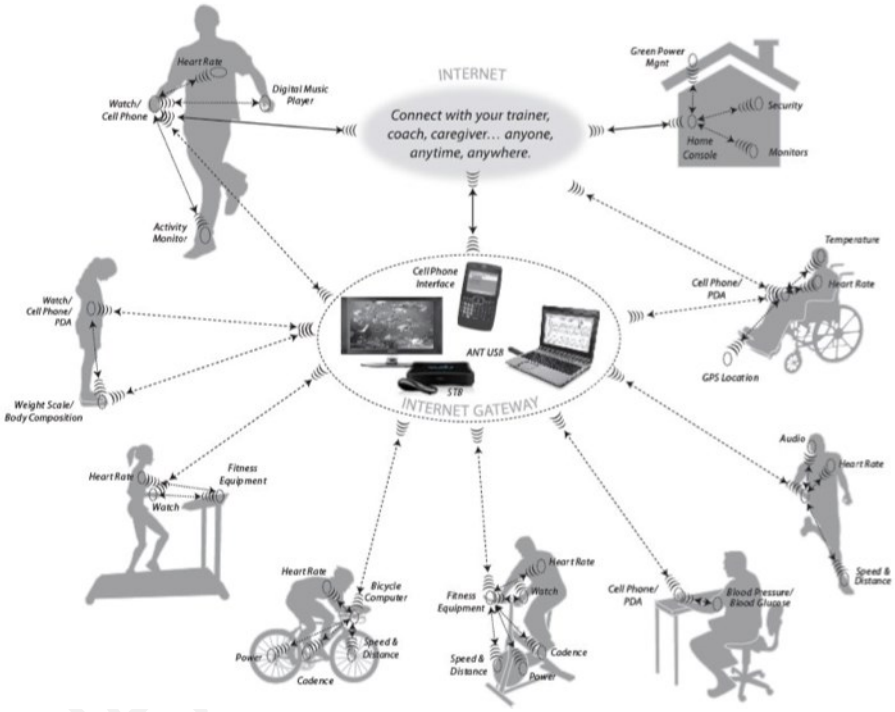

Figure 1-1. ANT+ Device Ecosystem

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

IMPORTANT:

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

Implement and test your product to this specification in its entirety

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

2 Related Documents

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

1. ANT Message Protocol and Usage
2. ANT+ Common Data Pages
3. ANT AN02 Device Pairing
4. ANT AN11 ANT Channel Search and Background Scan
5. ANT AN14 Continuous Scanning Mode

2.1 Glossary of Terms

Several specific terms are used in the ANT+ Bike Lights Device Profile. The meaning of these terms in the context of this device profile is as listed below.

Table 2-1. Glossary of Terms

Term	Meaning
ANT+ Bike Light	A bike light that implements the required wireless configuration features and messaging formats of this device profile, as well as any/all of the optional features.
ANT+ Controller	A device that controls ANT+ bike lights.
Principal Light	Sub-light index = 0. Described in data pages 1, 2. Refer to section 4.9.1.
Sub-light	Sub-light index >0. Described in data pages 3, 4. Refer to section 4.9.1.
Main Light	An ANT+ bike light in the connected state that is the master of the shared channel, and broadcasts data from all the connected lights.
Secondary Light	An ANT+ bike light in the connected state that is a slave on the shared channel.
Connected	Connected to ANT+ Bike Lights via a shared channel network.
Connected State	An ANT+ bike light is in the connected state when it is connected to ANT+ bike lights via a shared channel. Refer to section 5.2.5 for details of the connected state
Unconnected	An ANT+ bike light is unconnected when it is not connected to other ANT+ bike lights via a shared channel. An ANT+ controller may therefore communicate with an unconnected ANT+ bike light.
Unconnected State	An ANT+ bike light is in the unconnected state when it is not connected to other ANT+ bike lights via a shared channel. Refer to section 5.2.5 for details of the unconnected state
Pairing	Obtaining and storing the channel ID of the ANT+ bike light(s) (refer to AN02).
Configuration	Setting each ANT+ bike light's light type (e.g. headlight).
Continuous Scanning Mode	A mode that uses the whole ANT radio to listen to other ANT devices (refer to AN14).
Background Scan	A channel configuration that uses one channel to listen other ANT devices (refer to AN11).
Broadcast Channel	The ANT channel between the ANT+ controller and ANT+ bike lights.
Shared Channel	The ANT shared channel between the Main Light and the Secondary Light(s).
Forwarding	A main light 'forwards' commands (i.e. pages 32 - 34) from an ANT+ controller by swapping the order of bytes 0 and 1, and transmitting the new command on the shared channel.
Shall	Indicates a requirement that must be met to ensure seamless interoperability.
Should	Indicates a recommended approach or best practice.

May	Indicates an optional feature or approach.

2.2 Summary of Data Pages

A brief summary of the data pages used in this device profile is provided here as a reference. For details of these data pages, refer to section 7.

Table 2-2. Summary of Data Pages

DP #	Page Name	Usage
1	Light States 1	Describes the current state (mode, battery indication, beam height etc.) of the principal light.
2	Light Capabilities	Describes the capabilities (supported modes, light types etc.) of the principal light. Includes capabilities relating to the whole ANT+ bike light.
3	Sub-light States	Describes the current state of two sub-lights.
4	Sub-light Capabilities	Describes the capabilities (supported modes, light types etc.) of a sub-light.
5	Mode Description	Describes each mode supported by the bike light (pattern, speed, etc.)
6	Sub-light Mode Support	Describes which custom modes are supported by a sub-light.
7:15	Reserved for future use.	Do not use.
16	Connected Lights' Manufacturers Information	Contains the manufacturer ID for a secondary light.
17	Connected Lights' Product Information	Contains the product ID for a secondary light.
18	Main Light's Channel ID	Contains the channel ID of the main light to aid a second controller in joining an existing network.
19	Supplementary Info	Contains additional data, including % battery remaining.
20:31	Reserved for future use.	Do not use.
32	Disconnect Command	Used to disconnect bike lights from the network.
33	Connect Command	Used to form a network, to configure light types, and for basic state control while pairing.
34	Light Settings	Used to control the bike lights mode, beam height, etc.
35	Channel Period Decimation Command	Used to aid light network formation with larger number of bike lights.
36:63	Reserved for future use.	Do not use.
70	Request Page	Used to request other data pages
80	Manufacturer's Identification	Contains the manufacturer ID for the bike light.
81	Product Identification	Contains the product ID for the bike light.
87	Error Description	Contains system error information.

3 Overview of ANT+ Bike Lights Use Case

Bike lights are commonly used by cyclists to improve their visibility to surrounding traffic and to make it easier to see the route ahead. Typically a white light is used at the front of the bike as a headlight and a red light is used at the rear of the bike as a taillight. Additional lights may be added to the cyclist's person or helmet. Signal lights may also be added to indicate an intended change of direction by the cyclist.

Note that legislation exists in many countries relating to bike lights. It is the manufacturers' responsibility to check for applicable legislation and to ensure compliance. This device profile is not intended to provide any legal guidance.

ANT+ bike lights broadcast wireless information to a bike computer or similar controller, typically mounted on the bike handlebars. This information includes the manufacturer and product ID, battery level, and state of the bike light; for example on or off, and flashing speed.

An ANT+ bike light controller may display this information to the cyclist. For example the controller may beep to warn the user of low battery levels at the start of a journey, and indicate to the user which light requires a replacement battery. The ANT+ controller also controls the state of the ANT+ bike lights, either automatically or based on user input. For example the ANT+ bike light controller may automatically switch all the lights on at the start of a journey and off at the end.

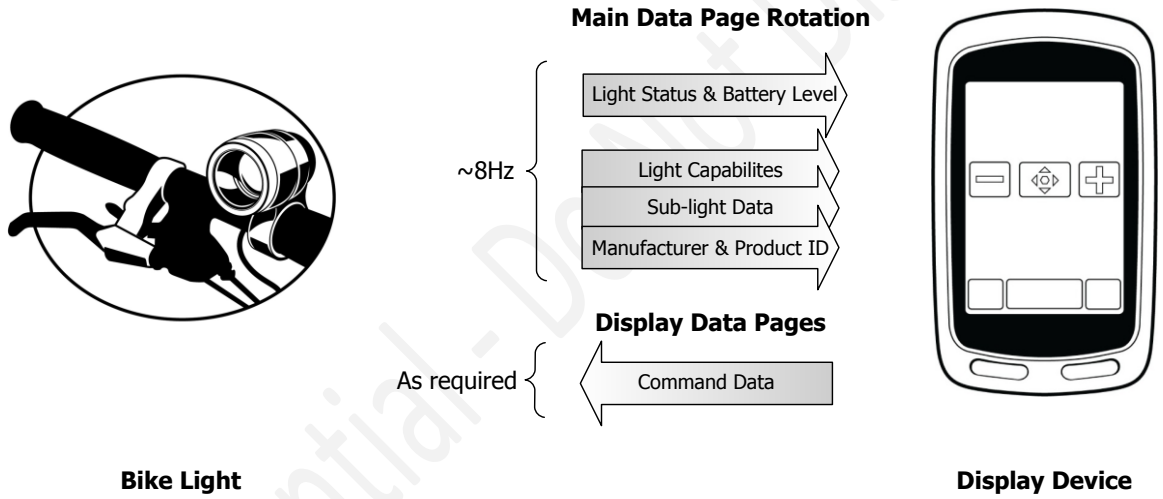

Figure 3-1. Basic Use Case for ANT+ Bike Lights and Controllers

It is typical for cyclists to use at least two bike lights at the same time. An ANT+ bike light controller may connect to up to 8 bike lights at the same time using independent channels.

Alternatively the ANT+ bike light controller may use just one channel to communicate with all the ANT+ bike lights in use. This is achieved using a shared channel network as described below. Note that as the controller unit typically has greater computational resources than a bike light, it is the controller that determines the network configuration and the lights simply follow the controller's commands. In this scenario, the ANT+ controller first scans to detect all nearby lights, then sets up the network and connects to the main ANT+ bike light to communicate with the full network.

4 ANT+ Bike Light Device

4.1 ANT+ Bike Light Components

Major components of ANT+ Bike Lights. The primary light and sub-light components are the controllable features of a physical bike light. The network main light, and network secondary light components are the networking features of an ANT+ bike light in a light network.

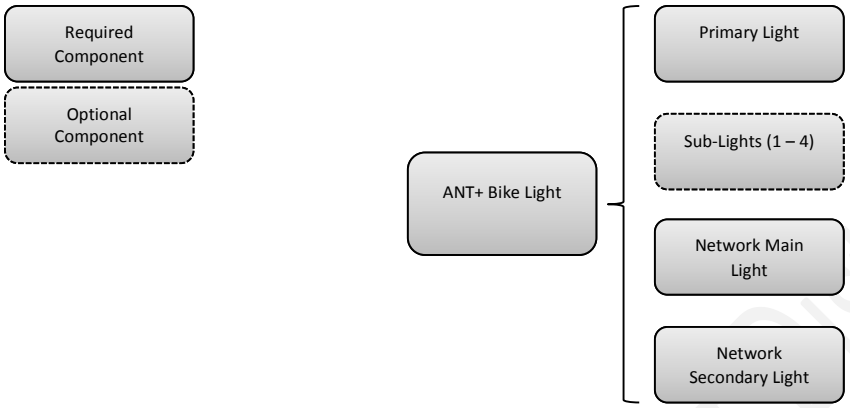

Figure 2. ANT+ Bike Light Components

Table 4-1. ANT+ Bike Light Components

Component	Document Sections
Primary Light	4.4
Sub-Lights (1-4)	4.5
Network Main Light	4.2
Network Secondary Light	4.3

4.2 Network Main Light

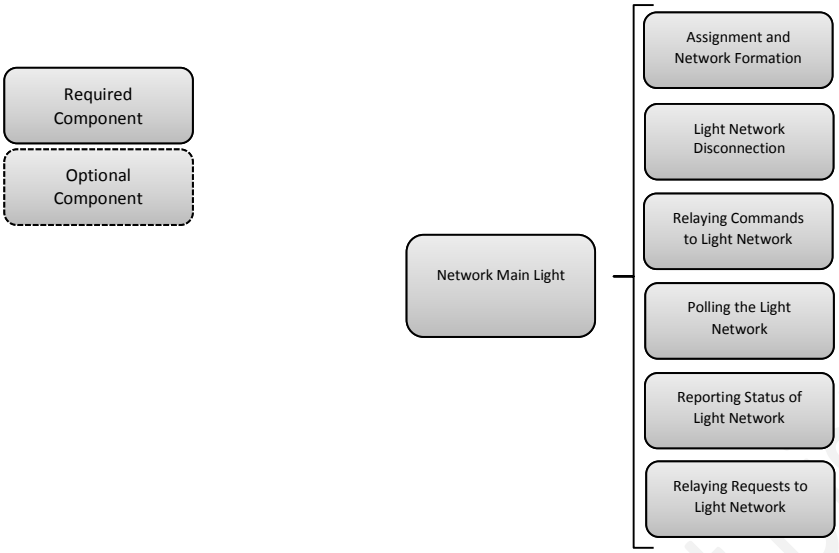

Figure 3. Network Main Light Components

Table 4-2. Network Main Light Components

Component	Document Sections
Assignment and Network Formation	5.2.5 (Connect Command - 7.17.1)
Light Network Disconnection	5.2.5 (Disconnect Command - 7.16)
Relaying Commands to Light Network	5.4
Polling the Light Network	7.3.3.2
Reporting Status of Light Network	7.3.3
Relaying Requests to Light Network	7.22.3

4.3 Network Secondary Light

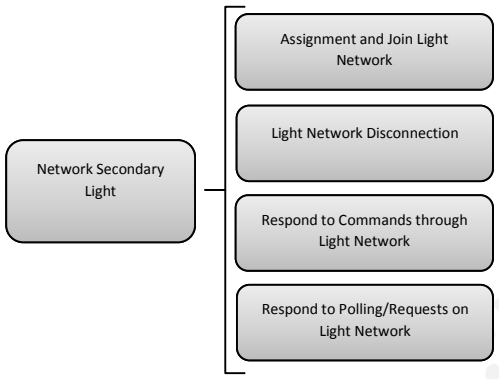

Figure 4. Network Secondary Light Components

Table 4-3. Network Secondary Light Components

Component	Document Sections
Assignment and Join Light Network	5.2.5 (Connect Command - 7.17.1)
Light Network Disconnection	5.2.5 (Disconnect Command - 7.16)
Respond to Commands through Light Network	5.4
Respond to Polling/Requests on Light Network	7.3.3.2 (Request Data Page - 7.22.3)

4.4 Primary Light

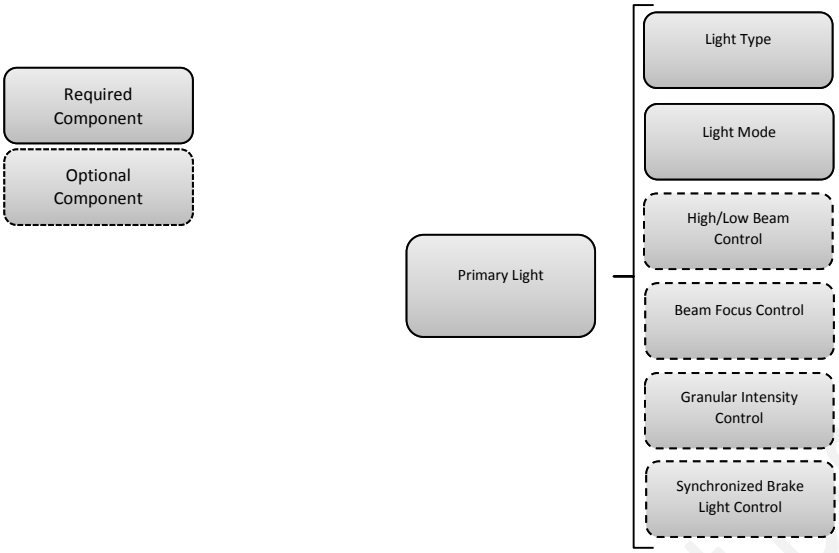

Figure 5. Primary Light Components

Table 4-4. Primary Light Components

Component	Document Sections
Light Type	4.6
Light Mode	4.7
High/Low Beam Control	4.8
Beam Focus Control	4.8
Granular Intensity Control	4.8
Synchronized Bike Light Control	4.8

4.5 Sub-Light (s)

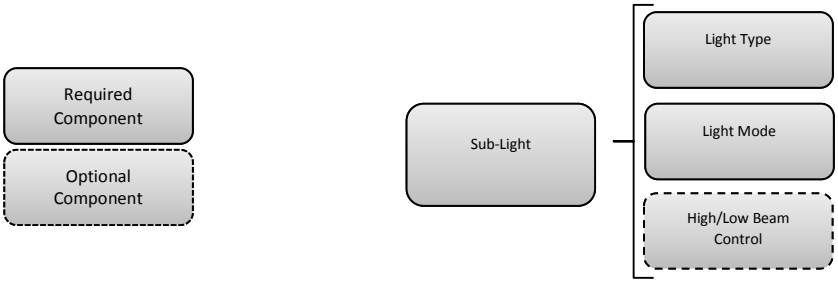

Figure 6. Sub- Light Components

Table 4-5. Sub-Light Components

Component	Document Sections
Light Type	4.6
Light Mode	4.7
High/Low Beam Control	4.8

4.6 Light Type

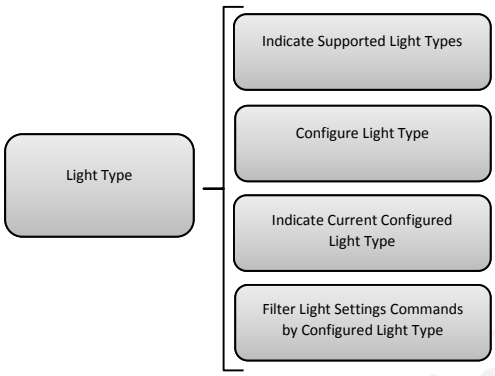

Figure 7. Light Type Components

Table 4-6. Light Type Components

Component	Document Sections
Indicate Supported Light Type	7.5.6
Configure Light Type	7.17.6
Indicate Current Configured Light Type	7.4.3
Filter Settings Commands by Configured Light Type	7.18.4

4.7 Light Mode

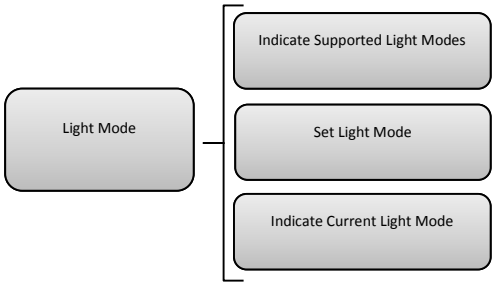

Figure 8. Light Mode Components

Table 4-7. Light Mode Components

Component	Document Sections
Indicate Supported Light Mode	5.3 (Capabilities Data Page - 7.5.4)
Set Light Mode	7.18.9
Indicate Current Light Mode	7.4.8

4.8 Additional Light Control Components

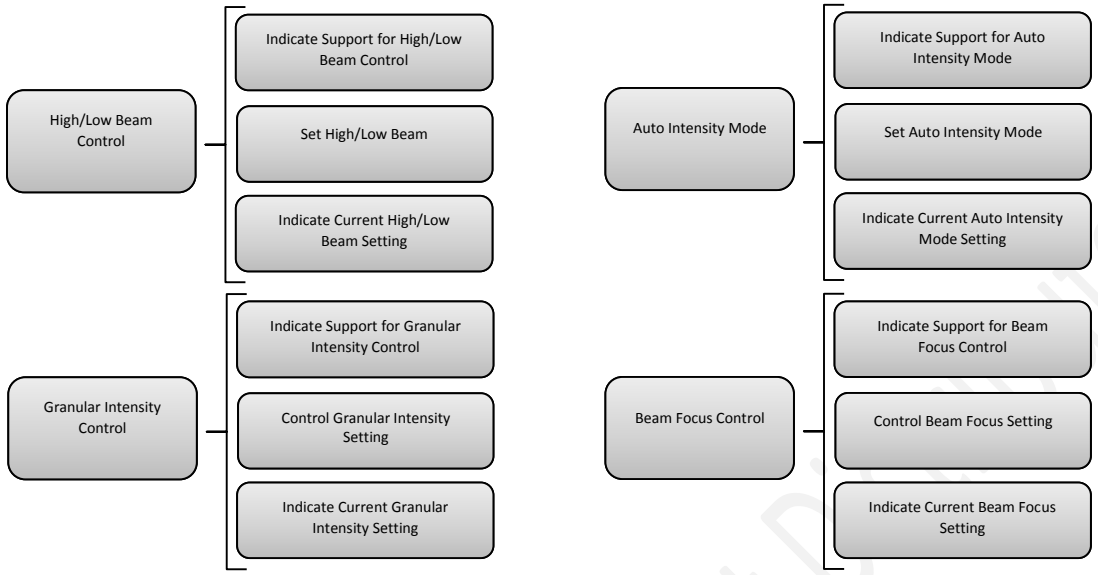

Figure 9. Components

Table 4-8. Components

Component		Document Sections
High/Low Beam Control	Indicate Support	7.5.1
	Set/Configure	7.18.9
	Indicate Current Setting	7.4.8
Auto Intensity Mode	Indicate Support	7.5.1
	Set/Configure	7.18.6
	Indicate Current Setting	7.4.9
Beam Focus Control	Indicate Support	7.4.4
	Set/Configure	7.18.8
	Indicate Current Setting	7.4.4
Granular Intensity Control	Indicate Support	7.4.4
	Set/Configure	7.18.8
	Indicate Current Setting	7.4.4

4.9 Types of ANT+ Bike Light

Most ANT+ bike lights are likely to be used for vision and visibility: e.g. headlights. These lights will typically keep their light beam on and in the same mode for the duration of the bike session. These lights will therefore be likely to consume the most power (to power the light itself) and to be relatively insensitive to delays in sending and receiving data.

