

# **ANT+ Device Profile**





# **Copyright Information and Usage Notice**

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

- a) You agree that any products or applications that you create using the ANT+ Documents and ANT+ Design Tools will comply with the minimum requirements for interoperability as defined in the ANT+ Documents and will not deviate from the standards described therein.
- b) You agree not to modify in any way the ANT+ Documents provided to you under this Agreement.
- c) You agree not to distribute, transfer, or provide any part of the ANT+ Documents or ANT+ Design Tools to any person or entity other than employees of your organization with a need to know.
- d) You agree to not claim any intellectual property rights or other rights in or to the ANT+ Documents, ANT+ Design Tools, or any other associated documentation and source code provided to you under this Agreement. Dynastream retains all right, title and interest in and to the ANT+ Documents, ANT+ Design Tools, associated documentation, and source code and you are not granted any rights in or to any of the foregoing except as expressly set forth in this Agreement.
- e) DYNASTREAM MAKES NO CONDITIONS, WARRANTIES OR REPRESENTATIONS ABOUT THE SUITABILITY, RELIABILITY, USABILITY, SECURITY, QUALITY, CAPACITY, PERFORMANCE, AVAILABILITY, TIMELINESS OR ACCURACY OF THE ANT+ DOCUMENTS, ANT+ DESIGN TOOLS OR ANY OTHER PRODUCTS OR SERVICES SUPPLIED UNDER THIS AGREEMENT OR THE NETWORKS OF THIRD PARTIES. DYNASTREAM EXPRESSLY DISCLAIMS ALL CONDITIONS, WARRANTIES AND REPRESENTATIONS, EXPRESS, IMPLIED OR STATUTORY INCLUDING, BUT NOT LIMITED TO, IMPLIED CONDITIONS OR WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, DURABILITY, TITLE AND NON-INFRINGEMENT, WHETHER ARISING BY USAGE OF TRADE, COURSE OF DEALING, COURSE OF PERFORMANCE OR OTHERWISE.
- f) You agree to indemnify and hold harmless Dynastream for claims, whether arising in tort or contract, against Dynastream, including legal fees, expenses, settlement amounts, and costs, arising out of the application, use or sale of your designs and/or products that use ANT, ANT+, ANT+ Documents, ANT+ Design Tools, or any other products or services supplied under this Agreement.

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

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

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

©2011 Dynastream Innovations Inc. All Rights Reserved.



# **Revision History**

Revision	Effective Date	Description
1.0	September 2011	Initial Release
1.1	November 2011	Added data page 34 (optional alternative data page 2 format)



# **Table of Contents**

1	Ove	rview of <i>l</i>	ANT+	7		
2	Rela	lated Documents8				
3	Ove	Overview of Light Electric Vehicle Use Case				
4	Cha	nnel Con	figuration	12		
	4.1	4.1 Slave Channel Configuration				
		4.1.1	Channel Period	12		
	4.2	13				
		4.2.1	Channel Type	13		
		4.2.2	Device Number	13		
5	Mes	sage Pay	load Format	14		
	5.1	ANT+ I	Message Data Formats	14		
	5.2	Data Pa	age Types	14		
	5.3	Transm	nission Patterns	15		
	5.4	Data Pa	age 1 – Speed & System Information 1	17		
		5.4.1	Temperature State	17		
		5.4.2	Travel Mode State			
		5.4.3	System State	19		
		5.4.4	Gear State	19		
		5.4.5	Error Message	20		
		5.4.6	LEV Speed	20		
	5.5	Data Pa	age 2/34 – Speed & Distance Information	21		
		5.5.1	Odometer	22		
		5.5.2	Remaining Range	22		
		5.5.3	Fuel Consumption	22		
		5.5.4	LEV Speed	22		
	5.6	Data Pa	age 3 – Speed & System Information 2	23		
		5.6.1	Battery State of Charge	23		
		5.6.2	Travel Mode State	23		
		5.6.3	System State	24		
		5.6.4	Gear State	24		
		5.6.5	% Assist	24		
		5.6.6	LEV Speed	24		
	5.7	Data Pa	age 4 – Battery Information	25		
		5.7.1	Charging Cycle Count	25		
		5.7.2	Fuel Consumption	25		
		5.7.3	Battery Voltage	25		
		5.7.4	Distance on Current Charge	25		
	5.8	Data Pa	age 5 – LEV Capabilities	26		

Z



		5.8.1	Travel Modes Supported	26
		5.8.2	Wheel Circumference	26
	5.9	Data Pag	ge 6 – 15: Reserved for Future Use	26
	5.10	Data	Page 16 – Display Data	27
		5.10.1	Wheel Circumference	27
		5.10.2	Travel Mode	27
		5.10.3	Display Command	28
	5.11	Requ	ired Common Data Pages	29
		5.11.1	Transmission Requirements for Common Data Pages	29
		5.11.2	Common Page 70 (0x46) – Request Data Page	29
		5.11.3	Common Page 80 (0x50) – Manufacturer's Identification	31
		5.11.4	Common Page 81 (0x51) – Product Information	31
		5.11.5	Other Common Data Pages	31
6	Trav	el Modes		32
	6.1	Travel M	lode Examples	33
		6.1.1	Display Supports More Travel Modes	33
		6.1.2	Display Supports Fewer Travel Modes	34
7	Mini	mum Req	uirements	35
	7.1	Minimun	n Transmission Timing Requirements	35
	7.2	Minimun	n Data Page Requirements	35
	7.3	LEV Inte	eroperability Icon	36



