LR210 LR260 LORA RELAY

INSTRUCTIONS MANUAL

TABLE OF CONTENTS

INTRODUCTION

This user manual helps you setup and use the LR210 and LR260 LoRa Relay controller, it contains both installation and protocol description for both versions of the product.

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TECHNICAL SUPPORT

If you have problem using this product and can’t find the information in this manual, please contact us at any of the following addresses

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PRODUCT DESCRIPTION

OVERVIEW

Both LR210 and LR260 are DIN-mounted relay controllers allowing independent control of 2 relays channels over a LoRa network. Main difference between the LR210 and LR260 is the power supply side, LR210 is supplied directly from AC mains whereas LR260 is a 8 to 30V DC powered version. Both LR210 and LR260 by default features an always on LoRa Class C receiver for instant response to downlink commands. In addition the LR260 can be configured into a special low power mode where the receiver is setup as a Class A LoRa devices with downlink only available after each uplink data packet. This manual is common for both versions of the product, differences will be highlighted where applicable. Where both products are referenced, the designation “LR2x0” will be used which applies to both LR210 and LR260.

FEATURES

- 2 relay channels, each supporting up to 10A current
- LR210: AC mains powered
- LR260: DC 8-30V powered
- LoRa EU868 version 1.0.2 device
- LoRa Class C receiver
- LR260 in special low power mode: LoRa Class A receiver
- LED status indication for power, LoRa and relay states
- User buttons for manual relay control with manual override functionality (Rev 1.1)
- User button for LoRa activation and reset control
- Each relay channel fully isolated
- Programmable default relay states at power on (Rev 1.1)
- Communication watchdog (Rev 1.1)

Note some features are available starting with production revision 1.1 (revision indicated on external product label), revision 1.1 was introduced in March 2023.

TECHNICAL DATA

RELAY SPECIFICATION (EACH CHANNEL)

- Contact material: Ag-Alloy (Cd free)
- Rated carry current: 10A
- Max switching current: 10A AC
5A DC
- Max switching voltage: 277 VAC
30 VDC
- Contact resistance: 100mΩ max
- Durability: 100 000 operations 5A 30 VDC
25 000 operations 10A 250 VAC
- Isolation voltage: 4000 VAC

LORAWAN

- Frequency: 868MHz (EU868 region)
- Output power: 14dBm
- Antenna: Built-In or SMA RF-connector
- Activation mode: OTAA (Over The Air Activation)

LR210 POWER SUPPLY

- Input voltage range: 85 to 250 VAC
- Input frequency: 47 to 63 Hz
- Input power: 1W (max)
- Isolation voltage: 4000 VAC

LR260 POWER SUPPLY

- Input voltage range: 8 to 30 VDC
over-voltage and reverse polarity protected
- Input power: 1W (max)

ENVIRONMENTAL

- Operating Temperature: -30C to +55C
- Storage Temperature: -40C to +85C
- Altitude: 0 to 2000m
- Operating humidity: max 85% RH (non-condensing)
- Usage: Indoor usage, pollution degree 2

INSTALLATION

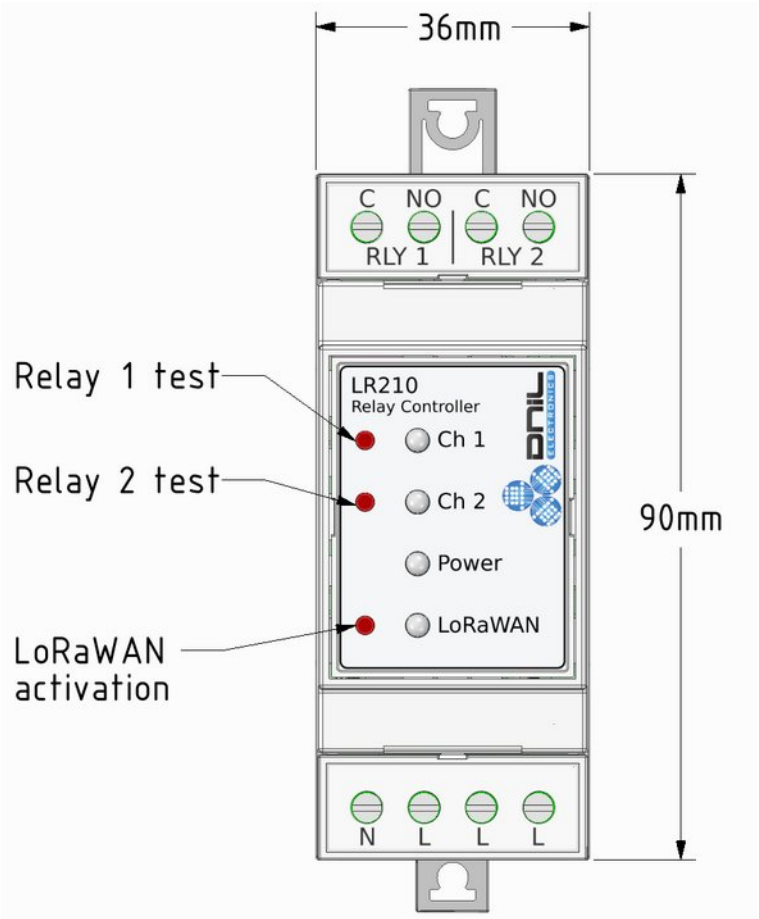
LR2x0 is installed on a standard 35mm DIN-rail using the built-in rail clips, the device is 36mm wide.