Signal lights are a different type of ANT+ bike light, that are likely to remain off for most of the session. These will be activated by the user as required to indicate an intended change of direction. These lights will consume less power to power the light itself and should respond quickly to user input.

Taillights are also used for visibility, similarly to headlights; however they may also be used to indicate braking, and have similar requirements to signal lights.

Note that the minimum requirements for all types of ANT+ bike light are the same, and are detailed in section 8.

An ANT+ bike light indicates its light type in the light state page (or sub-light state page, if applicable). It also indicates all the light types that it is capable of being used as in the light capabilities page (or sub-light capabilities page, if applicable). For example a taillight may also be capable of being used as a signal light, or a left signal light may also be capable of being used as a right signal light.

An ANT+ controller may make use of the current light state information or change the light type during network establishment and configuration. The connect command (page 33) is used to set the light type.

4.9.1 Combination Lights

A single bike light unit may consist of several separate lights that can be individually controlled. ANT+ bike lights may include up to 5 component lights. One of these lights is described in the standard main data pages (1 and 2) and referred to as the 'principal' light. The remaining ≤4 lights are referred to as 'sub-lights' and are described using sub-light main data pages 3 and 4. As these component lights are physically connected the data from all of them is transmitted on one channel and one light index is used for the whole ANT+ bike light.

An ANT+ controller can send commands to each component light individually, as though the lights were separate devices. The intended light is referenced using a combination of light index and sub-light index values.

4.10 Types of ANT+ Controller

An ANT+ controller is defined as a device that is used to control one or more ANT+ bike lights. An ANT+ controller may be a bike computer, a mobile phone with a suitable app installed, a handlebar remote, a brake lever, or even a sensor device with no screen or buttons that detects movement and implements basic on/off control.

An ANT+ controller may or may not include a display, and may or may not include buttons. The user interface may therefore be expected to vary. This may influence the pairing method chosen; several possible options are provided below. Similarly the implemented feature set may range from simple to elaborate as appropriate for each product.

Note that the minimum requirements for all types of ANT+ controller are the same, and are detailed in section 8**.**

5 Network Design

5.1 Initial Pairing and Configuration

ANT+ bike lights and controllers may be purchased as pre-paired sets, with stickers used to guide the user as to which lights should be installed in which position on the bike. This provides the simplest user experience; however users may also add or replace lights and/or controllers, or prefer to mount lights in a different position. However as ANT+ controllers may have limited UI capabilities, creating an intuitive pairing and configuration experience requires careful consideration.

The pairing and configuration methods described below provide example solutions that can be used as good practice.

5.1.1 Zero UI Controller Example

The most basic ANT+ controller would be a simple sensor (e.g. an accelerometer) with no UI. This would wake up on movement and send a command to all lights to turn on, and stay awake for the duration of a session. Once the bike stops moving the sensor would send a command to all lights to turn off the light beams after an appropriate timeout. The controller itself would then go to sleep. In this example the ANT+ controller has no buttons and no display. As control of individual lights is not feasible with this system, configuration does not apply. Pairing should be achieved as follows:

a) Mount all lights in their desired locations on the bike, and activate the radios (this may be the default state; or may require a button press on the light).

b) Perform a manufacturer defined action to put the ANT+ controller into pairing mode. As an example, this action could be to shake the controller in a defined way, or to use a companion phone app.

c) The ANT+ controller will then find all nearby lights (using either a continuous scan or background scan plus synchronous channels), and command them all to flash.

d) The user can then see that all the lights have been found and perform a second manufacturer defined action to confirm. The ANT+ controller will then set all lights to steady beam. The controller stores the channel ID for each light and is now paired to these lights. The controller will not find any new lights unless the user puts it into pairing mode again. The system is now ready to use.

e) Alternatively if the user can see that certain lights have not been found, the user can hold the controller near the missing light or check the battery on the missing light. If lights have been found that should not be paired to this ANT+ controller, the user should remove (or deactivate) these lights before performing the second manufacturer defined action on the controller.

f) If the user does not confirm that all lights are found then the controller will eventually timeout, stop the search and command all lights to turn off their beams.

5.1.2 Just Buttons Controller Example

Another typical ANT+ controller has a number of buttons but no display. A good pairing and configuration experience can be achieved as follows.

a) Mount all lights in their desired locations on the bike, and activate the radios (this may be the default state; or may require a button press on the light). Note that if the user plans to use multiple sets of lights, they should activate all sets of lights for this process.

b) Put the ANT+ controller into configuration mode, for example by pressing two buttons at once.

c) The ANT+ controller will then find all nearby lights, and make one of the lights flash. (The controller may do this using a continuous scan, or by using a synchronous channel to find each light in sequence.)

d) The user sees which light is flashing, and presses the button on the remote that the light should be associated with. For example if the user sees the headlight flashing, they could press the headlight button.

e) The ANT+ controller sets the light's beam to steady, indicating to the user that the light is now connected and recognised as a headlight. In this example the controller also sets the light type to 'headlight'.

f) The ANT+ controller then commands another light to flash.

g) The user sees which light is flashing and again presses a button on the remote that they wish the light to respond to. In this example, the light is another headlight being worn on the user's helmet, and the user does not wish to control it individually. Therefore the user presses the 'all on/off' button (or executes another specific action to indicate that the controller should connect to the light, but not associate it with a specific button).

h) The ANT+ controller sets the light's beam to steady, indicating to the user that the light is now assigned. In this example the controller sets the light type to 'default'.

i) The ANT+ controller then commands another light to flash.

j) The user sees which light is flashing. In this example, the light belongs to another user and should not be connected to the remote. The user removes or turns off the light, or executes a specific action (e.g. a three button press) to tell the remote to reject the light.

k) The ANT+ controller sets the light's beam to off, indicating to the user that the light will not be assigned. The ANT+ controller does not pair with this light, and may add it to a blacklist.

l) This process is repeated until all lights are assigned as desired.

m) When all the lights are assigned (or rejected), the ANT+ controller commands all lights to flash for 3 seconds before turning off the light beams. This indicates to the user that the configuration process is complete. The ANT+ controller then stores the channel IDs and configuration details for each assigned light, and returns to normal mode ready for the user to begin their ride.

5.1.2.1 Alternative – RSSI Example

An alternative approach using a typical ANT+ controller with a number of buttons but no display makes use of RSSI to simplify the pairing process.

a) Mount all lights in their desired locations on the bike, and activate the radios (this may be the default state; or may require a button press on the light). Note that if the user plans to use multiple sets of lights, they should activate all sets of lights for this process.

b) The user holds the controller close to one of the lights and presses a button until the light begins to flash.

c) The ANT+ controller commands the light with the strongest RSSI signal to flash when a button is held for 5s. The controller then associates the light with this button.

d) If the wrong light flashes, the user repeats the process – holding the same button near the same light until a light flashes.

e) The ANT+ controller blacklists the light previously associated with this button and commands the light with the next strongest RSSI to flash when the button is held for 5s. The controller then associates the flashing light with this button.

f) This process is repeated until all lights are assigned as desired.

This process is simpler for the user, and makes it unlikely that any light that is not part of the system is connected to. However it does require the controller to be mobile (at least at the time of pairing), and it may not allow for multiple lights to be connected to the same button.

5.1.2.2 Alternative – Self Configuration Example

It may be the case that active user involvement in the configuration process is not necessary, even when a new controller is used. Instead, the existing 'light type' setting of each light may be used by the ANT+ controller to self-detect which lights should be assigned to each button.

For example consider a system with a headlight, a taillight, and two signal lights. A user takes the new ANT+ controller and presses a button on the controller to wake it up.

The ANT+ controller then finds all the ANT+ bike lights and uses the light type field in data page 1 to identify the lights. The bike light with light type set to headlight is then assigned to the appropriate button, e.g. a button at the top of the controller. The bike light with light type set to taillight is then assigned to the appropriate button e.g. at the bottom of the controller. The remaining two lights both have the light type set to signal light, but do not indicate whether they should be left or right signals. The controller may choose the light with the lowest device number and assign this to light type 'signal light - left' and associate it with the left button. The remaining signal light is then set as 'signal light - right' and associated with the right button.

The configuration has now been completed by the controller. The user presses each button to check which light responds to each one. If the left and right lights are the wrong way round the user can either swap the physical position of the signal lights, or put the controller back into configuration mode and go through the process described in section 5.1.2.

5.1.3 Full Display Wizard Controller Example

An ANT+ controller with a detailed display can use this to provide a richer setup experience. For example, each light and sub-light can be displayed, allowing the user to select and configure each light. This UI also allows for configuration of any more complex bike light features.

It is recommended that this type of ANT+ controller pre-populates a suggested configuration and makes use of the capability information for each light to guide the user through the setup process.

Additionally, a PC or mobile application could be provided to enable this functionality for ANT+ controllers with limited UI.

5.2 Connecting to Bike Lights via a Network

As described in the overview above, an ANT+ controller may instruct the ANT+ bike lights, to form a network such that all the bike lights can be controlled using a single channel on the ANT+ controller. Note that the network formation process can also be achieved using a single channel on the ANT+ controller: use of additional channels is optional.

The network topology that is formed is shown in Figure 5-1. It is a shared channel network where the ANT+ controller is connected directly to one ANT+ bike light (referred to as the 'main light'). The main light is connected to the remaining lights (referred to as 'secondary lights') via an ANT shared channel.

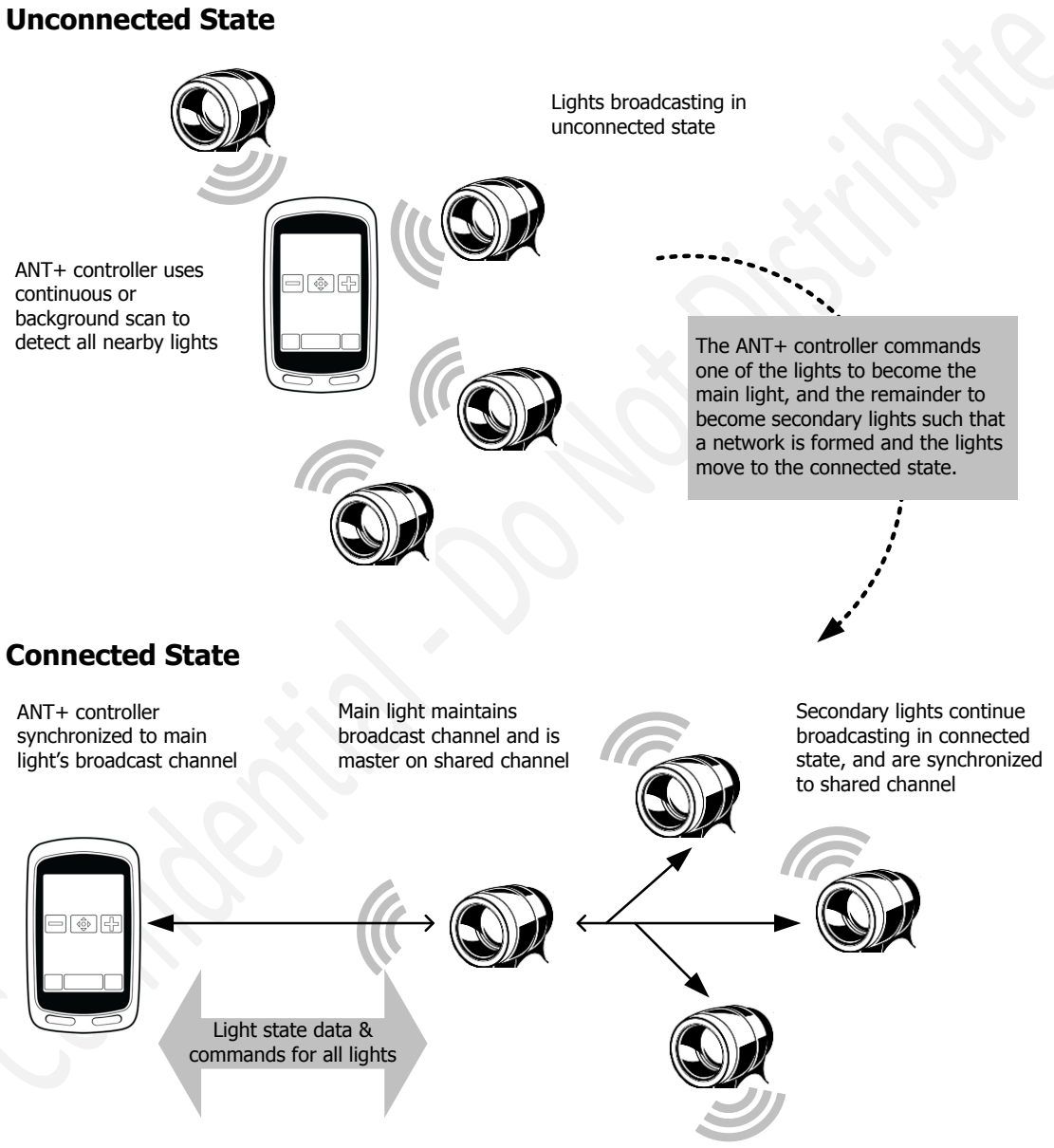

Figure 5-1. Shared Network Topology for ANT+ Bike Lights

NOTE: All ANT+ bike lights shall be capable of acting as main lights and secondary lights. However developers of ANT+ controllers may choose whether to include the network formation functionality. The alternative is to connect to the broadcast channel of each ANT+ bike light as described in section 5.6.

5.2.1 Detecting all Lights

It is recommended that the ANT+ controller uses a continuous scan (configured for extended messages) to detect all nearby lights before opening any synchronous channels. This provides the best user experience and the fastest network creation time. The scan provides the ANT+ controller with knowledge of each light's channel ID, state and battery level such that these can be displayed to the user in the shortest possible time. Refer to section 6.2 for information on configuring the ANT radio for a continuous scan.

The ANT+ controller may optionally send the request page to each ANT+ bike light to obtain the manufacturer and product information (pages 80 and 81), and capabilities (pages 2 and 4). For details of how to send messages from the ANT+ controller while in continuous scanning mode, refer to: ANT AN14 Continuous Scanning Mode.

5.2.1.1 Alternative to Continuous Scanning Mode

ANT+ controllers that do not support continuous scanning mode (or that require other channels to be open while the ANT+ bike lights network is formed) should use a background scan instead. ANT+ controllers that are particularly power sensitive should also use the background scan method. This will enable the ANT+ controller to receive the default broadcast messages and plan the network configuration.

However as background scans are receive only, it is not possible to request additional information from lights or send commands to them while in this mode. Refer to section 6.2 for channel configuration details.

5.2.2 Detecting Whether a Network Already Exists

An ANT+ controller should check whether a network connecting the ANT+ bike lights together has already been formed before attempting to create a new network. This is indicated in the light index field (byte 1 in most data pages) received from each light during the continuous scan.

If all of the lights indicate 'unconnected' (i.e. light index = 0), the ANT+ controller should create a network as described in section 5.2.3 below. If one or more of the lights indicate that they are currently connected, the ANT+ controller should connect to the existing network. The ANT+ controller should only recreate the network as a result of intentional user action.

5.2.2.1 Connecting to an Existing Network

An ANT+ controller may connect to an existing network by opening a channel using the main light's channel ID. This channel ID may be obtained by requesting data page 18 from any connected ANT+ bike light.

5.2.2.2 Recreating a Network

If the user indicates that a new network should be formed then the ANT+ controller shall respond based on the current state of the ANT+ bike lights.

- If **all** of the ANT+ bike lights are in the **connected** state with all light indices ≠ 0; the ANT+ controller may immediately send the disconnect command (section 7.16) to all ANT+ bike light to return them to their default unconnected state. The ANT+ controller may then create a new network as desired.
- If **all** of the ANT+ bike lights are in the **unconnected** state, with all light indices = 0; the ANT+ controller may immediately create the new network as desired.

However if the ANT+ bike lights are not all in the same state (i.e. some light indices = 0 AND some light indices ≠ 0) the ANT+ controller should wait an extended period of time (recommended: at least 5 seconds) until no ANT+ bike lights have changed state (connected/unconnected) before sending any commands to the ANT+ bike lights.

This requirement is to avoid two ANT+ controllers attempting to create a network at the same time and sending conflicting commands to the ANT+ bike lights. If the ANT+ controller includes a UI, it may notify the user that another controller is in the process of creating a network.

5.2.3 Forming the network

The ANT+ controller can use the information obtained from the continuous/background scan to determine the optimal network structure to be created. The network creation process for devices using continuous scan is conducted while still in scanning mode and is described in section 5.2.3.2. The network creation process for devices using a background scan requires closing the scanning channel and reusing it to connect to each device in turn until the network is formed. This is described in section 5.2.3.3.

5.2.3.1 Selecting the Main Light

The main light in a shared network topology will have the fastest connection to the ANT+ controller, and may use more power than the remaining lights in the network. The strength of the signal from each light will also vary depending on the physical location of the lights, and it may be helpful to choose the light with the highest RSSI value as the main light.

Alternatively the ANT+ controller may simply choose the first ANT+ bike light discovered to be the main light.

If the number of secondary lights that will be part of the network is greater than 4, then the ANT+ controller should ensure that the light that it selects to be the main light is capable of supporting the necessary number of secondary lights. This information is present in data page 2 (section 7.5.2).

5.2.3.2 Connection Process Using Continuous Scan

Once all the ANT+ bike lights have been observed to be in the unconnected state, the ANT+ controller should form the network. This is done by sending the connect command (page 33) to one of the ANT+ bike lights to tell it to act as the main light. The ANT+ bike light that receives this command shall then take on the main light role: i.e. it shall set its light index to 1, open a shared master channel as described in section 6.5, and transmit the data, requests and commands as described in section 7.3.3 and section 5.4.

NOTE: the ANT+ controller shall verify that a matching 'Sequence Number of Last Received Command' has been received before proceeding. Refer to section 5.2.3.3.1

The ANT+ controller then sends the connect command to the remaining ANT+ bike lights, commanding them to act as secondary lights. Each ANT+ bike light that receives this command shall set its light index as indicated in the command and open a shared slave channel as described in section 6.4 to connect to the main light. The secondary light shall then respond to the requests for data from the main light.

The ANT+ controller shall assign light indices in a sequential order, starting with a light index of 2 for the first secondary light.

The ANT+ controller may also send the connect command to any existing sub-lights to set their light type and initial state (on/off/flashing) if desired, before exiting continuous scanning mode.

The ANT+ controller should then open a channel (as described in section 6.1) to receive data from the main light detailing the state, capabilities and manufacturer/product information from each ANT+ bike light. The network formation is then complete. The ANT+ controller can then query each ANT+ bike light to obtain full details of its modes (section 5.3) and control each principal and sub-light's state as described in section 5.4.

This process is illustrated in Figure 5-2 below.

