Manual LoRaWAN
Mini Gateway
ID150188-02

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Title: Manual LoRaWAN mini gateway

1 Revision history

Version	Date	Changes
1.0	17-03-2016	First release
2.0	28-10-2016	Updated for new firmware release

1.1 Contact

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3 Introduction

The LoRaWAN mini gateway can be used to develop and test LoRaWAN motes. Also it can be used to test gateway communication.

This manual will first give a global description of the LoRaWAN communication. In the "Commands" chapter there will be a more specific explanation of the different settings.

4 Specifications

Radio connection	
Modulation	LoRa
Channel Up	868.100 MHz
Datarate Up	SF12 BW 125 kHz
Channel Down	869.525 MHz
Datarate Down	SF9 BW 125 kHz
Device Address	00 00 00 00
Network key	2B7E151628AED2A6ABF7158809CF4F3C
Application key	2B7E151628AED2A6ABF7158809CF4F3C
Tx Direction	Up
Tx Timing	No
Tx Confirmation	No
Send ACK	No

Table 1: Default radio settings

See chapter 8 if you want to change these settings.

Serial communication USB	
Datarate	38,4 kbps
Number of data bits	8
Parity	None
Number of stop bits	1

Table 2: Serial communication specifications

5 Installation

Connect the mini gateway to an USB port. The driver will be installed automatically. Otherwise the driver can be downloaded from the FTDI website:

htp://www.ftdichip.com.

Download the VCP drivers.

The gateway can be controlled with a terminal program like Realterm,

http://realterm.sourceforge.net/

All the communication with the gateway is in ASCII format.

6 LoRaWAN introduction

The LoRaWAN communication takes place in two directions, up (from mote to gateway) and down (from gateway to mote). The mini gateway can send and receive LoRaWAN messages both ways, as shown in Figure 1.

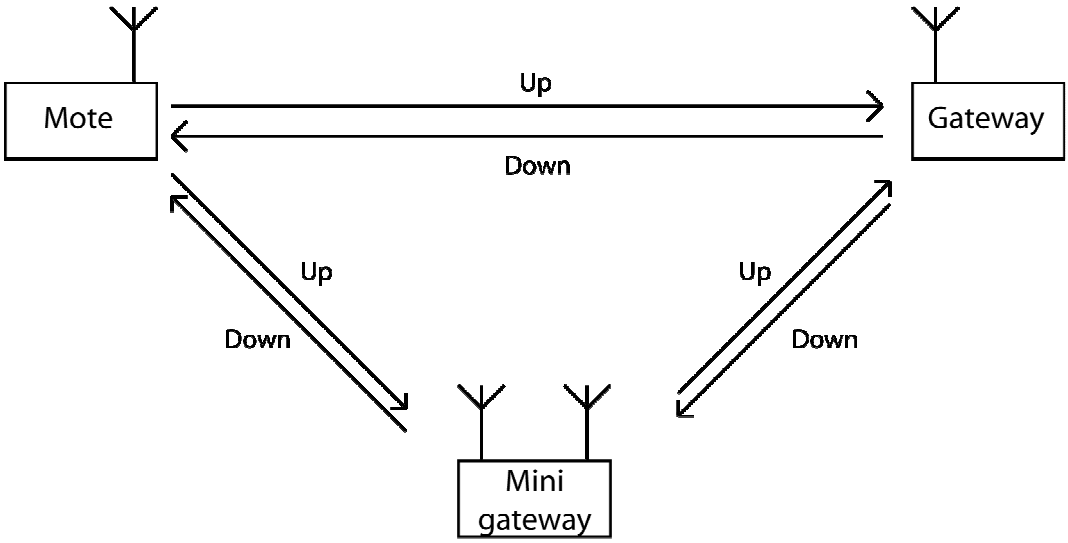

Figure 1: LoRaWAN communication

The commands described in chapter 8, will influence different settings for the LoRaWAN communication.

- The channel and datarate can be set for a direction individually.
- The Network and application key will be used for sent or received messages in both directions.
- The Tx settings influence the sent messages from the mini gateway up or down.
- The device address is used for sending messages and for sending an ACK on an up message from a mote.