# **List of Figures**

7
9
10
11
15
16
16
32
33
34
36

# **List of Tables**

Table 4-1. ANT Channel Configuration for LEV Display (i.e. Slave) Device12
Table 4-2. ANT Channel Configuration for Light Electric Vehicle (i.e. Master)
Table 5-1. ANT+ General Message Format14
Table 5-2. Data Page 1 Format – Speed & System Information 117
Table 5-3. LEV Motor and Battery Temperature Bit Field Description
Table 5-4. Travel Mode State Bit Field
Table 5-5. System State Bit Field19
Table 5-6. Gear State Bit Field19
Table 5-7. Error Message Codes   20
Table 5-8. Data Page 2 Format – Speed & Distance Information
Table 5-9. Data Page 34 Format – Alternative Speed & Distance Information21
Table 5-10. Data Page 3 Format – Speed & System Information 2
Table 5-11. Data Page 4 Format – Battery Information25
Table 5-12. Data Page 5 Format – LEV Capabilities
Table 5-13. Travel Modes Supported
Table 5-14. Data Page 16 Format – Display Data27
Table 5-15. Display Command Bit Field Description    28
Table 5-16. Common Data Page 70 Format
Table 5-17. Common Data Page 80
Table 5-18. Common Data Page 81
Table 6-1. Travel Mode Mapping and Recommended Settings
Table 7-1. Required Data Elements of the LEV
Table 7-2. Required Data Elements of the LEV Display

Z



# **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 <u>www.thisisant.com</u> or contact your ANT+ representative.

- 1. ANT Message Protocol and Usage
- 2. ANT+ Common Data Pages



Z

# 3 Overview of Light Electric Vehicle Use Case

Light electric vehicles (LEVs) provide point-to-point transportation for one person and some cargo at speeds and costs that are moderate. LEVs range in size from electric bicycles to one-person cars.

The ANT+ light electric vehicle provides a variety of information such as current speed, distance travelled, remaining battery life and range, and current state information (such as lights on/off, gear state and travel mode). An ANT+ LEV display is used to communicate this information to the user, and may also provide an interface through which a user may control the LEV's state. The display device may be a bike mounted unit, watch, cell phone or other personal display device. The purpose of the ANT+ LEV device profile is to provide a robust means of interoperable communication between LEVs and displays.



#### Figure 3-1. Overview of LEV Data

Figure 3-2 illustrates how the ANT+ LEV and display are typically used. While in use, the LEV continuously transmits speed, distance, battery and system state information using main data pages.

Device specific information is also interleaved at a slower data rate using ANT+ common pages. Note that both the LEV and the display transmit common pages. The main and common data pages form the standard broadcast data page rotation of ANT+ LEV devices.

Control data pages are defined to allow a user to control the LEV's state through a display's user interface.

The ANT+ LEV device profile also allows for the display to request specific data pages from the LEV as desired. Refer to ANT+ Common Pages document for more details.





Figure 3-2. Typical Use Case of an ANT+ LEV and Display

Many LEVs have a gear system that may be manually or automatically controlled. Some may have defined "travel modes" that allow the LEV to operate within economical, normal and higher power ranges. Some LEV's may also provide peripheral devices such as headlights and/or indicator signals. These system features may be controlled on the LEV itself, or through a sophisticated display's user interface.

The LEV has two data pages containing the LEV's current state information. This allows the display to determine that:

- The user changed the LEV's state using the LEV's user interface.
- The user changed the LEV's state using the display's user interface, and whether this request was successful.
- Errors have occurred.

If the LEV's state is changed through its own user interface, the current (i.e. changed) state will be indicated in the received data page (Figure 3-3a). The received data page shall also indicate if any errors occur (Figure 3-3b).

Simple displays may not provide a user interface and are only used to interpret the data sent from the LEV. More sophisticated displays may provide an interface for the user to request a change to the LEV system, such as changing gears or travel mode, and controlling lights or turn signals. The display data page informs the LEV of any user requested change of state.

This page is sent as an acknowledged message to ensure the request was received by the LEV. On receiving the display page, the LEV shall perform the requested action, and update the state information fields to reflect the current/changed status (Figure 3-3c). Note that if the LEV is unable to perform the requested action, it shall transmit the current (i.e. unchanged) state in the system data page, which may also include an error code indicating to the user why the requested action was not performed.

/





Figure 3-3. a) Direct LEV State Change; b) LEV Error; c) LEV State Change via Display

Ζ



# 4 Channel Configuration

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

#### 4.1 Slave Channel Configuration

The device expected to receive data from an ANT+ LEV must configure an ANT channel with its channel parameters set as listed in Table 4-1.

Parameter	Value	Comment
Channel Type	Slave (0x00)	The LEV is a master device; therefore, the display device must be configured as the slave. Bidirectional communication is required.
Network Key	ANT+ Managed Network Key	The ANT+ Managed Network Key is governed by the ANT+ Managed Network licensing agreement.
RF Channel Frequency	57 (0x39)	RF Channel 57 (2457MHz) is used for the ANT+ LEV
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 may 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	20 (0x14)	20 (0x14) – indicates search for an ANT+ LEV. Please see the ANT Message Protocol and Usage document for more details.
Device Number	1 – 65535 0 for searching	Set the Device Number parameter to zero to allow wildcard matching. Once the device number is learned, the receiving device should remember the number for future searches. Please see the ANT Message Protocol and Usage document for more details.
Channel Period	8192 counts	Data is transmitted from the LEV every $8192/32768$ seconds (4 Hz) and must be received at this rate.
Search Timeout	(Default = 30 seconds)	The default search timeout is set to 30 seconds in the receiver. This timeout is implementation specific and can be set by the designer to the appropriate value for the system.

#### Table 4-1. ANT Channel Configuration for LEV Display (i.e. Slave) Device

# 4.1.1 Channel Period

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



## 4.2 Master Channel Configuration

The ANT+ LEV shall establish its ANT channel as shown in Table 4-2.

#### Table 4-2. ANT Channel Configuration for Light Electric Vehicle (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+ LEV.
Transmission Type	5 (0x05)	ANT+ devices will follow the transmission type definition as outlined in the ANT protocol.
Device Type	20 (0x14)	An LEV device shall transmit its device type as 20 (0x14). 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 LEV. 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	8192 counts	Data is transmitted every 8192/32768 seconds (4 Hz).

# 4.2.1 Channel Type

As communication in both 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.

# 4.2.2 Device Number

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

The device number of the LEV 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.



# 5 Message Payload Format

#### 5.1 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 5-1. A	NT+ General	Message	Format
--------------	-------------	---------	--------

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

#### 5.2 Data Page Types

Multiple data pages are supported for the ANT+ light electric vehicle. These pages are divided into four distinct types of data: main data, control data, common data and requested data. Data Pages are sent at a combined rate of 4 Hz.