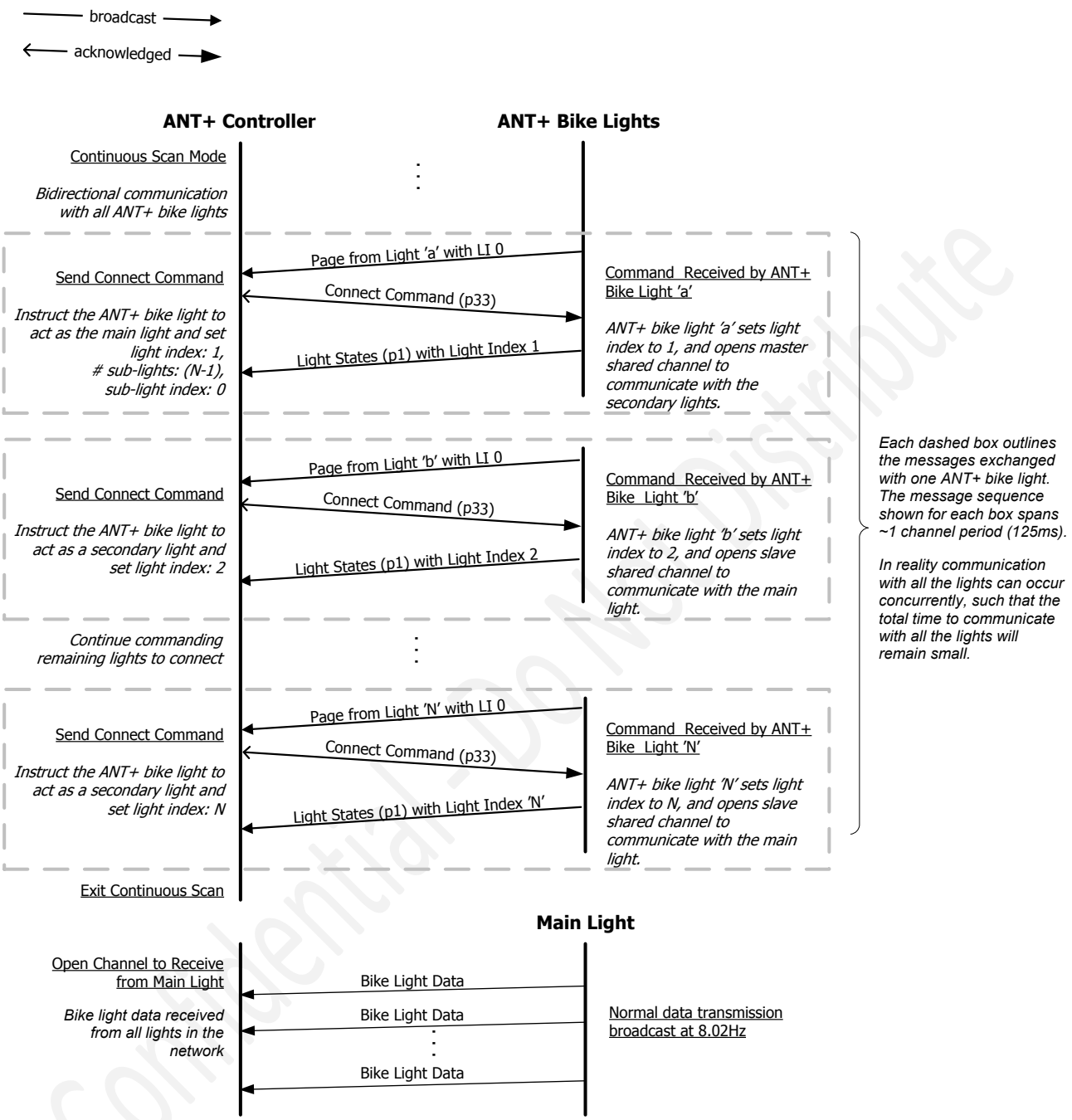

Figure 5-2. Continuous Scan Method Message Flow

5.2.3.3 Connection Process Using Background Scan

Once all the ANT+ bike lights have been observed to be in the unconnected state, the ANT+ controller should form the network. This is done by opening a channel to connect to one of the ANT+ bike lights, and sending the connect command (page 33) to tell it to act as the main light. The ANT+ controller may then optionally close this channel, or keep it open (to continue receiving data from the main light) and use additional channels for the following steps. The ANT+ bike light that receives this connect command shall then take on the main light role: i.e. it shall set its light index to 1, open a shared master channel as described in section 6.5, and transmit the data, requests and commands as described in section 7.3.3 and section 5.4.

NOTE: the ANT+ controller shall verify that a matching 'Sequence Number of Last Received Command' has been received before proceeding. Refer to section 5.2.3.3.1

The ANT+ controller shall then open a channel to connect to another ANT+ bike light, and send the connect command to tell it to act as a secondary light. The ANT+ bike light that receives this command shall set its light index as indicated in the command and open a shared slave channel as described in section 6.4 to connect to the main light. The secondary light shall then respond to the requests for data from the main light.

The ANT+ controller should then close this channel and reopen it to search for each of the remaining ANT+ bike lights in turn. The command page should be sent to each of these ANT+ bike lights to assign their light indices and command them to connect as secondary lights. The ANT+ controller should then close any channels connected to secondary lights.

The ANT+ controller should then open a channel (as described in section 6.1) to receive data from the main light detailing the state, capabilities and manufacturer/product information from each ANT+ bike light. The network formation is then complete. The ANT+ controller can then query each ANT+ bike light to obtain full details of its modes (section 5.3) and control each principal and sub-light's state as described section 5.4

This process is illustrated in Figure 5-3 and Figure 5-4.

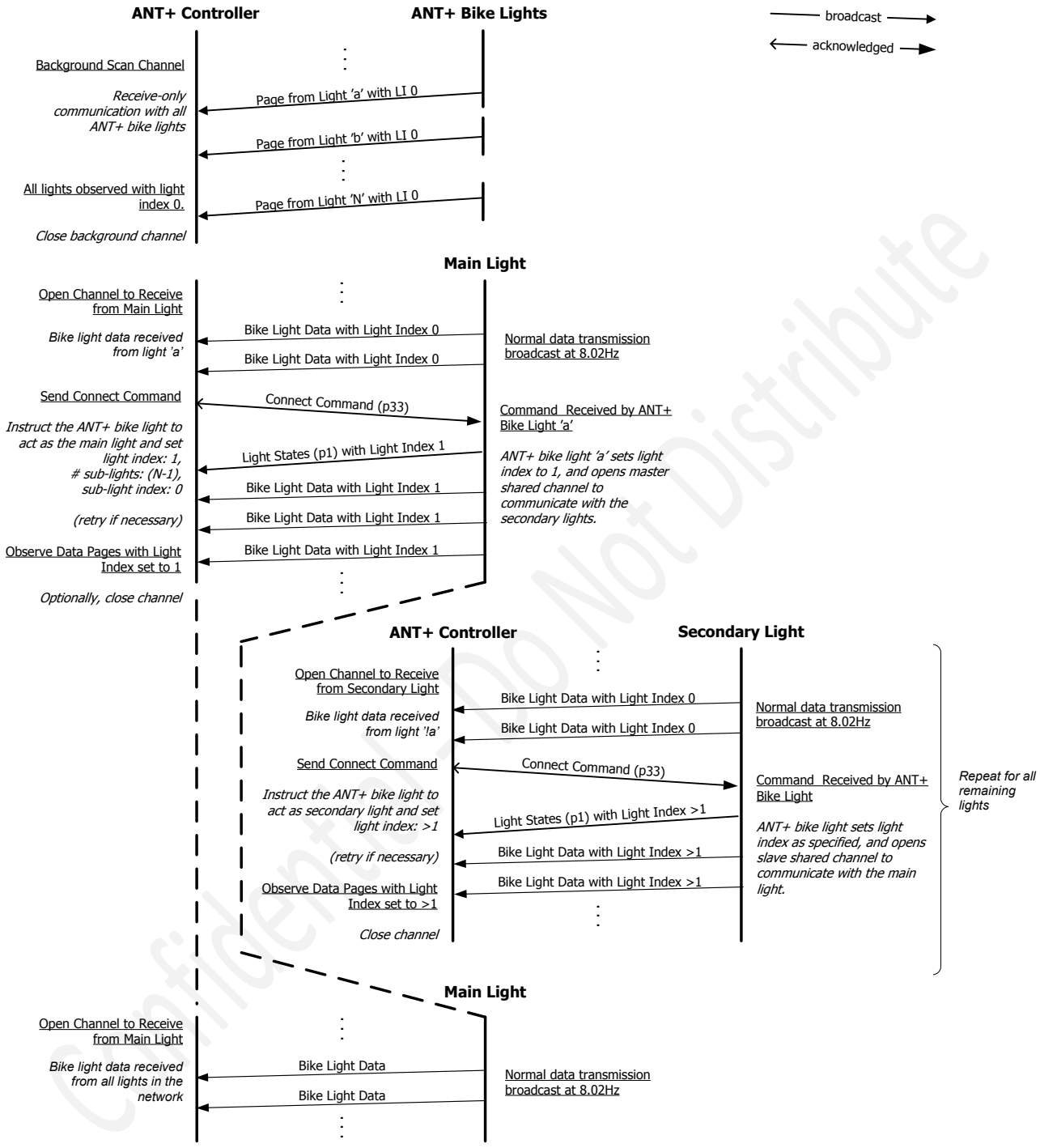

Figure 5-3. Background Scan Method Message Flow

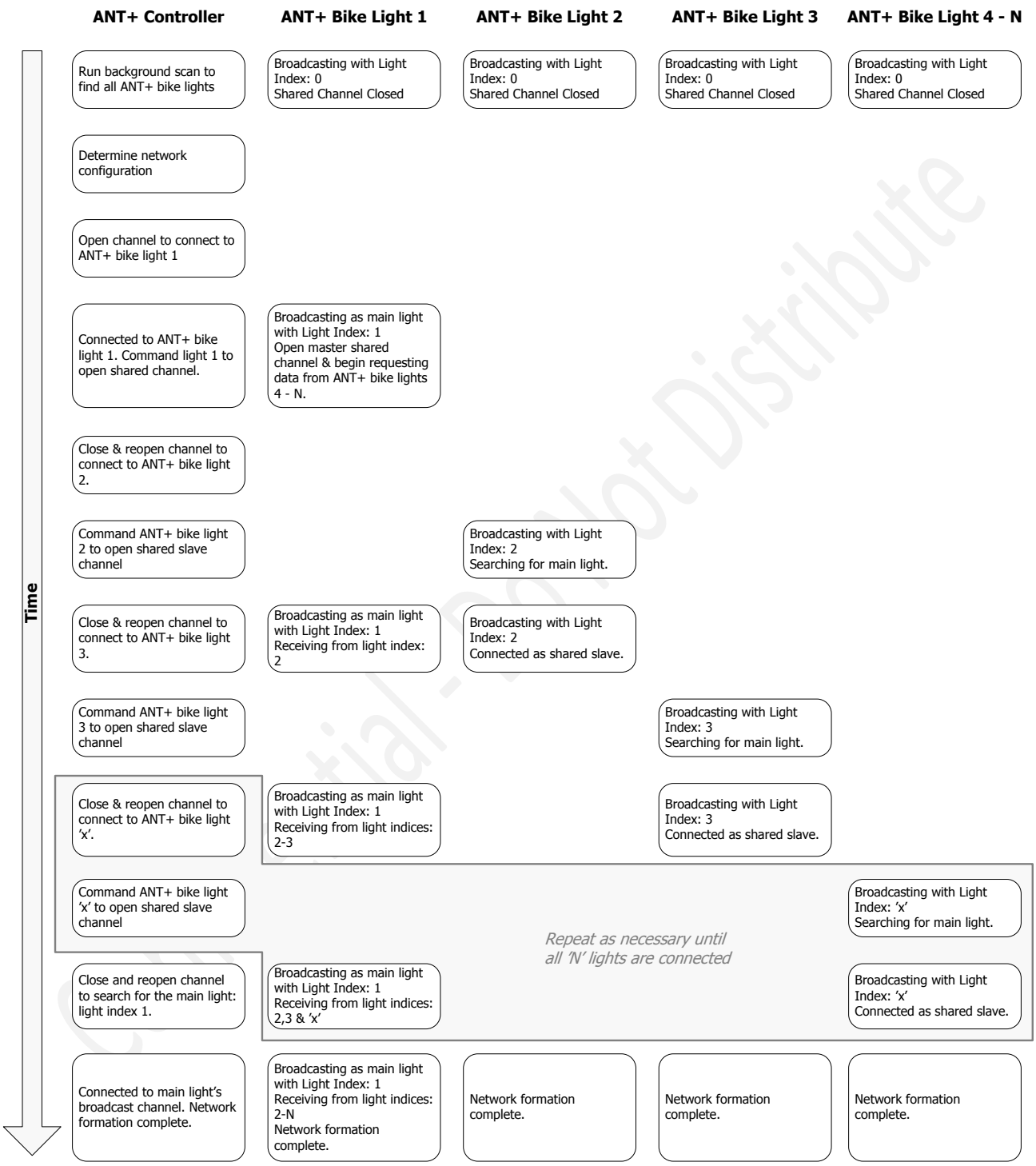

Figure 5-4. Formation of a Network using a Background Scan

5.2.3.3.1 Verifying the Network Formation May Proceed

In order to prevent two ANT+ controllers attempting to form a network at the same time, an ANT+ controller shall confirm that it has received a message from the main light where the field 'sequence number of last received command' matches the controller ID field that it sent in the connect command.

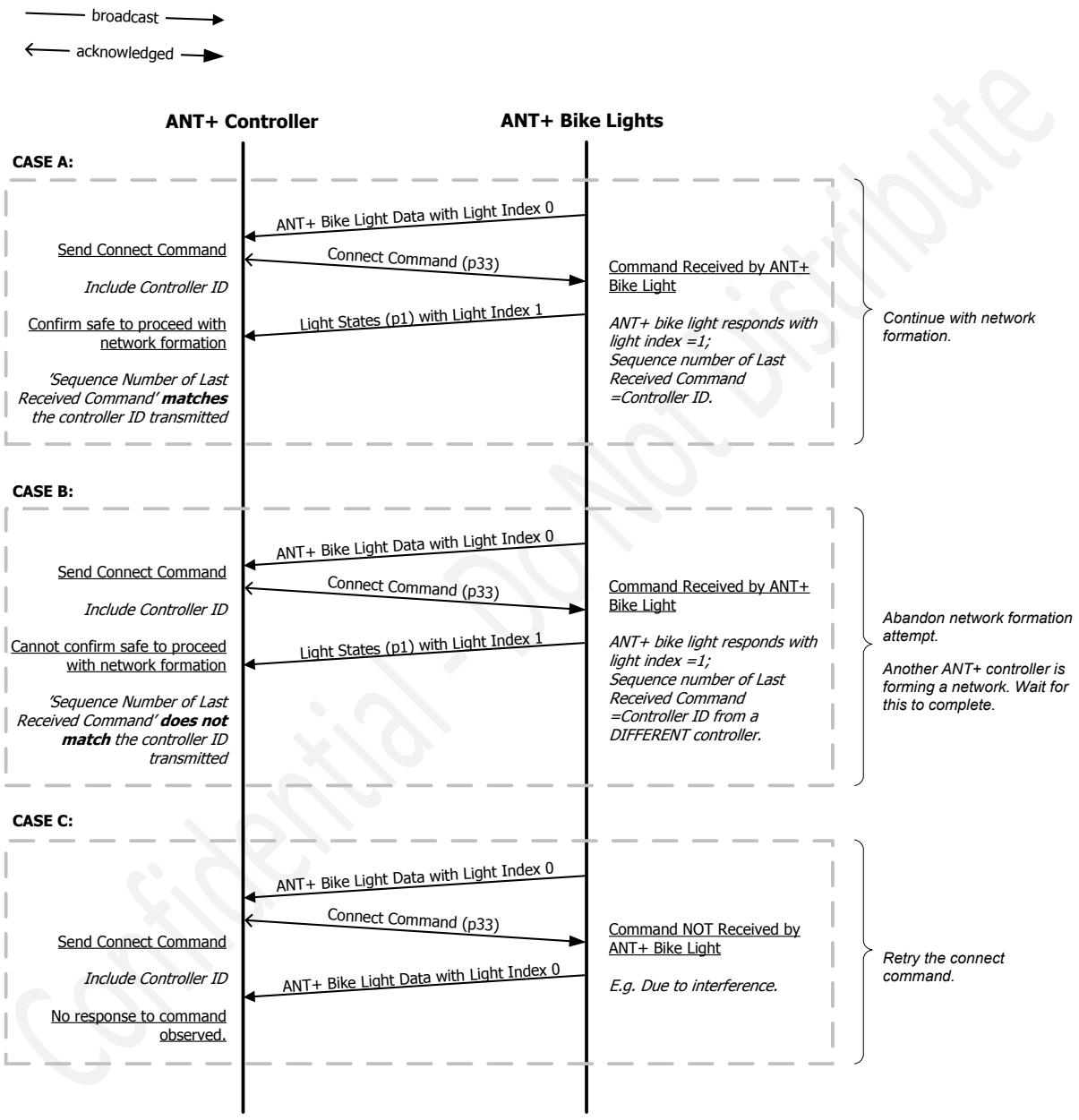

Figure 5-5. Verifying Controller ID = Sequence Number of Last Received Command

Figure 5-5 illustrates the possible responses to the connect command (Case A, B, or C) along with expected action to be taken by the controller in each case. In case B, the ANT+ controller shall abandon the attempt to form the network, and should remain connected to the main light.

Similarly if the ANT+ controller encounters an ANT+ bike light that does not initially have its light index set to 0: the ANT+ controller should return to scanning mode and wait for a variable length of time before reforming the network in accordance with section 5.2.2. If the ANT+ controller detects that the network has been reformed by another ANT+ controller before its waiting time has expired, it should join the new network and not attempt to reform it again. Refer to section 5.2.6.3

5.2.3.4 Setting the Shared Address on the ANT+ Bike Light

The ANT+ Bike Lights Device Profile uses the light index to act as the shared address on the shared channel. This must be correctly set in order to ensure that the secondary light receives and responds to the correct requests from the main light.

When a secondary light opens the shared channel in response to a connect command, it shall immediately send the shared format of data page 1 on the shared channel. This shall be sent using the light index specified by the connect command.

Note that it is required that this message be sent in order to ensure that the ANT+ bike light's ANT radio receives messages with a matching light index and passes them to the host. This message will stay in the ANT buffer until a message with matching light index is received, and will then be transmitted.

5.2.4 Maintaining the Network throughout a Session

Once the network is established, **each ANT+ controller that is connected to the main ANT+ bike light should send a message to the ANT+ bike light at least once every 30 seconds.** This confirms that the session is still in progress and that the connected status still applies. The secondary ANT+ bike lights should remain in the connected state as long as the shared channel remains connected.

If the ANT+ controller does not have any new commands or other messages to send within a given 30 second period, then the main light's channel ID (page 18) should be sent instead.

5.2.5 ANT+ Bike Light State Machine

Each ANT+ bike light moves from the unconnected state to the connected state when commanded to do so, and returns to the unconnected state in response to a disconnect command, or timeout. The state machine shown in Figure 5-6 illustrates each state and transition path.

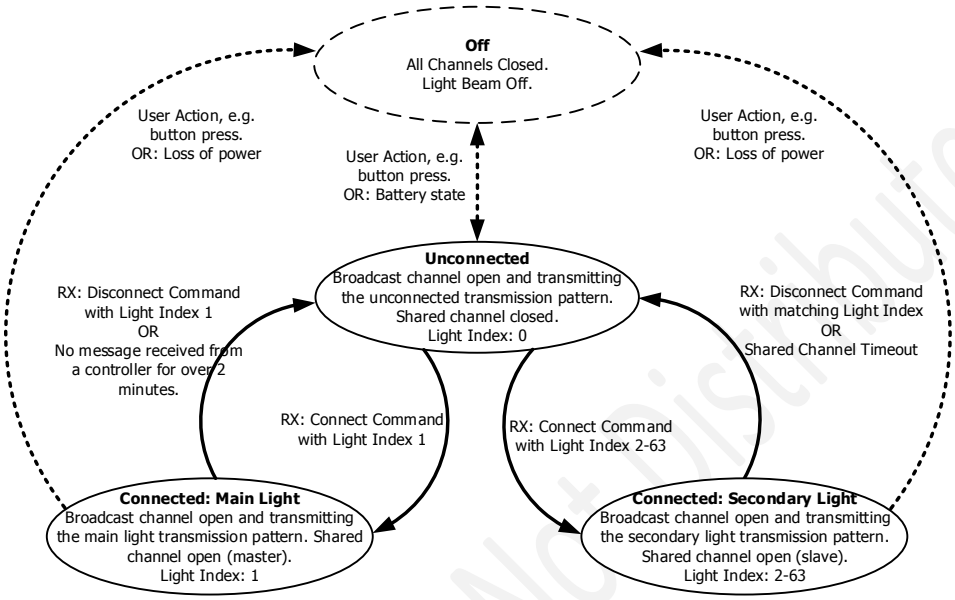

Figure 5-6. State Diagram for an ANT+ Bike Light

By default all ANT+ bike lights operate in the unconnected state and act as ANT master devices broadcasting the default transmission pattern (7.3.2).

Note that the main light shall return to the unconnected state if it has not received a message from any ANT+ controller for over 2 minutes (section 5.5). The secondary lights shall return to the unconnected state if they lose synchronization with the main light and are unable to reconnect. The recommended search timeout is 30 seconds, however this is an application specific value.

5.2.6 Making or Detecting Changes to an Existing Network

ANT+ controllers with advanced UI capabilities may be requested by the user to pair to an additional light. This situation may arise if a user carries spare batteries and needs to change a dead battery mid-journey, for example. If this occurs while the existing ANT+ bike lights are in the connected state, the ANT+ controller may add the ANT+ bike light to the existing network. Similarly if the user requests that the ANT+ controller remove a specific light from the system, this may also be done (as described below).

Other ANT+ controllers connected to the existing network should detect and handle these changes as described in section 5.2.6.3.

5.2.6.1 Adding an ANT+ Bike Light to an Existing Network

The ANT+ controller should first send connect command to the existing main light (light index =1), specifying a new number of secondary lights:

- # secondary lights = highest existing light index.

The main light shall respond by increasing the number of lights that it regularly requests data from, and by transmitting the data from the new light on the broadcast channel.

The ANT+ controller should send the connect command to the new ANT+ bike light, specifying the light index as follows:

- new light index = highest existing light index + 1.

The ANT+ bike light shall respond by moving to the connected state as a secondary light and joining the network with the index assigned.

5.2.6.2 Removing ANT+ Bike Lights from an Existing Network

To remove an ANT+ bike light from the network, the ANT+ controller should send a disconnect command to the main light specifying which light shall be disconnected. The main light forwards the disconnect command to the specified light, removes any pages from this secondary light from its transmissions on the broadcast channel, and stops requesting data from this secondary light on the shared channel.

If the light to be removed is the main light – then the network will need to be recreated entirely. This should be achieved as described in section 5.2.2.2.