7 Operation

The gateway is fitted with two RFM95-868-S2 radio modules. One of the modules will receive messages coming from motes and the other module will listen to messages from the gateway.

Every message the mini gateway receives will be check and will be broken down in the different fields. The mini gateway will send the following information using to serial communication:

Message	**Value**	**Description**
RSSI	00 - FF	Hexadecimal value for the RSSI of the received message.
CRC	OK/NOK	If the CRC of the received radio message is ok.
MAC Header	See Table 5	LoRaWAN MAC header
Sensor	4 bytes in Hex	Device address
Frame counter	2 bytes in Hex	Number of frame
Frame control	00 or 20	LoRaWAN Fctrl field
MIC	OK/NOK	If the MIC calculation of the LoRaWAN package is ok.

Data	Bytes in Hex	Data send from mote or gateway

Table 3: Message information

The MAC Header specifies the message type and the version of the LoRaWAN protocol used.

Bits	7 – 5	4 – 2	1 – 0
Field	Message type	Reserved	LoRaWAN protocol

Table 4: MAC Header fields

The LoRaWAN protocol field will always be 00.
The reserved field bits will always be 0.
The message type filed can have several values, in Table 5 the different values for the MAC header are listed.

MAC Header value Hex	**Message type**
00	Join request
20	Join Accept
40	Unconfirmed data up
60	Unconfirmed data down
80	Confirmed data up
A0	Confirmed data down

Table 5: Message types

The frame control field consists of different bits, the most important is bit 5 containing the ACK. Most of the times the other bits will be 0, so the frame control field can have the following values:

00 – No ACK
20 – ACK

For a full description of the frame control field see the LoRaWAN specification.

8 Commands

This chapter describes the commands that can be used to communicate with the mini gateway using a terminal program. All commands and data is sent as ASCII characters. All data is one or more bytes of hexadecimal numbers represented by 2 ASCII characters. So all data exist of 2 ASCII characters that can be 0 – F. All other characters will be set to 0.

All commands have a set and request operation. The set operation starts with a # and a request operation starts with a ?.

The answer of set operation will start with a * and the answer of a request operation starts with =.

8.1 ADDR – Transmit address

The transmit address is used by the mini gateway for transmitting messages. Also this address is used when ‘send ack’ is switched on, see 8.8.

To set the address, use the #ADDR command. Using command will delete any pending command, and will reset also the transmit frame counter.

To use this command the following needs to be send:

#ADDR[Address]

[Address] = The address of the node in 8 ASCII characters.
The reply of the gateway will be:

*ADDR [Address]

[Address] = The address that is set.

To request the current transmit address that is set use this command:

?ADDR

The reply will be:

=ADDR [Address]

[Address] = The address that is set.

8.2 DRDW – Datarate down

This command is used for the datarate that is used on the down channel of the LoRaWAN communication, see Figure 1.

To set the datarate use:

#DRDW[Datarate]

The [Datarate] can have the following values

Value	Description
00	SF 12 BW 125 kHz
01	SF 11 BW 125 kHz
02	SF10 BW 125 kHz
03	SF9 BW 125 kHz
04	SF8 BW 125 kHz
05	SF7 BW 125 kHz
06	SF7 BW 250 kHz

Table 6: Datarate values

The reply will be:

*DRDW [Datarate Description]

To request the current datarate use:

?DRDW

The reply will be:

=DRDW [Datarate Description]

8.3 DRUP – Datarate up

This command is used for the datarate that is used on the up channel of the LoRaWAN communication, see Figure 1.

To set the datarate use:

#DRUP[Datarate]

The [Datarate] values are listed in Table 6.

The reply will be:

*DRUP [Datarate Description]

To request the current datarate use:

?DRUP

The reply will be:

=DRUP [Datarate Description]

8.4 CHDW – Channel down

This command is used for the channel that is used on the down channel of the LoRaWAN communication, see Figure 1.