**Main data pages** include data such as LEV current state, speed, battery and trip information. Main data pages are the basis of the 4 page rotation transmission pattern described in section 5.3. Data pages 1, 2(or 34), and 3 are sent at 1 Hz each in the 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> channel period respectively. The remaining 4<sup>th</sup> channel period may be used to interleave other data pages (i.e. page 4 or 5), common data pages or manufacturer specific data pages. Data pages 1, 2, 3, and 5 are required and must be sent by all ANT+ LEVs and interpreted by all ANT+ LEV receivers/displays. Data page 34 is an optional data page that may be transmitted as an alternative to data page 2. This data page follows the same format as data page 2; however, fuel consumption is transmitted in the place of remaining range. Main data page 4 is optional.

**Control data pages** provide a means for the user to request LEV state changes via the display and must be sent using acknowledged messages. Display data page 16 contains the LEV control data. Simple displays may just receive and display LEV data from the LEV; however, more sophisticated displays can provide a user interface that allows the user to control the LEV's state. This data page must be interpreted by all ANT+ LEVs.

**Common data pages** are defined pages that are used by most ANT+ devices, and provide background information such as manufacturer information and battery voltage. Refer to the ANT+ Common Pages document and section 5.11 for more details. Both the ANT+ LEV and display transmit common pages at relatively low data rates.

The ANT+ LEV Device Profile also includes the **Request Data Page** (common page 70). This allows the display to request specific data pages from the LEV (request pages are not allowed from the LEV to the display). Refer to section 5.11.2 and the ANT+ Common page document for more details.



## 5.3 Transmission Patterns

The LEV transmits data pages at 4 Hz. Main data pages are transmitted in a 4 page pattern, as illustrated in Figure 5-1. Data pages 1, 2 (or 34), and 3 shall be transmitted in the first 3 channel periods of the 4 page pattern. This results in each page being transmitted at 1 Hz. The 4<sup>th</sup> channel period of the 4 page pattern shall contain one of: data page 4, data page 5, manufacturer specific or common data page.

Byte	4 Hz Data Page Rotation				
0	Data Page # (1)	Data Page # (2/34)	Data Page # (3)	Data Page # (varies)	
1	Temperature State (optional)		Battery State of Charge		
2	Current Travel Mode	Odometer	Current Travel Mode		
3	System State		System State	Common	
4	Gear State	Remaining Range/ Fuel Consumption	Gear State	& Optional	
5	Error Message (optional)	(optional) Reserved	% Assist (optional)	Data Pages	
6	LEV Speed	LEV Speed	LEV Speed		
7	Reserved	Reserved	Reserved		
Byte	Opti	onal & Common Data	Pages Interleaved at	: 1 Hz	
0	Data Page #	Data Page #	Data Page #	Data Page #	
1	Reserved	Reserved	(11110)	(1110)	
2	Charging Cycle Count	Travel Modes Supported			
3	(optional) Fuel	Wheel Circumference	Common	Manufacturer	
4	Consumption (optional)	Reserved	Data Pages	Specific	
5	Battery Voltage (optional)	Reserved	One every ~20 channel periods	(optional)	
6	Distance from	Reserved			
7	(optional)	Reserved			

Legend:	3 Hz Data	1Hz Data
	2 Hz Data	<1 Hz Data

Figure 5-1. ANT+ LEV 4 Page Rotation Pattern



This 4 page rotation pattern ensures that LEV speed is updated 3 out of every 4 transmitted data pages (3Hz), and LEV state information 2 out of every 4 (2Hz). Other data is transmitted at 1 Hz or less (i.e. optional main or manufacturer specific data pages, and common pages).

The ANT+ LEV further requires that a common page be sent approximately every 20 channel periods. The common pages are sent in the 4<sup>th</sup> channel period of the 4 page rotation, as shown in Figure 5-2.



Figure 5-2. ANT+ LEV Common Page Interleave

Note that the optional data page 34 may be transmitted in the place of data page 2. However, data page 2 shall be transmitted at least once every 30 seconds (i.e. once every 120 messages).

Figure 5-3 shows the effect of a request page on the LEV broadcast pattern. In this example, the request page (common page 70) was received after the transmission of data page 1. The LEV shall respond to the request page immediately and transmit the requested data page (data page Y) on the next channel period. After a requested data page has been sent, the 4 page rotation pattern is reset and the LEV shall then transmit data page 1, 2 (or 34) etc... As shown in this example, this will result in the common page being sent 22 channel periods after the previous common page.



Figure 5-3. ANT+ LEV 4 Page Rotation Pattern with Request Page

The data page rotation is reset to ensure that the display is receiving LEV state information at least every 0.5 seconds. The ANT+ LEV Display broadcasts a common data page roughly every 20<sup>th</sup> channel period<sup>1</sup>, rotating between page 80 and 81. The ANT+ LEV Display transmits data page 16 as an acknowledged message on user input. **The LEV display shall send its first common page immediately after detecting the LEV.** 

<sup>&</sup>lt;sup>1</sup> Rx fails may prevent a display from sending on exactly the 20<sup>th</sup> channel period. In this case, the common page is sent on the first successfully received message



#### 5.4 Data Page 1 – Speed & System Information 1

Data page 1 is one of the main data pages broadcast from an ANT+ LEV. All LEVs must send this page and it must be at a 1 Hz rate. Speed information is sent in pages 1, 2, and 3 to ensure this information is updated on a display at an average of 3 Hz. The travel mode, system state, and gear state are sent in pages 1 and 3 to ensure this information is received and updated at an average of 2 Hz. The error message and temperature state fields are unique to page 1 and are sent at 1 Hz. All fields in this message are required, with the exception of the temperature state and error fields, and shall be set as described in Table 5-2.