5.2.6.3 Handling Changes in the Network

If a new ANT+ bike light is commanded by an ANT+ controller to join an existing network, then additional data pages from the new ANT+ bike light will be received and retransmitted by the main light. The new ANT+ bike light will therefore be visible to any other ANT+ controllers connected to the network. The light indices of the remaining lights will remain unchanged.

If an ANT+ bike light is removed from the network (i.e. if an ANT+ controller sends the disconnect command to a specific ANT+ bike light), then data pages relating to this light will no longer be transmitted by the main light. The light indices of the remaining lights will remain unchanged.

If an ANT+ bike light stops transmitting (e.g. if the battery runs out), the main light shall also stop transmitting data pages relating to this ANT+ bike light. The light indices of the remaining lights will remain unchanged.

In the event that an ANT+ controller recreates the network, any existing ANT+ controllers that were connected to the old network will need to detect the network change and automatically reconnect to the new network.

The main light's light index will change from 1 to 0 when it receives the disconnect command from an ANT+ controller, and then from 0 to X (where $2 \leq X \leq 63$) when it is commanded to connect to the new main light. This change in light index will alert any other connected ANT+ controllers to the change in main light. The new 'main light's channel ID' is indicated by data page 18, allowing the ANT+ controllers to search specifically for the new main light, and reconnect to the new network.

5.2.6.4 Reconnecting Bike Lights to the Network

In the case an ANT+ bike light is unintentionally disconnected (unreliable RF communication, accidental power-off, etc.) from the shared network, the ANT+ controller may connect it again by assigning it the same light index it was assigned during the current network formation. Reconnecting ANT+ bike lights requires an ANT+ controller to store the device numbers and light indices of all bike lights in the shared network, and perform a search for the disconnected light's device number while maintaining the broadcast channel connection with the main light. Once the disconnected ANT+ bike light is discovered, the ANT+ controller may send it a connect command assigning it to its previously assigned light index.

Note that unrecognized ANT+ bike lights (device number not stored on ANT+ controller) may not be assigned to previously assigned light indices. If the ANT+ controller cannot rediscover an unintentionally disconnected bike light, it must reform the shared network to reassign the light index to the newly discovered ANT+ bike light.

5.3 Discovering an ANT+ Bike Light's Modes

Most bike lights are capable of operating in several modes such as steady, slow flash, and fast flash. The ANT+ Bike Lights Device Profile considers each light mode as a collection of settings that is described by a mode number.

The settings described by each mode number may include any or all of the following variables:

- Pattern i.e. the pattern with which the light intensity changes over time
- Speed i.e. the length of time per pattern repeat
- Mode Duration i.e. how long the bike light will remain in the mode without interruption
- Colour i.e. the colour of the light beam

Several common modes are defined as standard modes such that an ANT+ controller can assume the settings for these modes without querying the ANT+ bike light for a description. These modes have the settings listed in the table below.

Table 5-1. Definitions of Standard Modes

#	Mode	Pattern	Segment Time	Mode Duration	Colour	Pattern Segment 0:11
0	Off	Steady	Invalid	Continuous	Default	0
1	Steady 81-100%	Steady	Invalid	Continuous	Default	0
2	Steady 61-80%	Steady	Invalid	Continuous	Default	0
3	Steady 41-60%	Steady	Invalid	Continuous	Default	0
4	Steady 21-40%	Steady	Invalid	Continuous	Default	0
5	Steady 0-20%	Steady	Invalid	Continuous	Default	0
6	Slow flash	Defined	~1000ms*	Continuous	Default	0 H
7	Fast flash	Defined	~250ms*	Continuous	Default	0 H
8	Random flash	Random	Invalid	Continuous	Default	0
9	Auto	Random	Invalid	Continuous	Default	0
10	Turn signal left (self cancelling)	Defined	~500ms*	4s	Default	0 H
11	Turn signal left (ongoing)	Defined	~500ms*	Continuous	Default	0 H
12	Turn signal right (self cancelling)	Defined	~500ms*	4s	Default	0 H
13	Turn signal right (ongoing)	Defined	~500ms*	Continuous	Default	0 H
14	Hazard lights (both left and right signal lights flashing continuously)	Defined	~500ms*	Continuous	Default	0 H

* Note that the segment time values are an indication only and may vary between bike lights.

The turn signal modes shall only be responded to by the appropriate light type(s). Specifically:

- 'Turn signal left (self-cancelling / ongoing)' shall only be responded to by ANT+ bike lights configured as 'signal light – left'.
- 'Turn signal right (self-cancelling / ongoing)' shall only be responded to by ANT+ bike lights configured as 'signal light – right'.

ANT+ bike lights may also support other modes and reference these with mode numbers 48 – 63. Supported custom modes shall be numbered from 63 and count down with no gaps in numbering. This enables an ANT+ controller to determine the number of custom modes supported by an ANT+ bike light as illustrated in Figure 5-7.

ANT+ controllers may query the ANT+ bike light to request details of each of these modes. Any ANT+ bike light that supports custom modes shall respond to requests for data page 5 'mode description' with the page populated to describe the settings associated with each mode number.

Note that combination lights shall use the same mode definitions for all sub-lights; i.e. each mode number will mean the same thing for the whole ANT+ bike light. However sub-lights may support different modes.

An ANT+ controller may check which custom modes are supported by each sub-light by requesting data page 6 'sub-light mode support'. Any ANT+ bike light that supports sub-lights shall respond with the requested page.

Example of Received Data Pages

Data Page 2:
Light Index 0
Beam: Does not support High/Low Beam
 # Supported Modes: 6
Battery Capacity: 4400mAh
Supported Standard Modes: 0, 1, 7
Supported Light Types: Headlight, Helmet Light

6 Total Modes – 3 Standard Modes

=> 3 Custom Modes Supported

=> Custom modes 63, 62, 61 supported

Data Page 4:
Light Index 0
Beam: Does not support High/Low Beam
 # Supported Modes: 7
Sub-light Index: 1
Battery Capacity: 4400mAh
Supported Standard Modes: 0, 11, 13
Supported Light Types: Signal Light – Left, Right, & Configurable.

7 Total Modes – 3 Standard Modes

=> 4 Custom Modes Supported

=> Request data page 6 to check which custom modes the sub-light supports.

Data Page 6:
Light Index 0
Sub-light Index: 1
Supported Custom Modes: 62, 60, 59, 58

Figure 5-7. Example Illustrating Custom Mode Support Indication

5.3.1 Auto Mode

One of the standard modes defined in the ANT+ Bike Lights Device Profile is auto mode. In this mode, the light determines its settings automatically and independently of commands received from the ANT+ controller. As an example, consider a tail light that receives directly from a speed sensor (using the ANT+ Bike Speed Device Profile), and automatically adjusts its flashing rate.

5.4 Controlling the Connected Lights

The light settings command (page 34) is used to control the ANT+ bike lights. This command may be sent from an ANT+ controller either in response to user input, or autonomously. The command allows an ANT+ controller to specify a new mode, beam height and maximum intensity to be applied. The ANT+ controller must also specify which light(s) or sub-light(s) should apply the new settings. Alternatively the controller may specify a type of light that should respond e.g. 'all left signal lights'.

When the light settings command is received by the main light, it shall be forwarded to the appropriate secondary light(s) according the specified destination lights.

Commands sent on the shared channel using light index 0x00 should be sent using broadcast messages, which may be automatically retried. Acknowledged messages are not recommended for this case, as it is not possible to distinguish which lights did or did not receive the message based on whether an acknowledgement is received. Broadcast messages are more efficient.

Commands sent to a specific light should be sent using acknowledged messages, as in this case the acknowledgement is deterministic. However broadcast messages may also be used.

Refer to section 7.18 for details of the command.

5.4.1 Determining whether a Command was Successful

An ANT+ controller can determine whether a command was successful with increasing degrees of certainty, based on the following information.

Observe ANT Notifications:

- If the ANT+ controller receives an EVENT_TX_SUCCESS notification, it knows that a message was received by the main light. If the ANT+ controller receives an EVENT_TX_FAIL it may immediately retry the command (using the same sequence number).

Observe Main Light's Data Page 1:

- For 'light settings' commands: if the sequence number in data page 1/light index 1 matches the sequence number in the command that the controller sent; then controller can assume that the command it sent was received by the main light. In this case the ANT+ controller should observe the sequence number in page 1 of the destination light.
- If the sequence number in data page 1/light index 1 does not match the sequence number sent by the ANT+ controller, it may retry the command (using the same sequence number).

Observe Destination Light's Data Page 1 (and 3):

- For 'light settings' commands: if the sequence number indicated in data page 1 of the destination light matches the sequence number in the command that the ANT+ controller sent; the controller can assume that the command it sent was received by that light. If this is not successfully observed, the ANT+ controller may retry the command with a new sequence number.
- The relevant data in pages 1 and 3 can be observed to confirm that the new state reflects that requested; and the command was not ignored.

An ANT+ controller should not attempt to force a state to remain constant unless explicitly instructed to do so by the user. This is to avoid multiple ANT+ controllers attempting to enforce conflicting states.

5.5 Ending a Session and Returning to the Unconnected State

ANT+ bike lights should implement a timeout (of two minutes or more) such that if no ping message is received within this time the main ANT+ bike light should send the disconnect command at least three times to return all secondary lights to their default state. All the ANT+ bike lights shall then close their shared channel and update their state indication in the

light states page(s) to 'unconnected' (i.e. set their light index = 0). This prevents each light having to search and timeout and reduces the power consumed by the lights.

This means that when the ANT+ controller is removed from the system (or powered off) all the ANT+ bike lights will automatically disconnect. Lights that have timed out should also switch off the light beam.

It is recommended that the ANT+ bike lights are always returned to the unconnected state at the end of a session instead of keeping the network formed, even when the controller remains present. This saves power and provides greater resiliency to changes in the number of lights present at the start of the next session. For example a user may regularly swap between sets of lights such that one set is available for use while the other set is recharged.

The ANT+ controller should therefore use the disconnect command to return the ANT+ bike lights to the unconnected state, e.g. when the user indicates that the ride is complete. In this case, the ANT+ controller will send the disconnect command with light index 0. This prevents the main light having to timeout.

5.6 Controlling an ANT+ Bike Light via the Broadcast Channel

It may be desirable to use an ANT+ controller to control an ANT+ bike light directly, independent of whether a network exists. For example it may be desirable to mount two small controller units on the bike handlebars specifically to control the bike signal lights. The user can then use the left unit to control the left signal light and the right unit to control the right signal light.

This can easily be achieved simply by pairing the relevant controller to the desired light and sending commands to the light as desired. Identifying the correct light to pair with can be done by using RSSI or proximity to select nearby lights and asking the user to confirm when the correct light is found.

Alternatively the ANT+ controller can pair to the main light in the network and communicate with the desired light via the network.

6 Channel Configuration

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

6.1 Slave Channel Configuration

The device expected to receive data from an ANT+ bike light must configure an ANT channel with its channel parameters set as listed in Table 6-1.

Table 6-1. ANT Channel Configuration for an ANT+ Bike Light Controller (i.e. Slave)

Parameter	Value	Comment
Channel Type	Slave (0x00)	The ANT+ bike light is a master device; therefore, the controller 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+ bike light
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	35 (0x23)	35 (0x23) – indicates search for an ANT+ bike light. 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	4084 counts	Data is transmitted from the ANT+ bike light every 4084/32768 seconds (~8.02 Hz) and this is the minimum required receive 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.

6.1.1 Transmission Type

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

6.1.2 Channel Period

The message period is set up so that the display device can receive data at the full rate (~8.02Hz).

6.2

6.2 Scanning Configuration

ANT+ controllers/display devices that support forming a network of ANT+ bike lights shall use a continuous or background scan to identify the nearby ANT+ bike lights and check the connection state before forming a network. ANT+ controllers/display devices using continuous scanning mode shall use the parameters listed in Table 6-2.

Table 6-2. ANT Radio Configuration for a Controller/Display Device (Continuous Scan)

Parameter	Value	Comment
Channel Type	Slave (0x00)	The ANT+ bike light is a master device; therefore, the controller device must be configured as the slave. Bidirectional communication is recommended.
Extended Messages	Enable Channel ID Optional - Enable RSSI	Use Lib Config (Message ID: 0x6E) to enable extended data messages with Channel ID information included. If the implementation requires, RSSI information for each received data message can be included as well. Note that the RSSI feature is not available on all ANT parts. Refer to the datasheet for capabilities, and to the ANT Message Protocol and Usage document for details.
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+ bike light
Transmission Type	0	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	35 (0x23)	The device type may be wildcarded to search for all ANT+ devices; or set specifically to restrict the search to ANT+ bike lights only. 35 (0x23) – indicates search for an ANT+ bike light. Please see the ANT Message Protocol and Usage document for more details.
Device Number	0	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.
Search Timeout	Implementation Specific (~3s)	This timeout is implementation specific and can be set by the designer to the appropriate value for the system. A value of ~3 seconds allows the controller to discover large group of lights while maintaining relatively low latency for user experience.

ANT+ controllers/display devices using a background scan shall configure use the parameters listed in Table 6-3.

Table 6-3. ANT Channel Configuration for a Controller/Display Device (Background Scan)

Parameter	Value	Comment
Channel Type	Slave – Receive Only (0x40)	As a channel configured for background scanning does not transmit data, the channel shall be set to receive only.
Extended Assignment Byte	0x01	Configures the channel for background scanning. Please see the ANT Message Protocol and Usage document for more details.
Extended Messages	Enable Channel ID Optional - Enable RSSI	Use Lib Config (Message ID: 0x6E) to enable extended data messages with Channel ID information included. If the implementation requires, RSSI information for each received data message can be included as well. Note that the RSSI feature is not available on all ANT parts. Refer to the datasheet for capabilities, and to the ANT Message Protocol and Usage document for details.
Network Key	ANT+ Managed Network Key	The ANT+ Managed Network Key is governed by the ANT+ Managed Network licensing agreement
RF Channel Frequency	57	RF channel 57 (2457MHz) is used for the ANT+ bike light.
Transmission Type	0	The transmission type must be set to 0 for a pairing search.
Device Type	35 (0x23)	The device type may be wildcarded to search for all ANT+ devices; or set specifically to restrict the search to ANT+ bike lights only. 35 (0x23) – indicates search for an ANT+ bike light. Please see the ANT Message Protocol and Usage document for more details.
Device Number	0	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.
Search Timeout	Implementation Specific (~3s)	This timeout is implementation specific and can be set by the designer to the appropriate value for the system. A value of ~3 seconds allows the controller to discover large group of lights while maintaining relatively low latency for user experience.

6.3 Master Channel Configuration

6.3.1 Bike Light Master Channel Configuration

The ANT+ bike light shall establish its default ANT channel as shown in Table 6-4.

Table 6-4. ANT Channel Configuration for an ANT+ Bike Light (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+ bike light.
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	35 (0x23)	An ANT+ bike light shall transmit its device type as 0x23. 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+ bike light. 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 not be 0x0000.
Channel Period	4084 counts	Data is transmitted every 4084/32768 seconds (~8.02Hz).

6.3.1.1 Channel Type

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

6.3.1.2 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.

6.3.1.3 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+ bike light shall 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.

6.4

6.4 Shared Slave Channel Configuration

An ANT+ bike light shall open a channel configured as listed in Table 6-5 in response to a command received from an ANT+ controller instructing the ANT+ bike light to connect as a secondary light.

Table 6-5. ANT Channel Configuration for a Secondary Light (i.e. Shared Slave)

Parameter	Value	Comment
Channel Type	Shared Slave (0x20)	The main light is a shared master device; therefore, the secondary light must be configured as a shared 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+ bike light
Transmission Type	0 for pairing	The transmission type must be set to 0. 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	36 (0x24)	36 (0x24) – indicates search for a main light. Please see the ANT Message Protocol and Usage document for more details.
Device Number	1 – 65535	Specified in Connect Command (section 7.17.7). Please see the ANT Message Protocol and Usage document for more details.
Channel Period	4084 counts	Data is transmitted from an ANT+ bike light configured as a main light (shared master) every 4084/32768 seconds (~8.02Hz) 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.

6.4.1.1 Transmission Type

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

6.4.1.2 Channel Period

The shared channel message period is set up so that the ANT+ bike light configured as secondary light can receive data at the full rate (~8.02Hz).

6.5 Shared Master Channel Configuration

An ANT+ bike light device shall open a channel configured as listed in Table 6-6 in response to a command received from an ANT+ controller/display device instructing it to connect as the main light in the shared network.

Table 6-6. ANT Channel Configuration for a Main Light (i.e. Shared Master)

Parameter	Value	Comment
Channel Type	Shared Master (0x30)	Within the ANT protocol the master channel (0x30) allows for bi-directional communication on a shared channel 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+ bike light.
Transmission Type	Set MSN to 0 (0x0) or MSN of extended device number. Set LSN to 6 (0x6)	ANT+ devices follow the transmission type definition as outlined in the ANT protocol. This transmission type uses a 1 byte shared channel address and must be compliant with the global data messages defined in the ANT protocol
Device Type	36 (0x24)	An ANT+ main light shall transmit its device type as 0x24. 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+ bike light. 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 not be 0x0000.
Channel Period	4084 counts	Data is transmitted every 4084/32768 seconds (~8.02Hz).

6.5.1.1 Channel Type

As communication in two directions on a shared channel is required, the channel type is set to shared bidirectional master (0x30). The shared bidirectional master channel is also used to enable the interference avoidance features inherent to the ANT protocol.

6.5.1.2 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.

6.5.1.3 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+ bike light shall 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.

7 Message Payload Format

7.1 ANT+ Message Data Formats

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

Table 7-1. ANT+ General Message Format

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

7.2 Data Page Types

Messages in the ANT+ Bike Lights Device Profile include main pages and command pages.

Bike light main data pages contain the main data from the ANT+ bike light (and any connected lights) including state, capabilities, manufacturer and product information. Data pages 1, 2, 80 and 81 are the bike light main pages that should be transmitted by default. Data pages 3 and 4 should also be transmitted if sub-lights are present.

Command pages are sent from the controller to the ANT+ bike light device when required. Command pages 32 and 33 are used to create, destroy and configure networks of ANT+ bike lights. Command page 34 is used to control the ANT+ bike lights' state, beam height, and mode.

7.3 Transmission Patterns

ANT+ bike light devices have defined transmission patterns that change according to the current state of the device. The sections below define how the data should be transmitted over both the broadcast and shared channels of the device in the states defined in Figure 5-6:

Table 7-2. ANT+ Bike Light Device Transmission Patterns

State	Broadcast Channel	Shared Channel
Unconnected	Bike light device data (7.3.2).	N/A, Channel is closed.
Connected – Main Light	Bike light device data with interleaved light network data (7.3.3).	Shared Master – Poll all connected lights in the light network. Forward commands and data page requests to light network (7.3.3.2).
Connected – Secondary Light	Bike light device data updated to also include light network information (7.3.6).	Shared Slave – Respond to commands and data page requests from the main light.

7.3.1 Bike Light Transmission Patterns

An ANT+ bike light transmits at a rate of ~8 data pages every second. The main data pages 1, 2, 80, and 81 shall be included in the default broadcast transmission pattern. Additional main data pages 3, 4, 16, 17 and 18 can also be included in the transmission pattern at certain times, as detailed in the following sections.

Because the data in these pages generally changes on an event driven basis (e.g. the light state will change in response to a command) the transmission pattern is also event driven. Specifically the broadcast transmission restarts each time the state of an ANT+ bike light (or sub-light) changes. This is illustrated in the figures below.

7.3.2 Transmission Pattern for an Unconnected ANT+ Bike Light without Sub-lights

The regular broadcast transmission pattern for an unconnected ANT+ bike light with no sub-lights is shown in Figure 7-1. Data pages 1, 2, 80 and 81 are repeated continuously by default. If additional common pages or manufacturer specific pages are transmitted by the device, these should be included after each pattern repeat, as represented by the 'X' in pattern 'b'. A maximum of 10 manufacturer specific pages may be included in each pattern repeat.

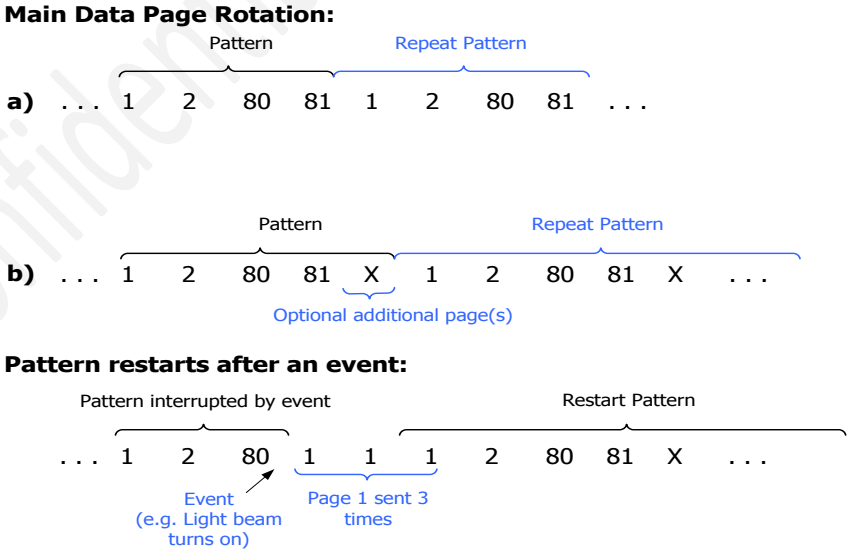

Figure 7-1. Default Broadcast Transmission Pattern

Whenever the ANT+ bike light receives a command from the ANT+ controller, or whenever the light changes state autonomously (i.e. when any fields in data page 1 change values), an event is considered to have taken place. After each event the transmission pattern resets such that the next message transmitted is data page 1. It is recommended that data page 1 is sent three times after an event to ensure that it is received quickly by the ANT+ controller. Note that after the interruption the transmission pattern may continue from the beginning as illustrated in Figure 7-1, or may resume from the point at which it was interrupted.