To set the channel use:

#CHDW[Channel]

The [Channel] can have the following values

Value	Channel (MHz)
00	868.100
01	868.300
02	868.500
03	867.100
04	867.300
05	867.500
06	867.700
07	867.900
10	869.525

Table 7: Channel values

The reply will be:

*CHDW [Channel Description]

To request the current channel use:

?CHDW

The reply will be:

=CHDW [Channel Description]

8.5 CHUP – Channel up

This command is used for the channel that is used on the up channel of the LoRaWAN communication, see Figure 1.

To set the channel use:

#CHUP[Channel]

The [Channel] can have the values listed in Table 7.

The reply will be:

*CHUP [Channel Description]

To request the current channel use:

?CHUP

The reply will be:

=CHUP [Channel Description]

8.6 APPK – Application key

With this command the application key for the de- and encryption of the payload is set. To set the application key use:

#APPK[Key]

The [Key] consists of 32 ASCII characters representing 16 bytes in hexadecimal notation.

The reply will be:

*APPK[Key]

To request the current key use:

?APPK

The reply will be:

=APPK[Key]

8.7 NWKK – Network key

With this command the network key for the calculation of the MIC. To set the network key use:

#NWKK[Key]

The [Key] consists of 32 ASCII characters representing 16 bytes in hexadecimal notation.

The reply will be:

*APPK[Key]

To request the current key use:

?APPK

The reply will be:

=APPK[Key]

8.8 SACK – Send ACK

The SACK command determines if the ACK bit of the Frame control field is set in messages send from the mini gateway.

Also the gateway will check if an incoming message from a mote has the same address as set with the ADDR command. If the address is a match the mini gateway automatically sends an ACK message.

To change the behaviour use:

#SACK[Value]

Where [Value] is:

Value	Behaviour
00	Don't sent ACK on address match Don't set ACK bit in frame control field
01	Sent ACK on address match Set ACK bit in frame control field

Table 8: SACK behaviour

The response is:

*ACK Yes/No

To request the current behaviour sent:

?SACK

The response is:

=ACK Yes/No

Note: having a mote requesting an ACK and also a working gateway will result in a collision between the ACK message coming from the mini gateway and the gateway. Be sure to disable any gateway in the vicinity of the test to use this function on the mini gateway.

8.9 TXTM – Transmit timing

The transmit timing is only used on messages send in the down direction. That is from mini gateway to mote. Transmit timing needs to be switched on if you want to communicate with type A motes.

Type A motes have a receive slot, 2 seconds after they send a message. To make sure a down message from the mini gateway is sent in the time window transmit timing needs to be switched on.

To switch the transmit timing use:

#TXTM[Value]

Where [Value] is:

00 = Off
01 = On

The reply will be:

*Tx Timing Yes/No

To request the Tx timing use:

?TXTM

The response will be:

=Tx timing Yes/No

8.10 TXCF – Transmit Confirmation

The transmit confirmation sets the LoRaWAN message type that is send. If you sent a confirmed message you request an ACK from either the mote or the gateway, the message is sent to. For more information see chapter 7.

To set the confirmation use:

#TXCF[Value]

Where [Value] is:

00 = Unconfirmed
01 = Confirmed

The response is:

*Tx Confirm Yes/No

To request the current message type sent:

?TXCF

The response is:

=Tx Confirm Yes/No

8.11 TXDI – Transmit direction

The transmit direction determines if the message you want to send is in the Up or Down direction. See Figure 1.

To set the direction use:

#TXDI[Value]

Where [Value] is:

00 = Up
01 = Down

The response is:

*Tx Direction Up/Down

To request the current direction use:

?TXDI

The response is:

=Tx Direction Up/Down

8.12 DATA – Send data

This command is used to send data to the node or gateway with all the settings done with de different commands. This command can be used to send a maximum 51 bytes of data.

The mini gateway will directly send a message except if the transmit direction is down and transmit timing is on.

To use this command send:

#DATA[Data]

[Data] = The data you want to send to the node. This field has a maximum of 102 characters representing 51 bytes.

The reply from the gateway will be:

*DATA[Data]

[Data] = The data that will be send.