Byte	Description	Length	Value	Units	Max Value
0	Data Page Number	1 byte	Data Page Number = 1 (0x01)	N/A	N/A
1	Temperature State	1 byte	Indicates current temperature status of the motor and/or battery. Refer to Table 5-3 Special Values: 0x00 - unknown	N/A	N/A
2	Travel Mode State	1 byte	Indicates the LEV's current travel mode. Refer to Table 5-4	N/A	N/A
3	System State	1 byte	Indicates the current state of the LEV's peripheral system. Refer to Table 5-5	N/A	N/A
4	Gear State	1 byte	Indicates the current state of the LEV's gears. Refer to Table 5-6	N/A	N/A
5	Error Message	1 byte	Indicates LEV Error. Refer to Table 5-7	N/A	N/A
6	LEV Speed LSB	1.5	Depresents the surrent LEV speed	0.1	409.5
7 (bits 0-3)	LEV Speed MSN	bytes	Represents the current LEV speed	km/h	km/h
7 (bits 4-7)	Reserved	4 bits	Value = 0xF	N/A	N/A

#### Table 5-2. Data Page 1 Format – Speed & System Information 1

#### 5.4.1 Temperature State

The temperature of the LEV motor and battery may be transmitted in this field based on Table 5-3. This is an optional field and shall be set to unknown if not used.

This field is unique to data page 1.

#### Table 5-3. LEV Motor and Battery Temperature Bit Field Description

Bit	Description	Value		
7	Motor Tomporpture Alert	0	No Alert/unknown	
/	Motor Temperature Alert	1	Overheating Alert	
		000	Unknown	
6-4	Motor Temperature	001	Cold	
		010	Cold/Warm	



		011	Warm
		100	Warm/Hot
		101	Hot
		110-111	Reserved
2	Dettery Temperature Alert	0	No Alert/unknown
3	battery reinperature Alert	1	Overheating Alert
		000	Unknown
	Battery Temperature	001	Cold
		010	Cold/Warm
2-0		011	Warm
		100	Warm/Hot
		101	Hot
		110-111	Reserved

### 5.4.2 Travel Mode State

The travel mode state field describes the current assistance/regenerative level of the LEV and shall be set according to Table 5-4. Refer to section 6 for more details on setting/mapping travel modes.

This field is a required field and is common to data pages 1 and 3.

Bit	Description	Value
7-6	Reserved	Reserved. Set to 0.
5-3	Current Assist Level	000 - Assist Off 001 - Assist 1 010 - Assist 2 011 - Assist 3 100 - Assist 4 101 - Assist 5 110 - Assist 6 111 - Assist 7
2-0	Current Regenerative Level	000 - Regenerative Off 001 - Regenerative 1 010 - Regenerative 2 011 - Regenerative 3 100 - Regenerative 4 101 - Regenerative 5 110 - Regenerative 6 111 - Regenerative 7

Z



### 5.4.3 System State

The system state field describes the current state of the LEV's peripheral system features. For example, this field indicates the state of the LEV's lights, and/or indicators. If the LEV system does not support a listed feature, that bit shall be set to the value indicated in Table 5-5.

This field is required, and common to data pages 1 and 3.

Bit	Description	Value
7-5	Reserved	Set to 0
4	Manual Throttle On/Off (status only)	indicates throttle: 0 - off/unsupported 1 - on
3	Light On/Off	indicates light(s): 0 – off/unsupported 1 – on
2	Light Beam	Indicates light(s): 0 – low beam/unsupported 1 – high beam
1	Turn Signal Left	Indicates if left turn signal: 0 – off/unsupported 1 – blinking
0	Turn Signal Right	Indicates if right turn signal: 0 – off/unsupported 1 – blinking

#### Table 5-5. System State Bit Field

#### 5.4.4 Gear State

The gear state bit field describes the current state of the LEV's gear system. As described in Table 5-6, this field indicates if a gear system exists, if it is manual or automatic, and the current gear the LEV is in.

This field is required and common to data pages 1 and 3.

#### Table 5-6. Gear State Bit Field

Bit	Description	Value
7	Gear exist	Indicates if gears exist: 0 – gear is not available 1 – gear is available
6	Manual/Auto	Indicates gear control: 0 – automatic/gear not available 1 – manual
5-2	Current Rear Gear	Rear gear setting of the LEV: 0001 – 1111 = selected gear 1-15 Special Value: 0000 – no rear gear available
1-0	Current Front Gear	Front gear setting of the LEV: 01 - 11 = selected gear 1-3 Special Value: 00 - no front gear available

Z



#### 5.4.5 Error Message

The error message field may contain both ANT+ and manufacturer defined error message codes as shown below in Table 5-7. For manufacturer specific messages, the display may just show the error number.

This is an optional field.

Message Code	Description
0	No Error
1	Battery Error
2	Drive Train Error
3	Battery End of Life
4	Overheating
5-15	Reserved
16-255	Manufacturer Specific Error Codes

Z

#### Table 5-7. Error Message Codes

#### 5.4.6 LEV Speed

The LEV Speed is a 12 bit value representing the current speed of the LEV in 0.1 km/h.

This is a required field and is common to data pages 1, 2 and 3.



#### 5.5 Data Page 2/34 – Speed & Distance Information

Data page 2 is one of the main data pages broadcast from an ANT+ LEV. All LEVs must send this page and it must be at a 1 Hz rate. Speed information is sent in pages 1, 2, and 3 to ensure this information is updated on a display at an average of 3 Hz. The odometer and remaining range fields are unique to this page and are sent at 1 Hz. All fields in this message are required, with the exception of remaining range, and shall be set according to the values shown in Table 5-8.

Byte	Description	Length	Value	Units	Max Value
0	Data Page Number	1 byte	Data Page Number = $2 (0x02)$	N/A	N/A
1	Odometer LSB			0.01 km	~167,772 km
2	Odometer	3 bytes	Accumulated total distance /tes		
3	Odometer MSB				
4	Remaining Range LSB	1.5 bytes	Remaining range of the LEV, based on the battery state of charge Special Values: 0x00 - unknown	km	4,095 km
5 (bits 0-3)	Remaining Range MSN				
5 (bits 4-7)	Reserved	4 bits	Value = 0xF	N/A	N/A
6	LEV Speed LSB	1.5	Represents the current LEV	0.1 km/b	409 5 km/b
7 (bits 0-3)	LEV Speed MSN	bytes	speed	0.1 KIII/II	-109.5 KIII/II
7 (bits 4-7)	Reserved	4 bits	Value = 0xF	N/A	N/A

#### Table 5-8. Data Page 2 Format – Speed & Distance Information

Data page 34 is an optional data page that may be transmitted instead of data page 2 and contains fuel consumption data rather than remaining range data as shown in Table 5-9. If this page is used, all fields are required fields, and data page 2 shall be sent at least once per 30 seconds.