7.3.2.1 Transmission Pattern for an Unconnected ANT+ Bike Light with Sub-lights

The broadcast transmission pattern for an unconnected ANT+ bike light including sub-lights is similar to the default transmission pattern shown above, but also includes main data page 3 and 4. Data pages 3 and 4 shall be transmitted once for each sub-light. Figure 7-2 shows the pattern for an ANT+ bike light with four sub-lights:

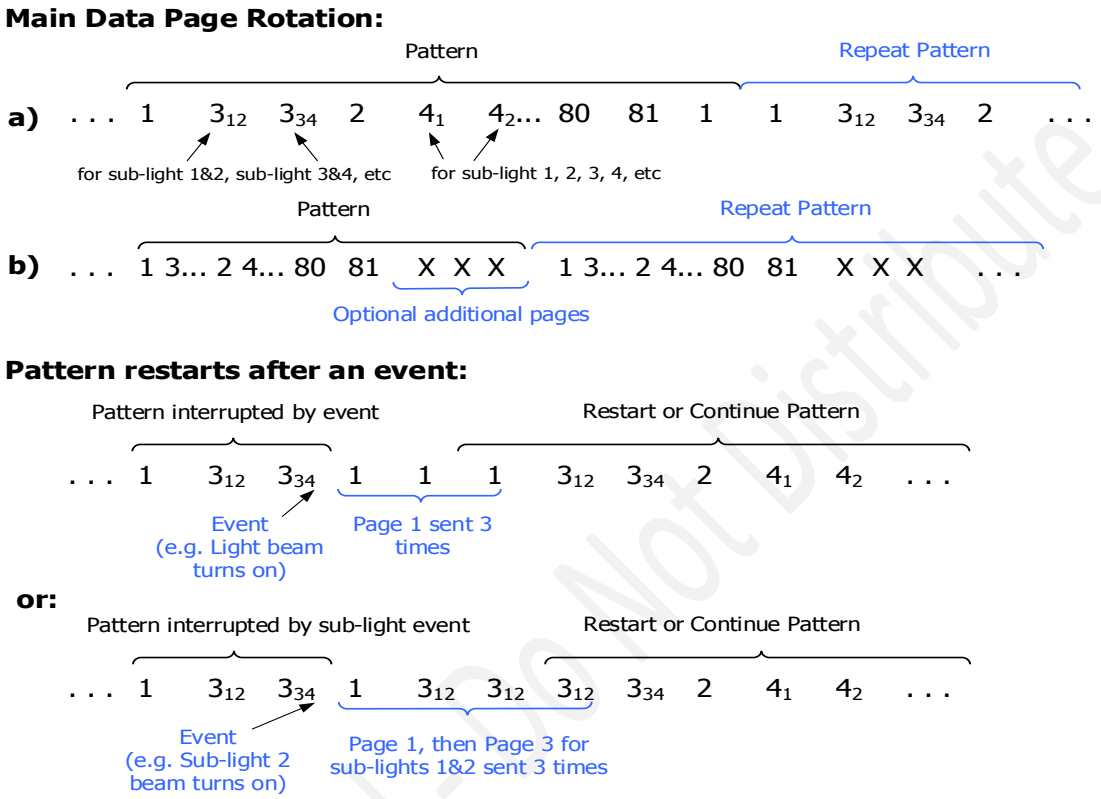

Figure 7-2. Default Broadcast Transmission Pattern with Sub-light Data Pages

Whenever the ANT+ bike light receives a command from the ANT+ controller, this pattern resets such that the next message transmitted is page 1. If the command was specific to a sub-light, then the pattern should still start with page 1 (containing the command sequence number) followed by the page 3 referencing the relevant sub-light, then continue as normal.

Note that if the event occurs on a sub-light data page 1 should be transmitted once, followed by 3 copies of data page 3. If the event occurs on the principal light then data page 1 should be transmitted 3 times, and the extra data page 3 transmissions are not required.

7.3.3 Transmission Pattern for a Connected ANT+ Main Bike Light

The regular broadcast transmission pattern for a connected ANT+ bike light that is acting as a main light includes data pages forwarded from the connected secondary lights, in addition to data pages describing the main light.

An ANT+ bike light with no sub-lights transmits a repeating pattern including data page 1, and optionally pages 2, 80 and 81. If the ANT+ bike light has sub-lights, then data page 3 shall also be included to describe each existing sub-light; and data page 4 is optional. These pages are all transmitted with light index 1 in byte 1, indicating that the main light is being described.

In addition, any data pages 1 and 3, received from connected secondary lights shall also be included in the main transmission pattern. Data pages 2, 4, 16, and 17 may optionally be included. These pages should maintain the light and sub-light indices of the lights that they were received from. Any additional optional data pages received from the secondary ANT+ bike lights may either be retransmitted unchanged, or ignored by the main ANT+ bike light.

The main light's channel ID (page 18) may optionally also be included. The resulting transmission pattern is shown in Figure 7-3.

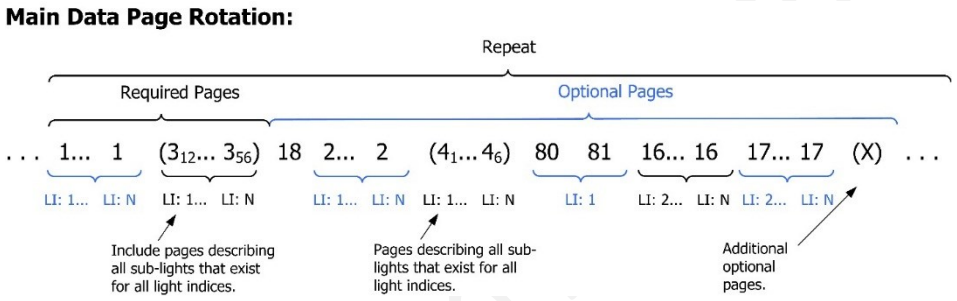

Figure 7-3. Regular Broadcast Transmission Pattern for a Main Light

Note that in this figure, parentheses '()' are used to indicate pages that are only present in certain circumstances (e.g. when sub-lights exist). Also note the light index associated with each page is shown as 1 for pages relating to the main light, and as >1 for pages relating to other pages.

7.3.3.1 Restarting the Transmission Pattern after an Event

Whenever an event takes place (i.e. when a light changes state), the regular pattern is interrupted such that the next messages transmitted describe the new state of the light (or lights) on which the event took place.

For example, consider a set of four ANT+ bike lights:

- Light Index 1 (Main Light) with 1 Sub-light: SLI 1
- Light Index 2 (Secondary Light) with 0 Sub-lights
- Light Index 3 (Secondary Light) with 2 Sub-lights: SLI 1, and SLI 2
- Light Index 4 (Secondary Light) with 0 Sub-lights

If an event occurs on light index 3, sub-light 2; the transmission pattern would be interrupted to send data page 1/light index 3 once, followed by data page 3/light index 3/ sub-light index 2 three times, before restarting the regular transmission pattern.

Figure 7-4 shows the page transmissions that would be sent following this event:

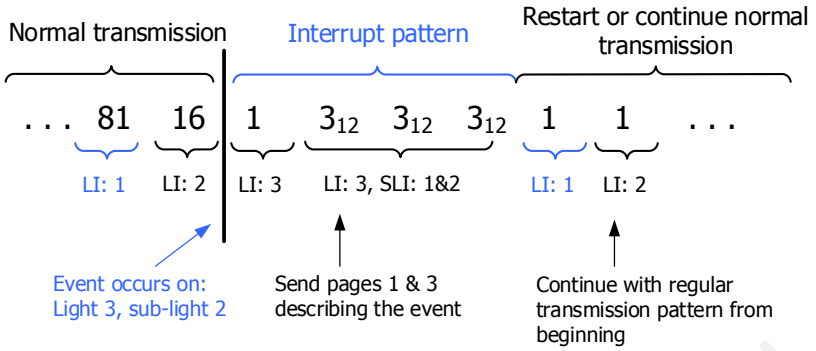

Figure 7-4. Example: Interrupting the Regular Broadcast Transmission Pattern

In another example, a set of events occur on multiple lights in close succession. The transmission pattern is interrupted to send the new information as illustrated in Figure 7-5 before resuming the regular transmission pattern from data page 1/light index 1.

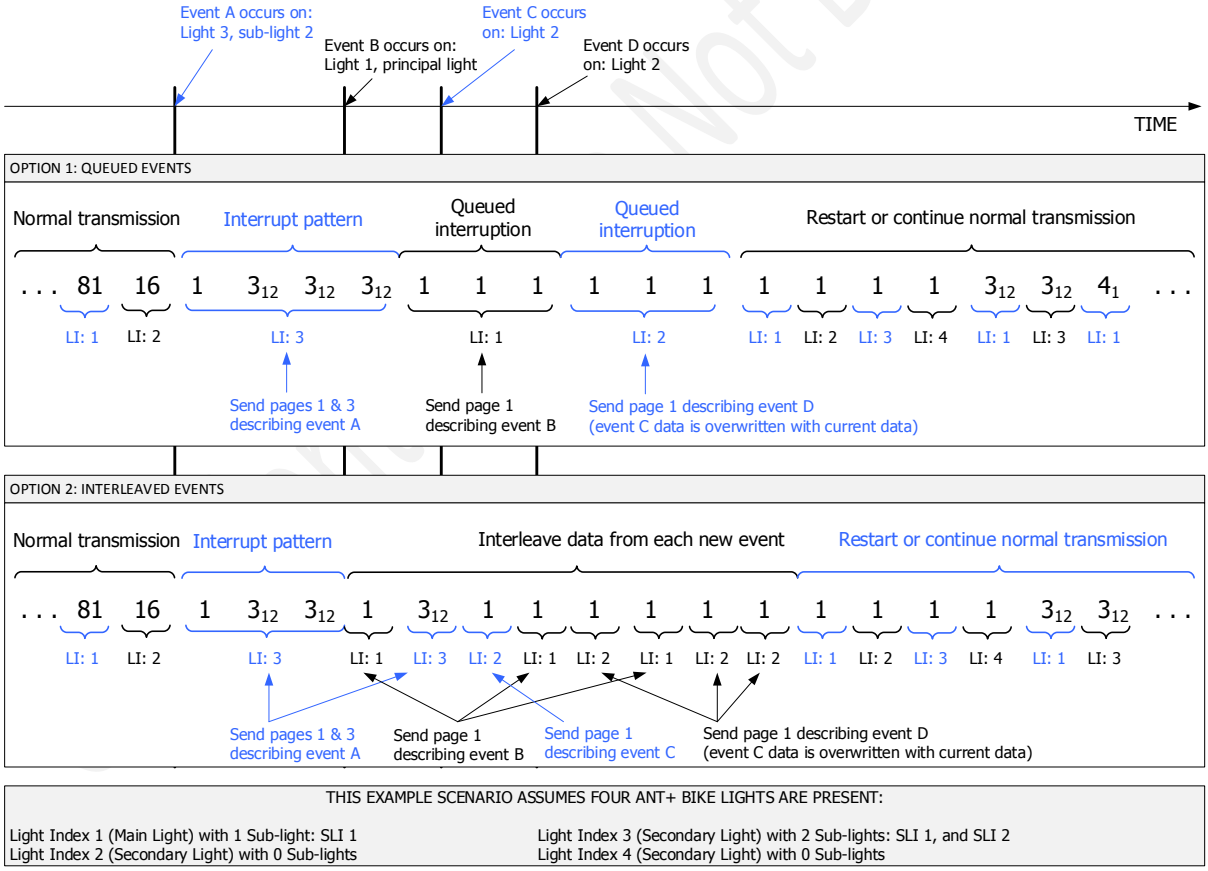

Figure 7-5. Example: Handling Multiple Events

Note that if successive events occur quickly, a situation may arise where a new event has occurred before the data page describing a previous event has been transmitted. In this situation: events on different lights may either be queued and

transmitted in sequence (as shown in ‘option 1’ in figure above) or be interleaved as shown in ‘option2’. However in both methods, a new event occurring on the same light and sub-light as a queued event should overwrite the queued event, ensuring that the current information for each light is always transmitted.

7.3.3.2 Shared Channel Transmission Pattern

The main light is the master device on the shared channel, and is therefore the device that manages communication with the secondary lights.

The main light should request data pages from each secondary light in turn. This should be done by sending data page 70, populated to indicate the requested data page (section 7.22.3). The request page (70) should always be sent twice consecutively to allow the secondary device time to process the request and respond on the next channel period.

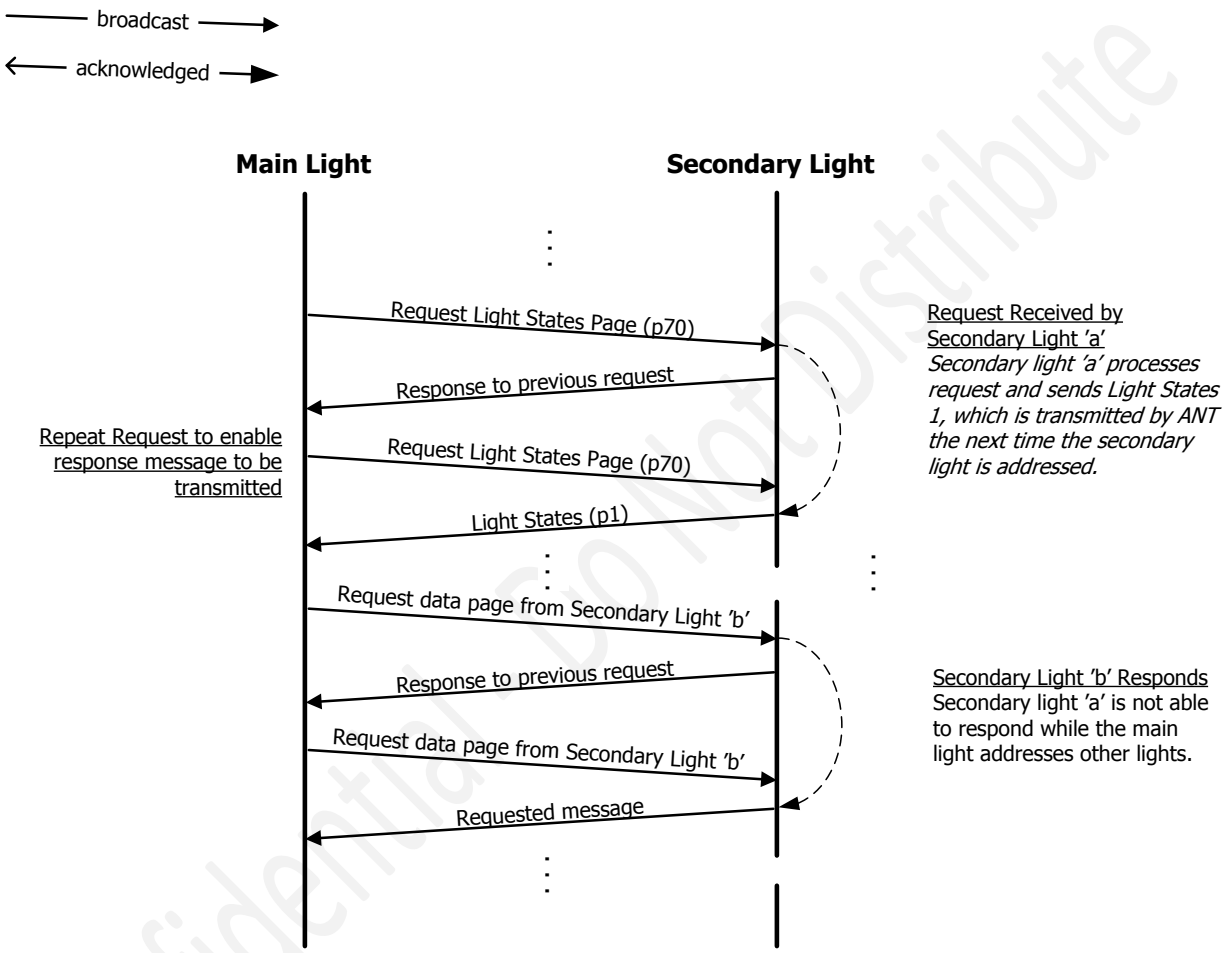

Figure 7-6. Message Flow on Shared Channel

The '# secondary devices' field in the connect command indicates which light indices should be polled by the main light (section 7.17.2). All relevant light indices should be included in this sequence of requests by default. When the shared channel is first opened by the master, no responses will be received until the secondary lights have found the channel. Once each secondary light finds the shared channel it will begin to respond to requests once it has set its shared address (section 5.2.3.4).

The recommended sequence in which to request data pages on the shared channel is as follows. When the shared channel is first opened the main light should use the request page 70 to request page 1 from each light in turn. Once the main light has received a response from a secondary light it should request data pages 16 and 17 from that light over the next rotations. If the main light has stored the remaining information from the secondary light identified by the manufacturer and product information in data pages 16 and 17, the main light may then revert to only requesting data page 1 and 3 from the secondary light by default.

Alternatively, if the main light does not recognize the secondary light identified by data pages 16 and 17, then it may continue to request the remaining data pages (2, 4, 6 (for any sub-lights that have custom modes), and 5) from the secondary light over the next rotations. Note that requesting data pages 5 and 6 when each light connects allows the main light to service requests for these pages more quickly.

Once the main light has received all data pages at least once from a secondary light, the main light should only request data pages 1 and 3 from that light (as these are the only pages that contain data that will change over time).

However as memory on a bike light may be limited it is also allowed to only request data pages 1 and 3 from each secondary light, and to wait to request any other data pages until they are requested by the ANT+ controller. If this approach is taken then once a specific page is requested from the main light, the main light shall request the relevant page from the relevant secondary light and then transmit the requested pages to the ANT+ controller.

In all cases the main light shall regularly request data page 1 and data page(s) 3 describing all existing sub-lights from each secondary light.

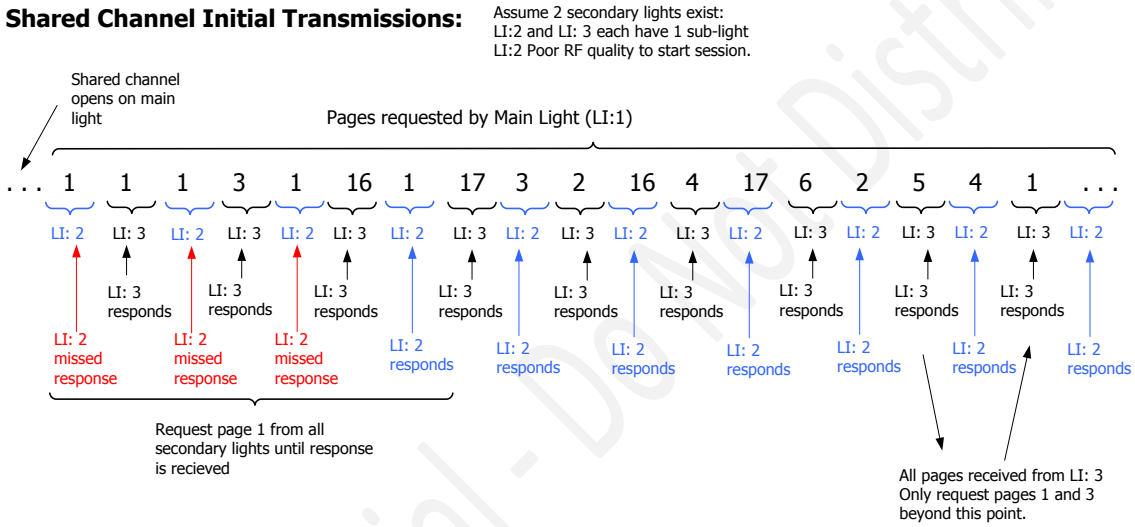

Figure 7-7. Example: Shared Channel Transmission Pattern

7.3.4 Transmission Pattern for a Connected Secondary ANT+ Bike Light

Secondary ANT+ bike lights maintain the original master channel while connected as a secondary light via the shared channel. This section describes the transmission pattern broadcast on the master channel while in the connected state.

The regular broadcast transmission pattern is the same as in the unconnected state, except it is recommended that the main light's channel ID page (18) is also included, as illustrated in Figure 7-8.

Whenever an event takes place (i.e. when the light changes state), this pattern resets such that the next message transmitted is page 1 as shown in Figure 7-1 and Figure 7-2.

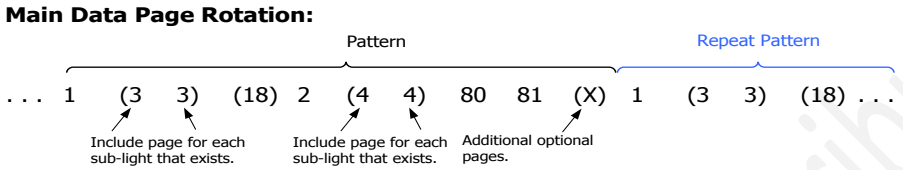

Figure 7-8. Broadcast Transmission Pattern for a Secondary Light

Note that the transmission pattern of data on the shared slave channel is determined by the main light. The secondary light set its shared address (section 5.2.3.4) and then simply responds to the main light's requests for data.

7.4 Data Page 1 – Light States 1 (0x01)

Data page 1 is one of the main data pages broadcast from an ANT+ bike light. All ANT+ bike lights shall send this page at the start of a data page rotation and immediately after a change of state (e.g. when a new command is received). All fields in this message shall be set as described in Table 7-3.

Table 7-3. Data Page 1 Format – Light States 1

Byte	Description	Length	Value	Units	Range or Rollover
0	Data Page Number	1 Byte	Data Page Number = 1 (0x01)	N/A	N/A
1	Light Index	1 Byte	Index of the ANT+ Bike Light. Refer to section 7.4.1. 64-255: Reserved, Do Not Use.	N/A	0-63
2	Reserved	1 Bit (0)	Reserved for future use. Set to 0.	N/A	N/A
2	Bike Radar Support	1 Bit (1)	0: Bike Radar Not Supported 1: Bike Radar Supported	N/A	N/A
2	Light Type	3 Bits (2:4)	Refer to Table 7-5	N/A	N/A
2	Battery Warnings	3 Bits (5:7)	Refer to Table 7-6	N/A	N/A
3	Number of Sub-lights	3 Bits (0:2)	Number of sub-lights in addition to the light described in this page. 5-7: Reserved, Do Not Use.	N/A	0-4
3	Reserved	5 Bits (3:7)	Reserved for future use. Set to 0x00.	N/A	N/A
4	Sequence Number of last received command	1 Byte	Sequence number contained in the most recently received command page. Set to 0xFF when uninitialized.	N/A	0-255
5	Beam Focus	1 Byte	Percentage of maximum beam focus. Beam Focus Not Supported: 0xFF	1%	0-100%
6	Light State Bit Field	1 Byte	Refer to Table 7-7	N/A	N/A
7	Light Intensity	1 Byte	Percentage of maximum intensity. Brake Override Mode Enabled: 0xFD Auto Intensity Mode Enabled: 0xFE Invalid: 0xFF.	1%	0-100%

Table 7-4. Shared Format of Data Page 1

Byte	Description	Length	Value	Units	Range or Rollover
0	Light Index	1 Byte	Index of the secondary light that is sending this page. 64-255: Reserved, Do Not Use.	N/A	2-63
1	Data Page Number	1 Byte	Data Page Number = 1 (0x01)	N/A	N/A
2:7	Set as described in Table 7-3				

7.4.1 Light Index

The light index field is used to identify each ANT+ bike light within the network when the light is connected. When the light is unconnected the light index shall be set to 0x00.

7.4.2 Bike Radar Support

The bike radar support field allows the device to indicate if it is a bike radar capable device.

7.4.3 Light Type

The light type field indicates the types of light that the ANT+ bike light is currently configured as. If 'signal light – configurable' is indicated, then the controller should configure the light as either 'signal light – left' or 'signal light – right'.

Table 7-5. Light Type

Bits		Value	Meaning
2:4		0	Headlight
		1	Reserved for future use. Do not Use.
		2	Taillight
		3	Signal Light - Configurable
		4	Signal Light - Left
		5	Signal Light - Right
		6	Reserved for future use. Do not use.
		7	Other

7.4.4 Beam Focus

The beam focus field indicates the current beam focus of the bike light. If the ANT+ bike light does not support beam focus control, then this field shall be set to 0xFF, invalid.

7.4.5 Battery Level

The battery level is indicated as described in Table 7-6. Note that if the ANT+ bike light includes more than one battery unit, the lowest battery level should be shown in this field.

Table 7-6. Battery Level

Bits	Value	Description
5:7	0 (0x00)	Reserved for future use
	1 (0x01)	Battery Status = New/Full
	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

7.4.6 Number of Sub-Lights

The number of sub-lights field is used to indicate the presence of multiple lights in one ANT+ bike light. If sub-lights are present, these can be treated by the ANT+ controller in the same way as separate lights in terms of commands and status

information. However the ANT+ controller cannot separate sub-lights in the network, as the information from these lights originates on one ANT radio.

Data from the sub-lights is transmitted using the sub-light state main data page.

This field shall not be set to values 5-7.

7.4.7 Sequence Number of Last Received Command

This field shall be populated based on the most recent command received by the ANT+ bike light. Specifically it should be populated with:

- The sequence number from byte 3 of the last command page 34 received by the ANT+ bike light.
- The controller ID from the last command page 32 or 33 received by the ANT+ bike light.

This allows an ANT+ controller to confirm whether a given command reached its destination. Note that if the ANT+ bike light changes state autonomously, this field value should not be changed as a result.

7.4.8 Light State Bit Field

The state for each connected light is indicated as described in the following table.

Table 7-7. Light State Bit Field

Bits	Description	Value	Meaning
1	Beam	0	Low Beam (Normal)
		1	High Beam
2:7	Current Mode Number	0	Light beam is off.
		1	Steady 81-100% intensity
		2	Steady: 61-80% intensity
		3	Steady: 41-60% intensity
		4	Steady: 21-40% intensity
		5	Steady: 0-20% intensity
		6	Slow flash
		7	Fast flash
		8	Random flash
		9	Auto
		10	Turn signal left (self cancelling)
		11	Turn signal left (ongoing)
		12	Turn signal right (self cancelling)
		13	Turn signal right (ongoing)
		14	Hazard lights (both left and right indicators flashing continuously)
		15:47	Reserved for future use. Do not use.
		48	Custom mode 48
		X	Custom mode 'X'
		63	Custom mode 63

An ANT+ controller may request the mode description data page from an ANT+ bike light to obtain the mode settings indicated by any custom modes supported. Refer to section 5.3.

7.4.9 Light Intensity

The intensity setting of the ANT+ bike light is indicated as a percentage of the maximum supported intensity. The ANT+ bike light shall set this field to 0xFE if it is in Auto Intensity Mode. In this state the light intensity will constantly be changing based on manufacturer defined behaviour (i.e. acceleration/deceleration, ambient light, etc.).

0xFD: Brake Light Mode Enabled

7.5 Data Page 2 – Light Capabilities (0x02)

Data page 2 is one of the main data pages broadcast from an ANT+ bike light. All ANT+ bike lights shall send this page as part of the data page rotation, and upon request from a controller. Refer to section 7.3 for details on when to send this data page. All fields in this message shall be set as described in Table 7-8.

Table 7-8. Data Page 2 Format – Light Capabilities

Byte	Description	Length	Value	Units	Range or Rollover
0	Data Page Number	1 Byte	Data Page Number = 2 (0x02)	N/A	N/A
1	Light Index	1 Byte	Index number of the ANT+ bike light to which the data in this page relates. Refer to section 7.4.1. 64-255: Reserved, Do Not Use.	N/A	0-63
2	Light Properties	1 Byte	Refer to Table 7-10.	N/A	N/A
3	Battery Capacity	1 Byte	Capacity of fully charged battery. 0xFF indicates invalid.	200mAh	0-50800mAh
4	# Supported Secondary Lights.	4 Bits	The number of secondary lights that the ANT+ bike light can support when acting as a main light.	1 light	4-63
	Reserved	2 Bits	Reserved, set to 0x00.	N/A	N/A
	Granular Control Capability	2 Bits (6:7)	Bit 6: Beam Focus Control 0: Capable 1: Incapable Bit 7: Beam Intensity Control 0: Incapable 1: Capable	N/A	N/A
6	Supported Standard Modes Bit Field LSB	1 Byte	Refer to Table 7-12.	N/A	N/A
	Supported Standard Modes Bit Field MSB	7 Bits (0:6)			
	Synchronous Brake Light Support	1 Bit (7)	0: Incapable 1: Capable	N/A	N/A
7	Supported Light Types	1 Byte	Refer to Table 7-13.	N/A	N/A

Table 7-9. Shared Format of Data Page 2

Byte	Description	Length	Value	Units	Range or Rollover
0	Light Index	1 Byte	Index of the secondary light that is sending this page. 64-255: Reserved, Do Not Use.	N/A	2-63
1	Data Page Number	1 Byte	Data Page Number = 2 (0x02)	N/A	N/A
2:7	Set as described in Table 7-8				

7.5.1 Light Properties

The capabilities for the light indicated by the light index field are set as described in the following table.

Table 7-10. Light Properties Bit Field

Bits	Description	Value	Meaning
0	Auto Intensity Mode	0	Does not support Auto Intensity Mode
		1	Supports Auto Intensity Mode
1	Beam	0	Does not support High/Low Beam
		1	Supports High/Low Beam
2:7	# Supported Modes	0	Does not support light modes (steady light only)
		1:63	Total number of modes supported

Note that the # supported modes field includes the number of standard modes and the number of custom modes supported by the light.

7.5.2 # Supported Secondary Lights

This field indicates the number of secondary lights that the main light is able to connect to in a network. This field shall contain a valid value. **Note that all ANT+ bike lights shall support at least 4 secondary lights.**

The number of supported secondary lights is typically limited by the available memory on the light, and should be specified assuming that each secondary light has 4 sub-lights. The values in Table 7-11 show the number of bytes required to store data pages 1 and 3 for each light and sub-light. An 8 byte buffer is included to enable the servicing of requests for additional data pages from the secondary lights. An additional buffer of 1 byte per secondary light is included to enable comparison of the change toggle bits in data page 3.

Table 7-11. Memory Required to Support Secondary Lights

Number of Supported Secondary Lights	Minimum Bytes Needed to Store Secondary Light Data
4	140
12	272
24	404
48	800
96	1592
249	8225

7.5.3 Granular Control Capability

7.5.4 Supported Standard Modes Bit Field

This bit field is used to indicate which of the standard modes are supported by the ANT+ bike light as described in the following table.

Table 7-12. Supported Standard Modes Bit Field

Byte	Bit	Description	Value	Meaning
5	0	Reserved for future use. Set to 0.	0	Reserved
			1	Do not use
	1	Steady 81-100% intensity	0	Not Supported
			1	Supported
	2	Steady: 61-80% intensity	0	Not Supported
			1	Supported
	3	Steady: 41-60% intensity	0	Not Supported
			1	Supported
	4	Steady: 21-40% intensity	0	Not Supported
			1	Supported
	5	Steady: 0-20% intensity	0	Not Supported
			1	Supported
	6	Slow flash	0	Not Supported
			1	Supported
	7	Fast flash	0	Not Supported
			1	Supported
6	0	Random flash	0	Not Supported
			1	Supported
	1	Auto	0	Not Supported
			1	Supported
	2	Turn signal left (self cancelling)	0	Not Supported
			1	Supported
	3	Turn signal left (ongoing)	0	Not Supported
			1	Supported
	4	Turn signal right (self cancelling)	0	Not Supported
			1	Supported
	5	Turn signal right (ongoing)	0	Not Supported
			1	Supported
	6	Hazard lights (both left and right indicators flashing continuously)	0	Not Supported
			1	Supported

7.5.5 Battery Capacity

The battery capacity field indicates the capacity of the light's battery when fully charged. If multiple batteries are used, then the battery capacity field reflects the combined capacity available to the light.

7.5.6 Supported Light Types

The supported light types bit field indicates the types of light that the ANT+ bike light can be configured as. If a controller attempts to configure an ANT+ bike light as an unsupported light type, the light should ignore the command. A controller should only attempt to configure lights in supported ways.

Table 7-13. Supported Light Types Bit Field

Bit	Light Type	Value	Meaning
0	Headlight	0	Light type not supported
		1	Light type supported
1	Reserved for future use.	0	Set to zero
2	Tail Light	0	Light type not supported
		1	Light type supported
3	Signal Light - Configurable	0	Light type not supported
		1	Light type supported
4	Signal Light - Left	0	Light type not supported
		1	Light type supported
5	Signal Light - Right	0	Light type not supported
		1	Light type supported
6	Reserved for future use.	0	Set to zero
7	Other	0	Light type not supported
		1	Light type supported

7.6 Data Page 3 – Sub-light State (0x03)

Data page 3 is one of the main data pages broadcast from an ANT+ bike light. ANT+ bike lights shall send this page in the data page rotation when sub-lights are present. Refer to section 7.3 for details on when to send or omit this data page. All fields in this message shall be set as described in Table 7-14.

Table 7-14. Data Page 3 Format – Sub-light State

Byte	Description	Length	Value	Units	Range or Rollover
0	Data Page Number	1 Byte	Data Page Number = 3 (0x03)	N/A	N/A
1	Light Index	1 Byte	Index of the ANT+ bike light comprising of the sub-light(s) described in this data page. Refer to section 7.4.1. 64-255: Reserved, Do Not Use.	N/A	0-63
2	Sub-light 'A' Index	3 Bits (0:2)	Index of sub-light 'A' described in bytes 2:4. 0, 4-7: Reserved, Do Not Use.	N/A	1-3
	Light Type	3 Bits (3:5)	Refer to Table 7-5.	N/A	N/A
	Reserved	1 Bit (6)	Reserved for future use. Set to 0.	N/A	N/A
	Change Toggle Bit 'A'	1 Bit (7)	Toggle each time any data in bytes 2:4 changes	N/A	0-1
3	State Bit Field	1 Byte	Refer to Table 7-7.	N/A	N/A
4	Intensity	7 Bits (0:6)	Percentage of maximum intensity. Auto Intensity Mode Enabled: 0x7E Invalid: 0x7F. Refer to section 7.4.9.	1%	0-100%
4	Battery Warning	1 Bit (7)	0: No Warning 1: Battery Level Low on sub-light 'A'	N/A	N/A
5	Light Type	3 Bits (0:2)	Refer to Table 7-5.	N/A	N/A
	Reserved	4 Bits (3:6)	Reserved for future use. Set to 0.	N/A	N/A
	Change Toggle Bit 'A+1'	1 Bit (7)	Toggle each time any data in bytes 5:7 changes	N/A	0-1
6	State Bit Field	1 Byte	Refer to Table 7-7.	N/A	N/A
7	Intensity	7 Bits (0:6)	Percentage of maximum intensity. Auto Intensity Mode Enabled: 0x7E. Invalid: 0x7F. Refer to section 7.4.9.	1%	0-100%
7	Battery Warning	1 Bit (7)	0: No Warning 1: Battery Level Low on sub-light 'A+1'	N/A	N/A

Table 7-15. Shared Format of Data Page 3

Byte	Description	Length	Value	Units	Range or Rollover
0	Light Index	1 Byte	Index of the secondary light that is sending this page. 64-255: Reserved, Do Not Use.	N/A	2-63
1	Data Page Number	1 Byte	Data Page Number = 3 (0x03)	N/A	N/A
2:7	Set as described in Table 7-14				

7.6.1 Sub-light Index

The data in bytes 2:4 describes the sub-light with the sub-light index indicated in the sub-light index field in byte 2. The data in bytes 5:7 describes the sub-light with the next sub-light index. For example, if sub-light 3 is described in bytes 2:4, then bytes 5:7 describe sub-light 4.

The data provided for each sub-light includes the light type that the sub-light is configured as, the battery level, the current state and the beam intensity.

This field shall not be set to 0, 4, 5, 6, or 7.

Note that as a best practice, if no sub-light A+1 exists, then bytes 5:7 should each be set to 0x00.

7.6.2 Change Toggle Bit 'A'/'A+1'

The change toggle bit is intended to enable a main light or controller to determine simply whether any changes have occurred on a sub-light described in the data page. This bit shall be toggled each time the data transmitted in bytes 2:4 (or 5:7) is different when compared to the last **transmitted** sub-light state data page **describing that sub-light**.

7.6.3 Battery Warning Flag

If the sub-light has a low or critical battery level this is indicated by setting the flag bit to 1.

7.7 Data Page 4 – Sub-light Capabilities (0x04)

Data page 4 is one of the main data pages broadcast from an ANT+ bike light. ANT+ bike lights shall send this page as part of the data page rotation, and upon request from a controller when sub-lights are present. Refer to section 7.3 for details on when to send or omit this data page. All fields in this message shall be set as described in Table 7-16.

Table 7-16. Data Page 4 Format – Sub-light Capabilities

Byte	Description	Length	Value	Units	Range or Rollover
0	Data Page Number	1 Byte	Data Page Number = 4 (0x04)	N/A	N/A
1	Light Index	1 Byte	Index number of the ANT+ bike light to which the data in this page relates. Refer to section 7.4.1. 64-255: Reserved, Do Not Use.	N/A	0-63
2	Light Properties	1 Byte	Refer to Table 7-10.	N/A	N/A
3	Sub-light Index	3 Bits (0:2)	Index of sub-light described in this data page. 0,5-7: Reserved, Do Not Use.	N/A	1-4
3	Part of principal light	1 Bit (3)	Set this bit if the sub-light will appear to the customer to be the same light as the principal light.	N/A	0-1
3	Reserved	4 Bits (4:7)	Reserved for future use. Set to 0.	N/A	N/A
4	Battery Capacity	1 Byte	Capacity of fully charged battery. 0xFF indicates invalid.	200mAh	0-50800mAh
5	Supported Standard Modes Bit Field LSB	2 Bytes	Refer to Table 7-12.	N/A	N/A
6	Supported Standard Modes Bit Field MSB				
7	Supported Light Types	1 Byte	Refer to Table 7-13.	N/A	N/A

Table 7-17. Shared Format of Data Page 4

Byte	Description	Length	Value	Units	Range or Rollover
0	Light Index	1 Byte	Index of the secondary light that is sending this page. 64-255: Reserved, Do Not Use.	N/A	2-63
1	Data Page Number	1 Byte	Data Page Number = 4 (0x04)	N/A	N/A
2:7	Set as described in Table 7-16				

7.7.1 Sub-light Index

The data in this page describes the capabilities of the sub-light with the sub-light index indicated.

This field shall not be set to values 0, 5, 6 or 7.

7.7.2 Part of Principal Light

This field may be used by the display to determine how to present the sub-light to the user: either as two independent lights (0), or as a single light (1).

This bit should be set in the case that a single bike light supports operating as two light types concurrently, with each light type represented as a sub-light. This bit should be zero if the sub-light is physically distinct from the principal light.

7.8 Data Page 5 – Mode Description (0x05)

An ANT+ controller may request this page (as described in section 5.3) to obtain information about custom modes supported by the ANT+ bike light, or any of its sub-lights. Data page 5 is broadcast from an ANT+ bike light when requested by an ANT+ controller. Any ANT+ bike lights that support custom modes shall support this page. All fields in this message shall be set as described in Table 7-18.

Table 7-18. Data Page 5 Format – Mode Description

Byte	Description	Length	Value	Units	Range or Rollover
0	Data Page Number	1 Byte	Data Page Number = 5 (0x05)	N/A	N/A
1	Light Index	1 Byte	Index number of the ANT+ bike light to which the data in this page relates. Refer to section 7.4.1. 64-255: Reserved, Do Not Use.	N/A	0-63
2	Mode Number	6 Bits (0:5)	Indicates the mode being described by the data in the remainder of this page.	N/A	N/A
2	Pattern	2 Bits (6:7)	Refer to Table 7-20.	N/A	N/A
3	Segment Time	1 Byte	The length of each pattern segment 0x00: Invalid.	10ms	0-2500ms
4	Mode Duration	5 Bits (0:4)	The time that the ANT+ bike light will remain in this mode by default. Special Value: 0x00 – continuous	1s	0-31s
4	Colour	3 Bits (5:7)	0 – Default 1 – White 2 – Yellow/Amber 3 – Red 4:6 – Reserved for future use 7 – Invalid/Other	N/A	N/A
5	Pattern Segment 0	2 Bits (0:1)	Refer to Table 7-21.	N/A	N/A
	Pattern Segment 1	2 Bits (2:3)	Refer to Table 7-21.	N/A	N/A
	Pattern Segment 2	2 Bits (4:5)	Refer to Table 7-21.	N/A	N/A
	Pattern Segment 3	2 Bits (6:7)	Refer to Table 7-21.	N/A	N/A
6	Pattern Segment 4	2 Bits (0:1)	Refer to Table 7-21.	N/A	N/A
	Pattern Segment 5	2 Bits (2:3)	Refer to Table 7-21.	N/A	N/A
	Pattern Segment 6	2 Bits (4:5)	Refer to Table 7-21.	N/A	N/A
	Pattern Segment 7	2 Bits (6:7)	Refer to Table 7-21.	N/A	N/A
7	Pattern Segment 8	2 Bits (0:1)	Refer to Table 7-21.	N/A	N/A
	Pattern Segment 9	2 Bits (2:3)	Refer to Table 7-21.	N/A	N/A
	Pattern Segment 10	2 Bits (4:5)	Refer to Table 7-21.	N/A	N/A
	Pattern Segment 11	2 Bits (6:7)	Refer to Table 7-21.	N/A	N/A

Table 7-19. Shared Format of Data Page 5

Byte	Description	Length	Value	Units	Range or Rollover
0	Light Index	1 Byte	Index of the secondary light that is sending this page. 64-255: Reserved, Do Not Use.	N/A	2-63
1	Data Page Number	1 Byte	Data Page Number = 5 (0x05)	N/A	N/A
2:7	Set as described in Table 7-18				

7.8.1 Mode Number

The mode number is used in light status and command pages to reference the light settings described in this data page.