#### Table 5-9. Data Page 34 Format – Alternative Speed & Distance Information

Byte	Description	Length	Value	Units	Max Value
0	Data Page Number	1 byte	Data Page Number = 34 (0x22)	N/A	N/A
1	Odometer LSB			0.01 km	~167,772 km
2	Odometer	3 bytes	Accumulated total distance		
3	Odometer MSB		liaveled		
4	Fuel Consumption LSB	1.5	Indicates the current rate of battery fuel consumption in	0.1	400 F . Wh //rm
5 (bits 0-3)	Fuel Consumption MSN	bytes	Special Value: 0x000 – unknown	Wh/km	409.5 WII/KIII
5 (bits 4-7)	Reserved	4 bits	Value = 0xF	N/A	N/A



6	LEV Speed LSB	1.5 bytes	Represents the current LEV speed	0.1 km/h	409.5 km/h
7 (bits 0-3)	LEV Speed MSN				
7 (bits 4-7)	Reserved	4 bits	Value = 0xF	N/A	N/A

# 5.5.1 Odometer

This is a required field and represents the total distance travelled by the LEV. This value may be used by the display to calculate trip distances.

# 5.5.2 Remaining Range

Remaining range is an optional field and is a prediction of the remaining range of the LEV based on the current LEV settings and conditions. This field is included in data page 2 format only, NOT data page 34.

# 5.5.3 Fuel Consumption

Optional field that indicates the current rate of battery fuel consumption, in watt-hours per kilometer. This field shall be set to 0x000 when unknown/not used.

This field is included in data page 34 format only, NOT data page 2.

# 5.5.4 LEV Speed

The LEV Speed is a 12 bit value representing the current speed of the LEV in 0.1 km/h.

This is a required field that is common to data pages 1, 2 and 3.



#### 5.6 Data Page 3 – Speed & System Information 2

Data page 3 is one of the main data pages broadcast from an ANT+ LEV. All LEVs must send this page at a 1 Hz rate. Speed information is sent in pages 1, 2, and 3 to ensure this information is updated on a display at an average of 3 Hz. The travel mode, system state, and gear state are sent in pages 1 and 3 to ensure this information is received and updated at an average of 2 Hz. The % assist and battery SOC fields are unique to page 3 and are sent at 1 Hz. All fields in this message are required, with the exception of % assist, and shall be set as described in Table 5-10.

Byte	Description	Length	Value	Units	Max Value
0	Data Page Number	1 byte	Data Page Number = 3 (0x03)	N/A	N/A
1	Battery SOC (State of Charge)	1 byte	bits 6-0: State of charge: percent of whole battery capacity. bit 7: battery empty warning	1%	100% max
2	Travel Mode State	1 byte	Indicates the LEV's current travel mode. Refer to Table 5-4	N/A	N/A
3	System State	1 byte	Indicates the current state of the LEV's peripheral system. Refer to Table 5-5	N/A	N/A
4	Gear State	1 byte	Indicates the current state of the LEV's gears. Refer to Table 5-6	N/A	N/A
5	% Assist	1 byte	Provides the % assistance level the LEV motor is providing. Special value: 0xFF unknown	%	max 100%
6	LEV Speed LSB	1.5	Represents the current LEV speed	0.1	409.5
7 (bits 0-3)	LEV Speed MSN	bytes		km/h	km/h
7 (bits 4-7)	Reserved	4 bits	Value = 0xF	N/A	N/A

#### Table 5-10. Data Page 3 Format – Speed & System Information 2

#### 5.6.1 Battery State of Charge

The most significant bit of the battery state of charge field is a battery empty warning bit. The remaining bits of this field indicate the remaining battery charge, and are expressed as a percentage of the whole battery capacity.

This is a required field and is unique to data page 3.

#### 5.6.2 Travel Mode State

The travel mode state field describes the current assistance/regenerative level of the LEV and shall be set according to Table 5-4. Refer to section 6 for more details on setting/mapping travel modes.

This is a required field and is common to data page 1 and 3.



# 5.6.3 System State

The system state field describes the current state of the LEV's peripheral system features. For example, this field indicates the state of the LEV's lights, and/or indicators. If the LEV system does not support a listed feature, that bit shall be set to the value indicated in Table 5-5.

This is a required field and is common to data pages 1 and 3.

# 5.6.4 Gear State

The gear state bit field describes the current state of the LEV's gear system. As described in Table 5-6, this field indicates if a gear system exists, if it is manual or automatic, and the current gear the LEV is in.

This is a required field and is common to data pages 1 and 3.

#### 5.6.5 % Assist

This field provides the assistance level of the LEV motor, as a percentage of motor power to total power. Total power is defined as the power generated by the user plus the power generated by the motor. Therefore, the percent assistance is derived by:

```
% Assist = Motor power / (Motor Power + User Power)
```

This is an optional field and is unique to data page 3.

# 5.6.6 LEV Speed

The LEV Speed is a 12 bit value representing the current speed of the LEV in 0.1 km/h.

This is a required field that is common to data pages 1, 2 and 3.



# 5.7 Data Page 4 – Battery Information

Data page 4 is one of the main data pages broadcast from an ANT+ LEV. This is an optional data page. All fields within this page are optional except for byte 0. Data page 4 may be sent on the fourth channel period of the 4 data page rotation pattern. This results in an average transmission rate of 1 Hz or less. Alternatively, this data page may be requested by the display using the request page (common page 70). Fields shall be set according to the values stated in Table 5-11.