7.8.2 Pattern

The pattern field indicates the type of light beam variation that applies to this mode, and is populated as described in the following table.

Table 7-20. Pattern Type Value Mapping

Value	Description	Meaning
0	Steady	The light intensity remains constant and at full intensity
1	Random	The light intensity varies with a random pattern
2	Defined	The light intensity varies according to a defined repeating pattern
3	Reserved	Reserved for future use. Do not use.

Defined patterns are described by a repeating series of pattern segments (bytes 5:7), each representing a light intensity level.

7.8.3 Segment Time

The segment time field indicates the number of milliseconds that each defined pattern segment lasts. All defined pattern segments last the same length of time. This value shall be set to a valid value when the pattern field is set to 'defined'.

For example, if the segment time is 50ms and there are seven defined pattern segments, each pattern repeat will last 350ms.

7.8.4 Mode Duration

The mode duration field indicates the number of seconds that the ANT+ bike light will remain in the specified mode by default. Once the ANT+ bike light has remained in this mode for the specified length of time, it will automatically switch to a new mode. The new mode will be either the light's default, or the previous mode if no default exists.

If the ANT+ bike light receives a command to change its mode before the mode duration has expired, the light should switch modes as normal and the mode duration field should not have any effect.

7.8.5 Colour

The colour field is used to specify the colour of the light beam for this mode. The colour of the light shall remain constant throughout the duration of the mode.

7.8.6 Pattern Segment 'X'

The pattern segment fields indicate the light intensity level for each period of time in the pattern. Each pattern segment lasts an equal time period. The intensity levels are set as described in the following table.

Table 7-21. Pattern Segment Value Mapping

Value	Meaning
0	Off
1	Low
2	Medium
3	High

Note that the pattern may be defined by a varying number of pattern segments up to a maximum of 12. Shorter patterns shall use 0 (off) for the remaining unused pattern segments.

7.8.6.1 Example Usage of Pattern Segments

Consider representing the pattern 'flash, flash, pause' as an example of using the pattern segment fields to describe a repeating pattern.

First, the desired light intensity levels should be established. For this example; assume that the desired light intensity levels are 'medium flash, bright flash, off'

Next, the desired pattern should be checked, and altered if necessary, to ensure that the final intensity level will not be 'off'.

In this example 'medium flash, bright flash, off' should be changed to 'off, medium flash, bright flash' to ensure that the final intensity level is not 'off'. (The final intensity level cannot be off, as this would be indistinguishable from a shorter pattern of 'medium flash, bright flash')

Finally the relative length of each intensity level should be considered. For this example, assume that the bright flash should last twice as long as the medium flash.

This sequence of pattern segments needed to describe this pattern can then be established as:

OO OM OHH

i.e. 00 02 03 30 00 00 => byte 5: 0x80; byte 6: 0x3c; byte 7: 0x00

7.9 Data Page 6 – Sub-light Mode Support (0x06)

An ANT+ controller may request this page (as described in section 5.3) to determine which custom modes are supported by each sub-light. Data page 6 is broadcast from an ANT+ bike light when requested by an ANT+ controller. Any ANT+ bike lights that have sub-lights shall support this page. All fields in this message shall be set as described in Table 7-22.

Table 7-22. Data Page 6 Format – Sub-light Mode Support

Byte	Description	Length	Value	Units	Range or Rollover
0	Data Page Number	1 Byte	Data Page Number = 6 (0x06)	N/A	N/A
1	Light Index	1 Byte	Index of the ANT+ Bike Light. Refer to section 7.4.1. 64-255: Reserved, Do Not Use.	N/A	0-63
2	Sub-light Index	3 Bits (0:2)	Index of sub-light described in this data page. 5-7: Reserved, Do Not Use.	N/A	1-4
2	Reserved	5 Bits (3:7)	Reserved for future use. Set to 0x00.	N/A	N/A
3	Reserved	1 Byte	Reserved for future use. Set to 0x00.	N/A	N/A
4	Reserved	1 Byte	Reserved for future use. Set to 0x00.	N/A	N/A
5	Reserved	1 Byte	Reserved for future use. Set to 0x00.	N/A	N/A
6	Supported Custom Modes Bit Field LSB	2 Bytes	Refer to Table 7-24.	N/A	N/A
7	Supported Custom Modes Bit Field MSB				

Table 7-23. Shared Format of Data Page 6

Byte	Description	Length	Value	Units	Range or Rollover
0	Light Index	1 Byte	Index of the secondary light that is sending this page. 64-255: Reserved, Do Not Use.	N/A	2-63
1	Data Page Number	1 Byte	Data Page Number = 6 (0x06)	N/A	N/A
2:7	Set as described in Table 7-22				

7.9.1 Sub-light Index

The data in this page describes the capabilities of the sub-light with the sub-light index indicated.

This field shall not be set to values 0, 5, 6 or 7.

7.9.2 Supported Custom Modes Bit Field

This bit field is used to indicate which custom modes are supported by each sub-light as described in the following table.

Table 7-24. Supported Custom Modes Bit Field

Byte	Bit	Description	Value	Meaning
6	0	Custom mode 48	0	Not Supported
			1	Supported
	1	Custom mode 49	0	Not Supported
			1	Supported
	2	Custom mode 50	0	Not Supported
			1	Supported
	3	Custom mode 51	0	Not Supported
			1	Supported
	4	Custom mode 52	0	Not Supported
			1	Supported
	5	Custom mode 53	0	Not Supported
			1	Supported
	6	Custom mode 54	0	Not Supported
			1	Supported
	7	Custom mode 55	0	Not Supported
			1	Supported
7	0	Custom mode 56	0	Not Supported
			1	Supported
	1	Custom mode 57	0	Not Supported
			1	Supported
	2	Custom mode 58	0	Not Supported
			1	Supported
	3	Custom mode 59	0	Not Supported
			1	Supported
	4	Custom mode 60	0	Not Supported
			1	Supported
	5	Custom mode 61	0	Not Supported
			1	Supported
	6	Custom mode 62	0	Not Supported
			1	Supported
	7	Custom mode 63	0	Not Supported
			1	Supported

7.10 Data Pages 7 – 15: Reserved for Future Use

Data pages 7 to 15 are reserved for future main data page definitions.

7.11 Data Page 16 – Connected Lights' Manufacturer's Information (0x10)

Data page 16 is one of the data pages broadcast from an ANT+ bike light when in the connected state. All main lights shall send this page upon request from a controller. This page may optionally be included as one of the main data pages broadcast from an ANT+ bike light as part of a data page rotation. All fields in this message shall be set as described in Table 7-25.

Table 7-25. Data Page 16 Format – Connected Lights' Manufacturer's Information

Byte	Description	Length	Value	Units	Range or Rollover
0	Data Page Number	1 Byte	Data Page Number = 16 (0x10)	N/A	N/A
1	Light Index	1 Byte	Index of the ANT+ Bike Light. Refer to section 7.4.1. 64-255: Reserved, Do Not Use.	N/A	2-63
2	Reserved	1 Byte	Reserved for future use. Set to 0x00.	N/A	N/A
3	HW Revision	1 Byte	To be set by the manufacturer.	N/A	N/A
4	Manufacturer ID LSB	2 Bytes	Refer to the FIT SDK for a current list of manufacturer IDs	N/A	N/A
5	Manufacturer ID MSB				
6	Model Number LSB	2 Bytes	To be set by the manufacturer.	N/A	N/A
7	Model Number MSB				

Table 7-26. Shared Format of Data Page 16

Byte	Description	Length	Value	Units	Range or Rollover
0	Light Index	1 Byte	Index of the secondary light that is sending this page. 64-255: Reserved, Do Not Use.	N/A	2-63
1	Data Page Number	1 Byte	Data Page Number = 16 (0x10)	N/A	N/A
2:7	Set as described in Table 7-25				

7.11.1 Manufacturer ID

The current list of manufacturer ID values can be found in the FIT.xls profile (available within the FIT SDK at www.thisisant.com). New manufacturers are required to be members of the ANT+ Alliance in order to be added to this list; please contact the ANT+ Alliance at antalliance@thisisant.com for details. The value 255 (0x00FF) has been reserved as a development ID and may be used by manufacturers that have not yet been assigned a value.

7.12 Data Page 17 – Connected Lights' Product Information (0x11)

Data page 17 is one of the data pages broadcast from an ANT+ bike light when in the connected state. All main lights shall send this page upon request from a controller. This page may optionally be included as one of the main data pages broadcast from an ANT+ bike light as part of a data page rotation. All fields in this message shall be set as described in Table 7-27.

Table 7-27. Data Page 17 Format – Connected Lights' Product Information

Byte	Description	Length	Value	Units	Range or Rollover
0	Data Page Number	1 Byte	Data Page Number = 17 (0x11)	N/A	N/A
1	Light Index	1 Byte	Index of the ANT+ Bike Light. Refer to section 7.4.1. 64-255: Reserved, Do Not Use.	N/A	2-63
2	SW Revision (Supplemental)	1 Byte	Supplemental SW Revision (Invalid = 0xFF)	N/A	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	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	N/A
5	Serial Number (Bits 8 – 15)				
6	Serial Number (Bits 16 – 23)				
7	Serial Number (Bits 24 – 31)				

Table 7-28. Shared Format of Data Page 17

Byte	Description	Length	Value	Units	Range or Rollover
0	Light Index	1 Byte	Index of the secondary light that is sending this page. 64-255: Reserved, Do Not Use.	N/A	2-63
1	Data Page Number	1 Byte	Data Page Number = 17 (0x11)	N/A	N/A
2:7	Set as described in Table 7-27				

7.12.1 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 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 be set to 0xFF.

7.13 Data Page 18 – Main Light's Channel ID (0x12)

Data page 18 shall be transmitted upon request by an ANT+ controller, and may optionally be included as one of the main data pages broadcast from an ANT+ bike light when in the connected state. This data page allows a controller to discover and connect to an already existing network as described in section 5.2.2.1. All fields in this message shall be set as described in Table 7-29.

Table 7-29. Data Page 18 Format – Main Light's Channel ID

Byte	Description	Length	Value	Units	Range or Rollover
0	Data Page Number	1 Byte	Data Page Number = 18 (0x12)	N/A	N/A
1	Reserved	1 Byte	Reserved for future use. Set to 0xFF.	N/A	N/A
2	Reserved	1 Byte	Reserved for future use. Set to 0xFF.	N/A	N/A
3	Reserved	1 Byte	Reserved for future use. Set to 0xFF.	N/A	N/A
4	Reserved	1 Byte	Reserved for future use. Set to 0xFF.	N/A	N/A
5	Device Number LSB	2 Bytes	The device number of the main light	N/A	1-65535
6	Device Number MSB				
7	Transmission Type	1 Byte	The broadcast channel transmission type of the main light	N/A	0-255

7.13.1 Device Number

This field indicates the 2 byte device number from the main light's channel ID.

7.13.2 Transmission Type

The 8 bit broadcast channel transmission type from the main light's channel ID (i.e. including the upper nibble of the extended device number).

7.14 Data Page 19 – Supplementary Info (0x13)

An ANT+ controller may request this page (as described in section 5.3) to determine additional information about the ANT+ bike light. This is an optional page for ANT+ bike lights. If this page is not supported, then requests for it should be ignored. Data page 19 is broadcast from an ANT+ bike light when requested by an ANT+ controller. All fields in this message shall be set as described in Table 7-30.

Table 7-30. Data Page 19 Format – Supplementary Info

Byte	Description	Length	Value	Units	Range or Rollover
0	Data Page Number	1 Byte	Data Page Number = 19 (0x13)	N/A	N/A
1	Light Index	1 Byte	Index of the ANT+ Bike Light. Refer to section 7.4.1. 64-255: Reserved, Do Not Use.	N/A	0-63
2	Sub-light Index	3 Bits (0:2)	Index of sub-light described in this data page. 5-7: Reserved, Do Not Use.	N/A	0-4
2	Reserved	5 Bits (3:7)	Reserved for future use. Set to 0x00.	N/A	N/A
3	Reserved	1 Byte	Reserved for future use. Set to 0x00.	N/A	N/A
4	Reserved	1 Byte	Reserved for future use. Set to 0x00.	N/A	N/A
5	Reserved	1 Byte	Reserved for future use. Set to 0x00.	N/A	N/A
6	Reserved	1 Byte	Reserved for future use. Set to 0x00.	N/A	N/A
7	Battery percentage	1 Byte	Percentage of battery remaining. Invalid: 0xFF.	1%	0-100%

Table 7-31. Shared Format of Data Page 19

Byte	Description	Length	Value	Units	Range or Rollover
0	Light Index	1 Byte	Index of the secondary light that is sending this page. 64-255: Reserved, Do Not Use.	N/A	2-63
1	Data Page Number	1 Byte	Data Page Number = 19 (0x13)	N/A	N/A
2:7	Set as described in Table 7-30				

7.14.1 Battery Percentage

This field is used to indicate the remaining battery level as a percentage. If this field is not supported it shall be set to invalid, 0xFF.

7.15 Data Page 20 – 31: Reserved for Future Use

Data pages 20 to 31 are reserved for future main data page definitions.

7.16 Data Page 32 – Disconnect Command (0x20)

Data page 32 is a command page sent from an ANT+ controller to an ANT+ bike light to reset it to its unconnected state. This

command should be sent as an acknowledged message from an ANT+ controller.

All ANT+ bike lights shall support this page. All fields in this message shall be set as described in Table 7-32.

Table 7-32. Data Page 32 Format – Disconnect Command

Byte	Description	Length	Value	Units	Range or Rollover
0	Data Page Number	1 Byte	Data Page Number = 32 (0x20)	N/A	N/A
1	Light Index	1 Byte	Light index of the light that should disconnect from the network. Special value: 0x00 indicates that all ANT+ bike lights should disconnect from the network. 64-255: Reserved, Do Not Use.	N/A	0-63
2	Controller ID	1 Byte	Reserved for future use. Set to 0x00.	N/A	0-255
3	Reserved	1 Byte	Reserved for future use. Set to 0x00.	N/A	N/A
4	Reserved	1 Byte	Reserved for future use. Set to 0x00.	N/A	N/A
5	Reserved	1 Byte	Reserved for future use. Set to 0x00.	N/A	N/A
6	Reserved	1 Byte	Reserved for future use. Set to 0x00.	N/A	N/A
7	Reserved	1 Byte	Reserved for future use. Set to 0x00.	N/A	N/A

Table 7-33. Shared Format of Data Page 32

Byte	Description	Length	Value	Units	Range or Rollover
0	Light Index	1 Byte	Light index of the light that should disconnect from the network. Special value: 0x00 indicates that all ANT+ bike lights should disconnect from the network. 64-255: Reserved, Do Not Use.	N/A	0-63
1	Data Page Number	1 Byte	Data Page Number = 32 (0x20)	N/A	N/A
2:7	Set as described in Table 7-32				

7.16.1 Light Index

The main light should check the light index and if it is set to 0x01; then the main light shall return to the unconnected state. Specifically it shall:

- Close its shared master channel
- Set its status to 'unconnected' in data page 1
- Set its light index to 0
- Stop transmitting data page 18 (Main light's channel ID)

If the light index is set to 0x00 then the main light shall forward the command as a broadcast message on the shared channel four times, and then return to the unconnected state as described above.

If the light index is set to a value other than 0x00 or 0x01 then the main light shall forward the command on the shared channel as an acknowledged message. The command should be retried up to 4 times until an EVENT_TX_SUCCESS is received. In this case the main light shall not change its own state.

Once the command is forwarded on the shared channel, it will be received by one or all of the secondary lights depending on the light index value. If the light index is zero, all secondary lights will receive the command. If the light index is any other value, only the light with the index specified will receive the command. Any secondary ANT+ bike light that receives this command shall:

- Close its shared slave channel
- Set its status to 'unconnected' in data page 1
- Set its light index to 0
- Stop transmitting data page 18 (Main light's channel ID)

7.16.2 Controller ID

The controller ID field shall be populated by the ANT+ Controller with the LSB of its serial number. ANT+ Controllers that do not have a serial number shall assign a fixed value to be used for this field.

7.17 Data Page 33 – Connect Command (0x21)

Data page 33 is a command page sent from an ANT+ controller to an ANT+ bike light to initiate a connection with a new ANT+ bike light. The command includes the light index and settings that should be used while in the connected state, and the channel ID variables (i.e. device number and transmission type) to be searched for (if applicable). This command should be sent as an acknowledged message from an ANT+ controller.

All fields in this message shall be set as described in Table 7-34.

Table 7-34. Data Page 33 Format – Connect Command

Byte	Description	Length	Value	Units	Range or Rollover
0	Data Page Number	1 Byte	Data Page Number = 33 (0x21)	N/A	N/A
1	Light Index Setting	1 Byte	Light index that should be used by the light that receives this message. Special Value: 255 (0xFF) do not change light index. 64-254: Reserved, Do Not Use.	N/A	1-63
2	# Secondary Lights	1 Byte	Indicates the number of secondary lights that will connect to the shared channel. 63-254: Reserved, Do Not Use Invalid: 255 (0xFF)	1 light	1-62
3	Controller ID	1 Byte	LSB of ANT+ Controller's Serial Number	N/A	0-255
4	Sub-Light Index	3 Bits (0:2)	Indicates the sub-light that the light state setting and light type setting apply to. Index of sub-light described in this data page. 5-7: Reserved, Do Not Use.	N/A	0-4
4	Light State Setting	2 Bits (3:4)	Refer to Table 7-36.	N/A	N/A
4	Light Type Setting	3 Bits (5:7)	Refer to Table 7-5	N/A	N/A
5	Device Number LSB	2 Bytes	The device number of the main light. Invalid: 0x0000	N/A	1-65535
6	Device Number MSB				
7	Transmission Type	1 Byte	The transmission type of the main light. Invalid: 0x00	N/A	1-255

Table 7-35. Shared Format of Data Page 33

Byte	Description	Length	Value	Units	Range or Rollover
0	Light Index	1 Byte	Light index that should be used by the light that receives this message. 64-255: Reserved, Do Not Use.	N/A	1-63
1	Data Page Number	1 Byte	Data Page Number = 33 (0x21)	N/A	N/A
2:7	Set as described in Table 7-34.				

7.17.1 Light Index Setting

The light index setting field should be interpreted as follows by an unconnected light (i.e. a light whose current light index is zero):

The ANT+ bike light should set its light index to the value specified in the light index setting field.

- If the light index setting is 1, the ANT+ bike light is assigned as the main light for the network, and should open a shared master channel as detailed in section 6.5.
- Alternatively, if the light index setting is 2 – 63, the ANT+ bike light is assigned as a secondary light, and should open a shared slave channel as detailed in section 6.4.

Note that an ANT+ controller shall assign light indices in a sequential order starting with a light index setting of 2 for the first secondary light. For any secondary light in the shared network, the light index setting field shall not be greater than one more than the # secondary lights field in the connect command sent to the main light.

Light index 255 (0xFF) should only be used when controlling an unconnected light e.g. to set the light type or light state setting without changing the light index or affecting which channels the light has open.

The light index setting field shall be interpreted as follows by a connected light (i.e. a light whose current light index is >0):

- The ANT+ bike light shall not change its light index.
- If the light index setting is 1, the connect command applies to the main light only.
- If the light index setting is 2 – 63, the connect command applies to the secondary light with the specified light index. If this command is received by the main light, then it should be forwarded to the specified secondary light.

Note that a connect command with light index 255 (0xFF) should be ignored by a connected light.

7.17.2 # Secondary Lights

This field indicates the number of secondary lights that will connect to the shared channel so that the main light knows which light indices to poll. For example, if the number of secondary lights is 5, the main light should poll light indices 2-6.

7.17.3 Controller ID

The controller ID field shall be populated by the ANT+ Controller with the LSB of its serial number. ANT+ Controllers that do not have a serial number shall assign a fixed value to be used for this field.

7.17.4 Sub-light Index

The sub-light index field indicates the sub-light to which the light state and light type settings should be applied. If the sub-light index is set to 0, then the commanded light settings should only be applied to the principal ANT+ bike light, not to any sub-lights.

This field shall not be set to value 5, 6, or 7.

7.17.5 Light State Setting

The ANT+ controller may use the light state setting field to command the ANT+ bike light to turn the light beam off, flashing, or on (steady). The ANT+ bike light should respond to the command immediately.

Table 7-36. Light State Setting

Bits	Description	Value	Meaning
0:1	State	0	Invalid: Do not change light state.
		1	Off
		2	Flashing
		3	Steady Beam

Note that the light state setting field provides the ANT+ controller with limited control over the ANT+ bike light's state. This can be used during configuration of the network, enabling basic control of the ANT+ bike light without requiring the ANT+ controller to obtain the full mode information from the bike light.

An ANT+ bike light that receives the command 'flashing' should set itself to any mode that does not have a constant beam intensity. An ANT+ bike light that receives the command 'steady' should set itself to any mode that has a constant beam intensity.