Byte	Description	Length	Value	Units	Max Value
0	Data Page Number	1 byte	Data Page Number = $4 (0x04)$	N/A	N/A
1	Reserved	1 byte	Value = 0xFF	N/A	N/A
2	Charging Cycle Count LSB	1.5 bytes	Tracks the number of charge cycles1.5the LEV has gone through.bytesSpecial Value: 0x000 – unknown	1 count	4095
3 (bits 0-3)	Charging Cycle Count MSN			1 count	
3 (bits 4-7)	Fuel Consumption MSN	1.5	Indicates the current rate of battery fuel consumption in watt-hours per	0.1	409.5 Wh/km
4	Fuel Consumption LSB	bytes	Special Value: 0x000 – unknown	Wh/km	
5	Battery Voltage	1 byte	Measured battery voltage Special Value: 0x00 – unknown	1⁄4 V	255 max (63.75V)
6	Distance on Current Charge LSB	) huto	Distance in km that the LEV has traveled on the current charge.	0.1.4m	
7	Distance on Current Charge MSB	2 byte	e Special Value: 0x0000 - unknown	0.1 km	6,553.5 KM

#### Table 5-11. Data Page 4 Format – Battery Information

# 5.7.1 Charging Cycle Count

Optional field that tracks the number of times the LEV has been charge cycled (i.e. charged and discharged). This field shall be set to 0x000 when unknown/not used.

# 5.7.2 Fuel Consumption

Optional field that indicates the current rate of battery fuel consumption, in watt-hours per kilometer. This field shall be set to 0x000 when unknown/not used.

# 5.7.3 Battery Voltage

Optional field that represents the recorded battery voltage of the LEV battery, in 0.25 V units. This field shall be set to 0x00 when unknown/not used.

# 5.7.4 Distance on Current Charge

Optional field that represents the distance in km that the LEV has traveled on the current charge. The LEV should reset this field after every charge. This field shall be set to 0x0000 when unknown/not used.



## 5.8 Data Page 5 – LEV Capabilities

Data page 5 is one of the main data pages broadcast from an ANT+ LEV. **All LEVs must be able to send this data page.** Data page 5 should be sent in the fourth channel period of the 4 data page rotation. This page may be sent at a user defined rate (~1 Hz or less) or on the display's request using the request page (common page 70). Fields shall be set according to values stated in Table 5-12.

Byte	Description	Length	Value	Units	Max Value
0	Data Page Number	1 byte	Data Page Number = $5 (0x05)$	N/A	N/A
1	Reserved	1 byte	Value = 0xFF	N/A	N/A
2	Travel Modes Supported	1 byte	Bit field indicating which travel modes are supported by the LEV. Refer to Table 5-13	N/A	N/A
3	Wheel Circumference LSB	1 byte	Indicates LEV's wheel circumference in mm	1	4005 mm
4 (bits 0-3)	Wheel Circumference MSN	4 bits	Special Value: 0x00 - unknown	1 11111	4095 11111
4 (bits 4-7)	Reserved	4 bits	Value = 0xF	N/A	N/A
5	Reserved	1 byte	Value = 0xFF	N/A	N/A
6	Reserved	1 byte	Value = 0xFF	N/A	N/A
7	Reserved	1 byte	Value = 0xFF	N/A	N/A

#### Table 5-12. Data Page 5 Format – LEV Capabilities

# 5.8.1 Travel Modes Supported

The ANT+ LEV Device Profile supports up to 7 assist, and 7 regenerative travel modes. Assist level 1 indicates the least amount of assistance supplied by the LEV and assist level 7 indicates the most amount of assistance. Similarly, regenerative level 1 indicates the least amount of regeneration and regenerative level 7 indicates the most amount of regeneration. The travel modes supported field indicates the how many assist and regenerative travel modes are supported in the LEV. Refer to section 6 for more details on travel modes.

#### Table 5-13. Travel Modes Supported

Bit	Description	Value
7-6	Reserved	Reserved. Set to 0.
5-3	Number of Assist modes supported	0 (none) to maximum 7 assist modes
2-0	Number of Regenerative modes supported	0 (none) to maximum 7 regenerative modes

# 5.8.2 Wheel Circumference

This optional field stores the programmed wheel circumference of the LEV in mm. This value may be predetermined on the LEV, or set by the display using data page 16. This field shall be set to 0x000 when unknown/not used.

# 5.9 Data Page 6 – 15: Reserved for Future Use

Data pages 6 to 15 are reserved for future main data page definitions.



#### 5.10 Data Page 16 – Display Data

Data Page 16 is sent from the display to the LEV and is used to inform the LEV of any user requested changes to the LEV state, such as switching gears, using turn indicators, etc. This data page is optional for a display but must be supported by all LEVs. All fields in this message shall be set as described in Table 5-14.

**Data page 16 is sent as an acknowledged message**. This ensures the display can determine that the LEV received the data.

Byte	Description	Length	Value	Units	Max Value
0	Data Page Number	1 byte	Data Page Number = 16 (0x10)	N/A	N/A
1 2 (bits 0-3)	Wheel Circumference LSB Wheel Circumference MSN	1.5 bytes	Sets the wheel circumference of the LEV in mm Special Values: 0xFF – not supported by display / not set	1 mm	4095 mm
2 (bits 4-7)	Reserved	4 bits	Set to value = 0xF	N/A	N/A
3	Travel Mode	1 byte	Indicates the current travel mode set/requested. Refer to Table 5-4. Special value 0xFF – not supported by display / not set	N/A	N/A
4	Display Command LSB	2 hyter	Reflects the desired state of the LEV.	NI / A	NI / A
5	Display Command MSB	2 Dytes	Refer to Table 5-15	N/A	IN/A
6	Manufacturer ID LSB	2 bytes	Manufacturer ID of the Display (not a	N/A	N/A
7	Manufacturer ID MSB		setting). ANI + managed.		

Table 5-14. Data Page 16 Format – Display Data

# 5.10.1 Wheel Circumference

This is an optional field that may be used to set the wheel circumference on the LEV. If unused, the field shall be set to 0xFFF.

# 5.10.2 Travel Mode

The travel mode field describes the current assistance/regenerative level of the LEV, as requested by the user. If the user has not requested a change in travel mode, this value simply reflects the current travel mode as indicated in data page 1.

The travel mode field is set according to Table 5-4, bits 5-0. Refer to section 6 for more on setting/mapping appropriate travel mode values.

If the display does not support setting travel modes, then this field shall be set to 0xFF.