7.17.6 Light Type Setting

The ANT+ controller should use this field to configure the ANT+ bike light as desired. The ANT+ controller should not attempt to set the light type of the ANT+ bike light to an unsupported type. The ANT+ bike light shall configure its light type as requested. The ANT+ bike light shall ignore any requests to set its light type to a type that it does not support.

7.17.7 Device Number and Transmission Type Fields

The device number and transmission type fields contain the channel ID parameters for the main light. These shall be included as valid values whenever the light index setting is set to a value between 2 and 63. The ANT+ bike light shall use the parameters specified in Table 7-37 and Table 7-38.

Note that the device number and transmission type fields should be set to invalid when the light index setting is 0.

Table 7-37. Intended Main Light Connect Command Channel ID Parameters

Direction	Connect Command Values	Shared Channel Parameters
Remote → Intended Main Light	**Device Number**	Device Number indicated in Connect Command
	Intended Main Light Broadcast Channel (see section 6.3.1.3)	
	Transmission Type	Transmission Type indicated in Connect Command
	Upper Nibble = Extended Main Light Device Number (see section 6.5)	
	Lower Nibble = 6	

Table 7-38. Secondary Light Connect Command Channel ID Parameters

Direction	Connect Command Values	Shared Channel Values
Remote → Intended Secondary Light	**Device Number**	Device Number indicated in Connect Command
	Intended Main Light Broadcast Channel Device Number (see section 6.3.1.3).	
	Transmission Type	Transmission Type indicated in Connect Command
	Upper Nibble = Extended Main Light Device Number (see section 6.5).	
	Lower Nibble = 6	
	Transmission Type may be set to 0, to wildcard shared slave channel.	

7.18 Data Page 34 – Light Settings (0x22)

Data page 34 is a command page sent to an ANT+ bike light to control the light. All ANT+ bike lights shall respond to this page, and all ANT+ controllers shall support sending this page. This command should be sent as an acknowledged message from an ANT+ controller. The main light shall use a broadcast message to send this command on the shared channel when the light index field is set to 0x00. An acknowledged message may be used when the light index is 2 – 63, and in this case retries are permissible. All fields in this message shall be set as described in Table 7-39.

Table 7-39. Data Page 34 Format – Light Settings

Byte	Description	Length	Value	Units	Range or Rollover
0	Data Page Number	1 Byte	Data Page Number = 34 (0x22)	N/A	N/A
1	Light Index	1 Byte	Index of the ANT+ bike light that should respond to this page. Refer to 7.18.1. 64-255: Reserved, Do Not Use.	N/A	0-63
2	Sub-light Index	3 Bits (0:2)	Sub-Light: 0-4 Index of sub-light described in this data page. 5-7: Reserved, Do Not Use.	N/A	0-4
	Sub-Light Address Flag	1 Bit (3)	0: Address specific sub-light 1: Address primary light and all sub-lights	N/A	N/A
	Light Type	4 Bits (4:7)	Refer to Table 7-41.	N/A	N/A
3	Sequence Number	1 Byte	Increment with each new command.	N/A	255
4	Controller ID	1 Byte	LSB of ANT+ Controller's Serial Number	N/A	0-255
5	Auto Intensity Mode Setting	2 Bits (0:1)	Refer to Table 7-42	N/A	N/A
	Brake Override Setting	2 Bits (2:3)	0: Invalid, do not change brake light setting. 1: Force brake event 2: Cancel brake event 3: Reserved, do not use.	N/A	N/A0
	Beam Adjustment Specifier	2 Bits (4:5)	Bit 4: 0: Adjust beam focus 1: Do not adjust beam focus Bit 5: 0: Do not adjust beam intensity 1: Adjust beam intensity		
	Reserved	2 Bits (6:7)	Reserved for future use. Set to 0b00.	N/A	N/A
6	Set Light State	1 Byte	Refer to Table 7-43	N/A	N/A
7	Beam Adjustment	1 Byte	Refer to Beam Adjustment Specifier. 0xFF: Do not adjust beam focus or intensity. No Adjustment: Set to 0xFF	1%	0 – 100%

			Beam Focus Adjustment Only: 0-100% in increments of 1% Beam Intensity Adjustment Only : 0-100% in increments of 1% Concurrent Beam Focus and Intensity Adjustment : Bits 0-3: Beam Focus (Units 6.67%) Bits 4-7: Beam Intensity (Units 6.67%) Percentage of maximum beam focus. Invalid: 0xFF		

Table 7-40. Shared Format of Data Page 34

Byte	Description	Length	Value	Units	Range or Rollover
0	Light Index	1 Byte	Index of the ANT+ bike light that should respond to this page. Refer to 7.18.1. 64-255: Reserved, Do Not Use.	N/A	0-63
1	Data Page Number	1 Byte	Data Page Number = 34 (0x22)	N/A	N/A
2:7	Set as described in Table 7-39				

7.18.1 Light Index

The light index field is used to indicate which ANT+ bike light(s) should apply the commanded light settings. If this field is set to 0x00, all lights should respond (note that the sub-light index field still applies). If the light index is set to any other value, then only the ANT+ bike light with a matching light index should respond.

7.18.2 Sub-light Index

The sub-light index field indicates the sub-light to which the commanded light settings should be applied. If the sub-light index is set to 0, then the commanded light settings should only be applied to the principal ANT+ bike light, not to any sub-lights.

To address the primary light and all sub-lights, the sub-light index field shall be set to 0 and the sub-light address flag shall be set to 1.

7.18.3 Sub-Light Address Flag

The sub-light address flag indicates if the light settings should be applied to a specific primary/sub-light as indicated by the sub-light index field or to all primary/sub-lights on the ANT+ bike light. If the sub-light address flag is set to 0, then the sub-light index field shall be applied.

If the sub-light address flag is set to 1, then the sub-light index field shall be ignored.

7.18.4 Light Type

Note that the light type field shall only be interpreted if the light index field is set to 0 and the sub-light index field is set to 0, with the sub-light address flag set to 1.

The light type field indicates the type of ANT+ bike light that should respond to the command. If 'signal light – all' is indicated, then the command applies to all signal lights including configurable, left and right. If the light type field is set to invalid, then the commanded light settings should be applied to all light types.

Refer to section 7.18.10 for a detailed decision tree on processing Light Settings commands.

Table 7-41. Light Type

Bits	Value	Command
4:7	0	Headlight
	1	Reserved. Do not use
	2	Taillight
	3	Signal Lights –All
	4	Signal Light – Left
	5	Signal Light – Right
	6	Reserved. Do not use
	7	Other
	8-14	Reserved. Do not use.
	15	Invalid

7.18.5 Controller ID

The controller ID field shall be populated by the ANT+ Controller with the LSB of its serial number. ANT+ Controllers that do not have a serial number shall assign a fixed value to be used for this field.

7.18.6 Auto Intensity Mode Setting

The auto intensity mode setting allows ANT+ Controllers to enable or disable the auto intensity mode on an ANT+ bike light that indicates support for the feature (see section 7.5.1). The remote shall set this field to 0x03 (Invalid), if it does not intend to modify the current auto intensity mode setting.

Table 7-42. Auto Intensity Mode Setting

Bits	Description	Value	Meaning
0:1	Auto Intensity Mode Setting	0	Invalid: Do not change auto intensity mode setting.
		1	Disable auto intensity mode.
		2	Enable auto intensity mode.
		3	Reserved, do not use.

7.18.7 Brake Override Setting

7.18.8 Beam Adjustment

Adjust the beam focus or intensity of the light. If this field is set to 0xFF, the bike light shall not change its beam focus.

7.18.9 Set Light State

The settings indicated in the 'set light state' field shall be interpreted as shown in the following table.

Table 7-43. Set Light State

Bits	Description	Value	Meaning
0:1	Set Light Beam	0	Invalid – do not change beam height.
		1	Off
		2	Low Beam (default)
		3	High Beam
2:7	Set Light Mode	0	Invalid – do not change mode.
		1	Mode 1
		x	Mode x
		63	Mode 63

Note that the ANT+ controller should not attempt to set the ANT+ bike light to a mode that it does not support. In the case the ANT+ bike light receives a command requesting it to switch to an unsupported mode, the command shall be ignored.

7.18.10 Decision Tree for Processing the Light Settings Command

The light index, sub-light index and light type fields shall be used to determine which principal and sub-lights should apply the settings specified by the received command.

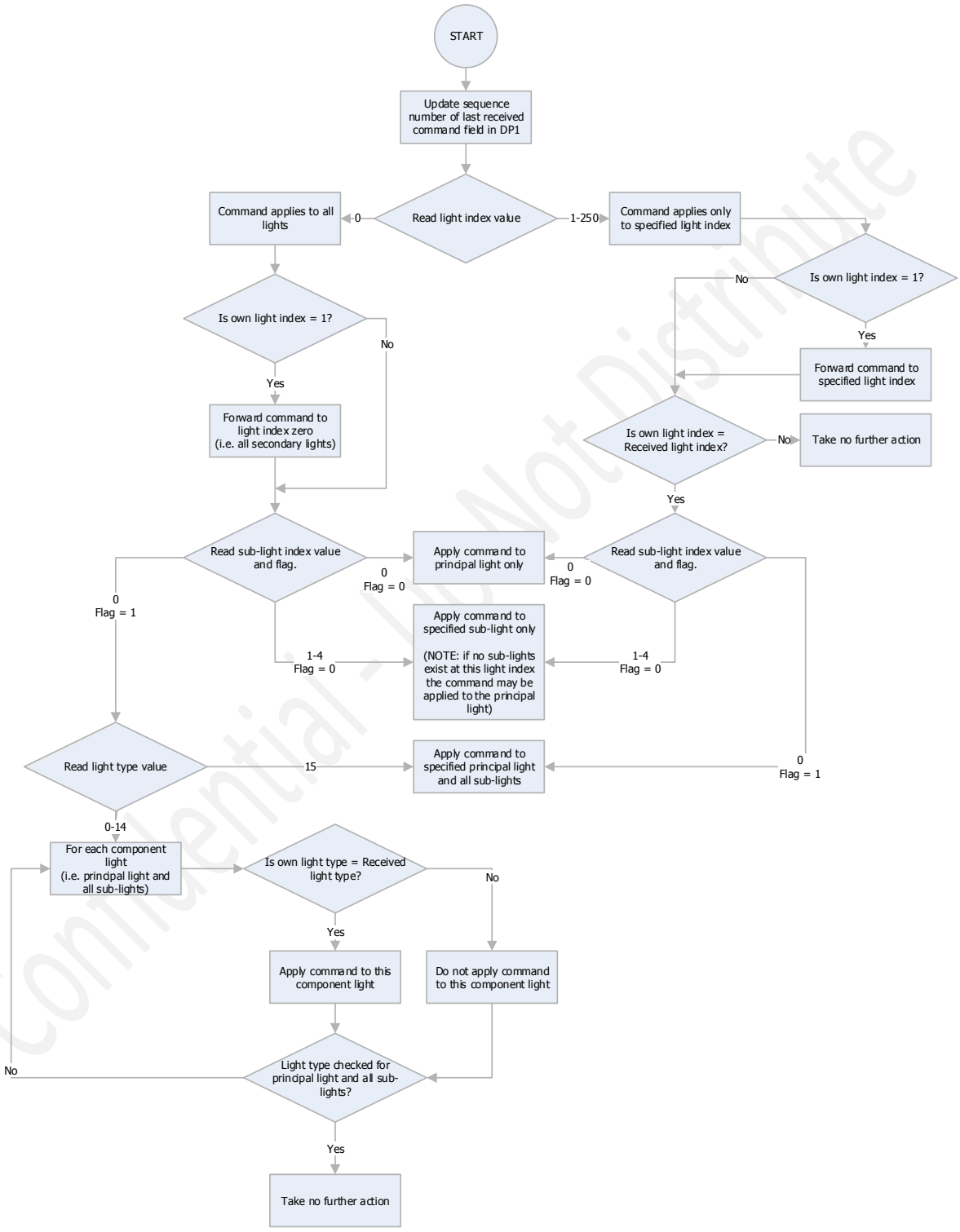

Figure 7-9. Applying the Light Settings Command

7.19

7.19 Data Page 35: Channel Period Decimation

Data page 35 is a command page sent to an ANT+ bike light. This data page is optional.

Table 7-44. Data Page 35 Format – Channel Period Decimation

Byte	Description	Length	Value	Units	Range or Rollover
0	Data Page Number	1 Byte	Data Page Number = 35 (0x22)	N/A	N/A
1 - 4	Reserved	1 Byte	Value = 0xFF	N/A	N/A
5-6	Decimated Channel Period Timeout (LSB) Decimated Channel Period Timeout (MSB)	2 Bytes	Duration of decimated channel period in milliseconds.	ms	0-65535
7	Channel Period	1 Byte	0 – ~2 Hz (16336/32468) 1 – ~4 Hz (8168/32768) 2-255 (Reserved, Do not use)	N/A	N/A

7.20 Data Page 36 - 63: Reserved for Future Use

Data pages 36 to 63 are reserved for future main data page definitions.

7.21

7.22 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.

7.22.1 Common Page 80 (0x50) – Manufacturer's Identification

Common data page 80 transmits the manufacturer's ID, model number, and hardware revision.

Note that this data page shall not be used on the shared channel. When this data page is sent on the broadcast channel it shall always describe the ANT+ bike light that is sending the page. Data page 16 (0x10) which includes a light index field should be used on the shared channel and shall be used by the main light to describe the secondary lights' manufacturer information.

Refer to the ANT+ Common Pages document for details of this page.

7.22.2 Common Page 81 (0x51) – Product Information

Common data page 81 transmits the device's software revision and its 32-bit serial number.

Note that this data page shall not be used on the shared channel. When this data page is sent on the broadcast channel it shall always describe the ANT+ bike light that is sending the page. Data page 17 (0x11) which includes a light index field should be used on the shared channel and shall be used by the main light to describe the secondary lights' product information.

Refer to the ANT+ Common Pages document for details of this page.

7.22.3 Common Page 70 (0x46): Request Data Page

Common Data Page 70 allows an ANT+ device to request a specific data page from another ANT+ device. In this device profile:

- Page 70 allows the controller to request a specific data page from the ANT+ bike light. The request data page shall be sent using an acknowledged message by the ANT+ controller and shall be formatted as shown in Table 7-45.
- The shared format of page 70 is used by the main light to request data pages from the secondary lights as described in section 7.3.3.2. It is recommended that this page is sent as a broadcast message (to reduce power consumption), however acknowledged messages are also allowed. The request data page shall be formatted as shown in Table 7-46.

Table 7-45. Common Data Page 70 – Request Data

Byte	Description	Length	Value	Units
0	Command ID	1 Byte	70 (0x46) – Data Page Request	N/A
1	Light Index	1 Byte	Index of the ANT+ bike light that should respond to this page request. Valid Values: 0-63 Invalid: 255 (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.	N/A

			Valid Values: 0 – 254 Invalid: 255 (0xFF)	
5	Requested Transmission Response	1 Byte	Describes transmission characteristics of the data requested. Bit 0-6: Number of times to transmit requested page. ANT+ Bike Lights are required to support at least 2 data page repetitions for requested pages. 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

Table 7-46. Shared Format of Data Page 70

Byte	Description	Length	Value	Units	Range or Rollover
0	Light Index	1 Byte	Index of the ANT+ bike light that should respond to this page request. 64-255: Reserved, Do Not Use.	N/A	2-63
1	Data Page Number	1 Byte	Data Page Number =70 (0x46)	N/A	N/A
2:7	Set as described in Table 7-45				

7.22.3.1 Light Index

The light index field should be used to specify the light index when requesting data pages that contain a light index field, and set to invalid otherwise.

7.22.3.2 Descriptor Bytes 1 & 2

The descriptor byte fields are used to describe requested subpages.

Descriptor Byte 1 should be used to specify:

- The sub-light index when requesting data pages that contain a sub-light index (1-4, 6, 16, 17)
- The mode number, when requesting data page 5 – mode description

And be set to invalid otherwise.

Descriptor Byte 2 should be set to invalid.

7.22.3.3 Requested Transmission Response

The ANT+ bike light should be able to support all requested transmission response types; however, the ANT+ Bike Lights Device Profile further stipulates that the ANT+ controller shall only request broadcast messages from an ANT+ bike light.

Note that some ANT+ bike lights do not support sending acknowledged messages and will instead respond with broadcast messages regardless of the response type requested.

ANT+ bike lights are only required to support up to two transmission response repetitions to minimize polling memory requirements on the shared network.

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

7.23 Optional Common Data Pages

Additional common pages may be used on the broadcast channel. However it is not recommended to use other common pages on the shared channel.

7.23.1 Other Common Data Pages

Other common data pages that are listed in the ANT+ Common Pages document can be sent from the ANT+ bike light. Other common data pages are implemented at the discretion of the developer.

8 Minimum Requirements

8.1 Minimum Requirements for an ANT+ Bike Light

All ANT+ bike lights are required to support both the unconnected state, the 'connected state: main light' and the 'connected state: secondary light'. These states are described in section 5.2.5.

8.1.1 Minimum Transmission Timing Requirements

An ANT+ bike light shall support the transmission patterns described in section 7.3.

8.1.2 Minimum Data Page Requirements for the Broadcast Channel

An ANT+ bike light is required to transmit the data pages listed in Table 8-1 in accordance with the transmission pattern described in section 7.3.

Table 8-1. Required Data Elements of the ANT+ Bike Light

Required Data Page	Transmission Requirements while Unconnected or Connected: Secondary	Transmission Requirements while Connected: Main
Data Page 1	Include in data page rotation. Optionally send on request.	For all secondary lights and main light: Include in data page rotation. Optionally send on request.
Data Page 2	Include in data page rotation and send on request.	For all secondary lights and main light: Send on request. Optionally include in data page rotation.
Data Page 3	Include in data page rotation when sub-lights are present. Optionally send on request.	For all existing sub-lights on secondary lights and main light: Include in data page rotation. Optionally send on request.
Data Page 4	Include in data page rotation when sub-lights are present and send on request.	For all existing sub-lights on secondary lights and main light: Send on request. Optionally include in data page rotation.
Data Page 5	Send on request if custom modes are supported.	For all secondary lights and main light: Send on request if custom modes are supported.
Data Page 6	Send on request when sub-lights are present.	For all secondary lights and main light: Send on request if one or more sub-lights are present.
Common Pages 80, 81	Include in data page rotation and send on request.	For main light: Send on request. Optionally include in data page rotation.
Data Pages 16, 17	N/A	For all secondary lights: Send on request. Optionally include in data page rotation.
Data Page 18	While connected: Send on request. Optionally include in data page rotation.	Send on request. Optionally include in data page rotation.
Data Pages 32, 33, 34	Receive and respond.	Receive and respond.
Common Page 70	Receive and respond to requests for pages.	Receive and respond to requests for pages.

8.1.3 Minimum Data Page Requirements for the Shared Channel

An ANT+ bike light is required to transmit the data pages listed in Table 8-1 in accordance with the transmission pattern described in section 7.3.

Table 8-2. Required Data Elements of the ANT+ Bike Light

Required Data Page	Transmission Requirements
Data Page 1	Required. Refer to section 7.3.3.2.
Data Page 2	Required. Refer to section 7.3.3.2.
Data Page 3	Required if sub-lights exist. Refer to section 7.3.3.2.
Data Page 4	Required if sub-lights exist. Refer to section 7.3.3.2.
Data Page 5	Required if custom modes are supported.
Data Page 6	Required if sub-lights exist.
Data Page 16	Required. Refer to section 7.3.3.2.
Data Page 17	Required. Refer to section 7.3.3.2.
Command Page 32	Receive and respond
Command Page 33	Receive and respond
Command Page 34	Receive and respond
Common Page 70	Required. Main light shall use this page to poll the secondary lights, and the secondary lights shall respond to requests.

8.2 Minimum Requirements for an ANT+ Controller

An ANT+ controller is required to be able to configure a channel as described in section 6.1, and send command page 34. It is recommended that an ANT+ controller is also able to receive and understand all the main data pages, and be able to transmit command pages 32 and 33. Any pages used shall be used in compliance with all the requirements in sections 1 - 7.

8.3 Additional Requirements

In addition to the requirements outlined in sections 8.1 – 8.6, the following general requirements apply to communication on the broadcast channel:

- An ANT+ bike light shall only send broadcast messages to the ANT+ controller/display, and shall not send acknowledged or burst messages. However an ANT+ controller/display shall decode (and display) data sent as acknowledged messages from the ANT+ bike light.
- An ANT+ controller/display shall not decode any unexpected burst messages that are sent from the ANT+ bike light, and shall handle this situation gracefully.
- Reserved bytes in received data pages shall not be decoded.
- The receipt of undefined data pages shall be handled gracefully.

In addition to the requirements outlined in section 8.1 and section 8.2, the following general requirements apply to communication on the shared channel:

- A main light shall not send burst messages.
- A secondary light shall not decode any unexpected burst messages that are sent from the main light, and shall handle this situation gracefully.
- Reserved bytes in received data pages shall not be decoded.
- The receipt of undefined data pages shall be handled gracefully.

8.4 ANT+ Bike Light 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+ bike light status and control information, and that it is interoperable with other devices that carry the same icon.

An ANT+ bike light or ANT+ display/controller that meets the minimum compliance specifications and has been certified may use the icon shown in Figure 8-1 on packaging, documentation, and marketing material.

Figure 8-1. ANT+ Bike Light Interoperability Icon