Ζ

# 5.10.3 Display Command

For displays that provide a user interface for LEV control, this bit field describes the user commands requested. The ANT+ LEV display commands are listed in Table 5-15.

Bit	Description	Value
15-10	Reserved	Reserved. Set to 0.
9-6	Current Rear Gear	Rear gear setting of the LEV: 0001 – 1111 = selected gear 1-15 Special Value: 0000 – no rear gear available
5-4	Current Front Gear	Front gear setting of the LEV: 01 – 11 = selected gear 1-3 Special Value: 00 – no front gear available
2	Light on/off	0 – Light(s) Off
5		1 – Light(s) On
2	Light high hoom/low hoom	0 – High Beam Off
Z	Light high beam/low beam	1 – High Beam On
		0 – Left Turn Signal Off
1	i urn signai iert	1 – Left Turn Signal Blinking
0	Turn cional right	0 – Right Turn Signal Off
U	i urn signal right	1 – Right Turn Signal Blinking

Table 5-15. Displ	ay Command Bit	<b>Field Description</b>



#### 5.11 Required Common Data Pages

Common data 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 Data Pages document for details of all common data pages.

#### 5.11.1 Transmission Requirements for Common Data Pages

Either common page 80 or common page 81 must be sent by an ANT+ LEV every 20<sup>th</sup> channel period. A common data page message must be sent by an ANT+ LEV Display approximately every 20<sup>th</sup> channel period. Refer to section 5.3.

# 5.11.2 Common Page 70 (0x46) – Request Data Page

The request data page allows a device to request a specific data page from another device. In this case, it allows the LEV display to request broadcast data from the LEV.

#### The request page is sent as an acknowledged message from a display.

**The LEV must be able to respond to requests for data pages described in this document**. However, other pages may be requested by a display that may not be supported. In these cases, the LEV may not respond at all and continue to send data according to its device profile. Any display device that plans to use this data page shall handle this "no response" case elegantly.

The contents of this data page are detailed in Table 5-16; however for more details on using this page, refer to the ANT+ Common Pages Document.

The LEV shall respond to the request immediately and send the requested data page on the next channel period. In order to maintain up to date state information on the display, the LEV shall reset its 4 page transmission pattern after sending the requested data page (refer Figure 5-3, section 5.3.).

Byte	Description	Length	Value	Units
0	Data Page Number	1 Byte	70 (0x46) – Data Page Request	N/A
1	Reserved	1 Byte	Value = 0xFF	N/A
2	Reserved	1 Byte	Value = 0xFF	N/A
3	Descriptor Byte 1	1 Byte	Invalid: 255 (0xFF)	N/A
4	Descriptor Byte 2	1 Byte	Invalid: 255 (0xFF)	N/A
5	Requested Transmission Response	1 Byte	Describes transmission characteristics of the data requested. <b>Bit 0-6:</b> Number of times to transmit requested page. <b>Bit 7:</b> Setting the MSB means the device replies using acknowledged messages if possible. <b>Special Values:</b> 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 Value = 2 (0x02) for Request ANT-FS session	N/A

#### Table 5-16. Common Data Page 70 Format



#### 5.11.2.1 Descriptor Bytes 1 & 2

For LEV, these fields are invalid and shall be set to 0xFF.

#### 5.11.2.2 Requested Transmission Response

When requesting a data page from the LEV, the **ANT+ LEV display shall only request broadcast message types from a LEV**. Acknowledged or burst message types shall not be requested. In addition, the maximum number of broadcast messages requested shall be 4 (equivalent to 1 second worth of data).

#### 5.11.2.3 Requested Page Number

When requesting a data page from the LEV, the display uses this field to indicate the page number requested.

#### 5.11.2.4 Command Type

For LEV, this field shall always be set to 0x01, Request Data Page.



Z

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

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

Table 5-17	Common	Data	Page	80
------------	--------	------	------	----

Byte	Description	Length	Value	Units
0	Data Page Number	1 Byte	0x50 – Common Page 80	N/A
1	Reserved	1 Byte	Value = 0xFF	N/A
2	Reserved	1 Byte	Value = 0xFF	
3	HW Revision	1 Byte	To be set by the manufacturer.	N/A
4	Manufacturer ID LSB		Contact the ANT+ Alliance for a current list of	NI / A
5	Manufacturer ID MSB	2 Bytes	manufacturing IDs, or to be assigned a manufacturing ID.	
6	Model Number LSB		To be not by the menufactures	NI / A
7	Model Number MSB	2 Bytes	To be set by the manufacturer.	

For the current list of Manufacturer Identification values, or if you wish to be added to this list, please contact the ANT+ Alliance.

#### 5.11.4 Common Page 81 (0x51) – Product Information

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

#### Table 5-18. Common Data Page 81

Byte	Description	Length	Value	Units
0	Data Page Number	1 Byte	0x51 – Common Page 81	N/A
1	Reserved	1 Byte	Value = 0xFF	N/A
2	Reserved	1 Byte	Value = 0xFF	N/A
3	SW Revision	1 Byte	To be set by the manufacturer.	N/A
4	Serial Number LSB			
5	Serial Number	4.5.1	The lowest 32 bits of the serial number.	
6	Serial Number	4 Bytes	value UXFFFFFFFF to be used for devices without serial	N/A
7	Serial Number MSB		numbers.	

# 5.11.5 Other Common Data Pages

Other common data pages that are listed in the ANT+ Common Data Pages document can be sent from the ANT+ LEV. The timing requirement for other common data pages are the same as described in section 5.11.1. Other common data pages are implemented in the LEV at the discretion of the developer.



# 6 Travel Modes

Travel mode numbers have been designed such that regenerative level 1 indicates the least amount of regeneration and regenerative level 7 indicates the most amount of regeneration. Similarly, assist level 1 indicates the least amount of assistance supplied by the LEV and assist level 7 indicates the most amount of assistance.

The ANT+ LEV device profile defines a method for mapping the defined travel mode to the number of available travel modes. This will allow consistency across LEVs and displays that may support a different number of travel modes. For example, a display may support the selection of up to 4 travel modes, while an LEV supports 7 travel modes. Similarly, an LEV may support less travel modes than that of a display.

The mapping illustrated in Figure 6-1 shall be used by both the display and the LEV to ensure appropriate changing of travel modes regardless of the number of travel modes supported by either device. Note, the mapping of travel mode numbers is the same for both assist and regenerative modes.





The ANT+ LEV Device Profile further defines the recommended travel mode settings, depending on the number of travel modes that either an LEV or display device supports (Table 6-1). For example, if a display supported only two travel modes (i.e. low and high), then it should send travel mode 3 for the low assistance level (i.e. not travel mode 1 or 2), and travel mode 7 for the high assistance mode setting (i.e. not travel modes 4, 5, or 6). If this display were connected to an LEV that supported all 7 modes, then although the user cannot access all of them via their display, they will at least access the greatest assistance range of the LEV.

# Modes Supported	Travel Mode Groupings							Recommended Travel Mode Settings
1	1, 2, 3, 4, 5, 6, 7					7		
2		1, 2, 3		4, 5, 6, 7				3, 7
3	1,	2	3,	4		5, 6, 7		2, 4, 7
4	1	2,	3	4,	5	6,	7	1, 3, 5, 7
5	1	2	3	4,	5	6,	7	1,2,3, 5, 7
6	1	2	3	4	5	6,	7	1, 2, 3, 4, 5, 7
7	1	2	3	4	5	6	7	1, 2, 3, 4, 5, 6, 7

Z

#### Table 6-1. Travel Mode Mapping and Recommended Settings



#### 6.1 Travel Mode Examples

The following section provides examples of setting travel modes when the number of modes supported between an LEV and display do not match. Two use cases are described:

- 1. Number of travel modes supported by the display is > number of modes supported by the LEV
- 2. Number of travel modes supported by the display is < number of modes supported by the LEV

#### 6.1.1 Display Supports More Travel Modes

When an ANT+ LEV display supports more travel modes than the LEV, it is recommended that the display alters its user interface such that only the LEV's available modes are displayed, not the display's available modes.

Figure 6-2 provides an example use case of an LEV display supporting 6 travel modes. The display receives the LEV capabilities (system data page 16), which indicates the LEV supports only 3 modes. The displays shall alter its interface and show 3 available modes to the user (a). The display's travel modes will be mapped according to Figure 6-1 and Table 6-1. In this use case, the LEV may send travel modes 2, 4 and 7 (b), and the display shall only allow the selection of travel modes 2, 4 and 7, and shall not use travel modes 1, 3 and 5 (c).



Figure 6-2. Example Travel Mode Mapping/Settings



# 6.1.2 Display Supports Fewer Travel Modes

When an ANT+ LEV display supports less travel modes than the LEV, the LEV may use its full range of modes if there is a manual control, while the display shall only be able to set and interpret a reduced number of modes. The modes that the display may control/interpret shall be determined using the mapping described in Figure 6-1 and Table 6-1.

Figure 6-3 provides an example use case of a simple display that supports less travel modes than the LEV supports. In this case, the user may set the LEV travel mode manual to any of the available 5 modes. The display shall interpret the travel mode value using the mapping provided in Table 6-1. For example, if the user sets the LEV travel mode to 2, then the display shall interpret this as "low".





The display, on the other hand, only allows the user to select LEV travel modes 3 and 7. If the LEV is only controlled via the display (i.e. no manual control exists), then the user shall only be able to set travel modes 3 and 7 of the LEV, and modes 1, 2, and 5 will remain unused.

L



# 7 Minimum Requirements

#### 7.1 Minimum Transmission Timing Requirements

Data pages 1, 2, and 3 must be sent at 1 Hz, while all other data pages share the final 4 Hz channel period slot.

Display data page 16 shall be sent when the user requests a change of LEV state via the display.

The common data page messages shall be sent once every 20th data message (LEV) or approximately every 20th channel period (display). This will allow the full manufacturer information to be transmitted approximately once every 5 seconds. In the LEV use case, the display device transmits common pages allowing the LEV to know that it is still connected to the display. The LEV display shall send its first common page immediately on detecting the LEV.

The request data common page shall only be sent from a display to the LEV to request specific data pages. It is not valid for the LEV to request data from a display.

Refer to section 5.11.1 for more details on the transmission requirements of the common data pages.

#### 7.2 Minimum Data Page Requirements

The ANT+ LEV must transmit all non-optional bytes of data pages 1, 2 (or alternatively data page 34), 3, and 5. Data pages 4 and 16 are optional (but recommended). The ANT+ LEV must transmit common data pages 80 and 81 as detailed in section 5.11.1. These required fields are the minimum data set that must be sent from the ANT+ LEV and are outlined in Table 7-1. The ANT+ LEV must also be able to decode the ANT+ LEV display data page (i.e. page 16).

Required Data Page	Transmission Requirements
Data Page 1	1 Hz
Data Page 2 (or alternative data page 34)	1 Hz (data page 2 at least once per 30 seconds)
Data Page 3	1 Hz
Data Page 5	On Request
Data Page 16	On system update or on request from the Display. Sent as acknowledged
Common Page 80 – Manufacturer ID	every 40th message
Common Page 81 – Product ID	every 40th message

#### Table 7-1. Required Data Elements of the LEV

Displays that are compatible with the ANT+ LEV must be able to decode the minimum data set (Table 7-1), providing interoperability with all manufacturers of ANT+ LEVs. The ANT+ LEV display must also be able to transmit the data pages listed in Table 7-2.

#### Table 7-2. Required Data Elements of the LEV Display

Required Data Page	Transmission Requirements
Common Page 80 – Manufacturer ID	Approximately every 40th message
Common Page 81 – Product ID	Approximately every 40th message



Note that data page 16 is not a required page for a display. However, if data page 16 is received by an ANT+ LEV, **the ANT+ LEV must be able to decode data page 16**.

#### 7.3 LEV 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 LEV information, and that it is interoperable with other devices that carry the same icon.

An ANT+ LEV or display that meets the minimum compliance specifications may use the icon shown in Figure 7-1 on packaging, documentation, and marketing material.



Figure 7-1. ANT+ LEV Interoperability Icon

Ζ