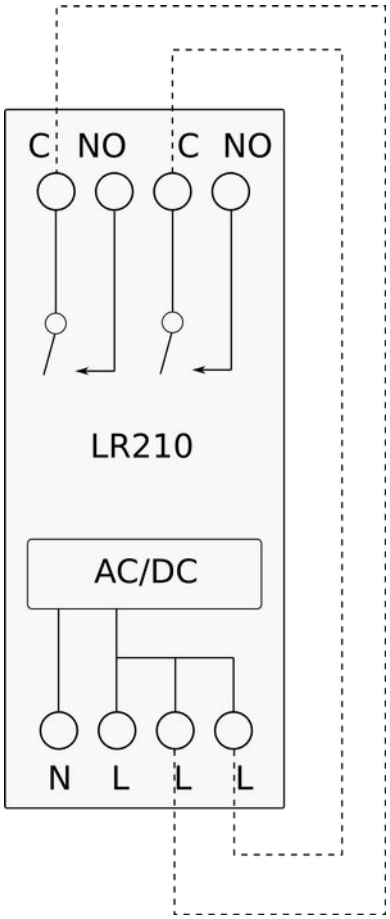
Wires are installed to terminal blocks at the top and bottom of the device, referring to the picture the relay connections are at the top and supply power at the bottom. The terminals each accept 0.05 to 4.0mm² (30-12 AWG) wires.

Each relay is connected using a common (“C”) and a normally open (“NO”) terminal, note that both relay channels are isolated both from each other as well as from the mains supply voltage.

LR210 AC MAINS CONNECTIONS

Supply voltage is connected between the neutral (“N”) and one of the line “L” terminals. There are a total of three line terminals marked ”L” which are all internally connected. The intention is to allow using the line terminals as a connection bar for example to run mains line voltage to either one of the relay terminals. Refer to the following connection diagram showing the internal functions of the LR210 as well as the optional (dashed) connections when the ”L” terminals are used as a connection bar.

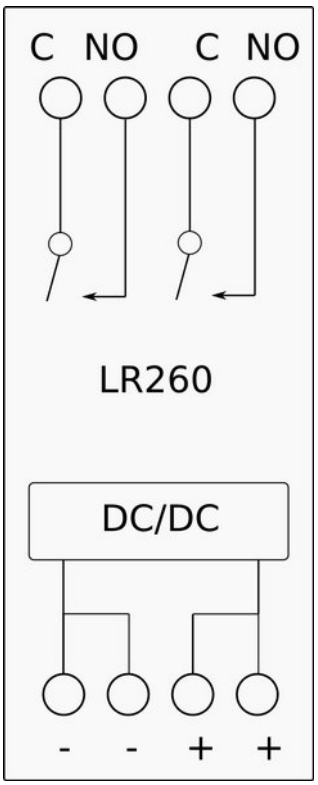




LR260 DC SUPPLY CONNECTIONS

A 8 to 30V DC power supply is connected to the terminals labeled ‘+’ and ‘-’ at the bottom of the DIN enclosure on the LR260. Similar to the LR210 there are dual terminals for both ‘+’ and ‘-’ which are internally connected, please reference picture on the right. The dual terminals are supplied with the intention to be usable as bus bars.

The LR260 is internally equipped with a 0.75A fuse, no additional fuse is required external to the device for protecting the LR260 itself however wiring to the LR260 should be protected. DC input is over-voltage protected capable of handling up to 120V transients, as well as reverse polarity protection.



OPERATION

POWER ON

When mains power is connected to the device the green LED labeled “Power” will be illuminated after 2-3 seconds. This indicates that the device is ready for LoRa activation and for manual relay operation via front panel buttons.

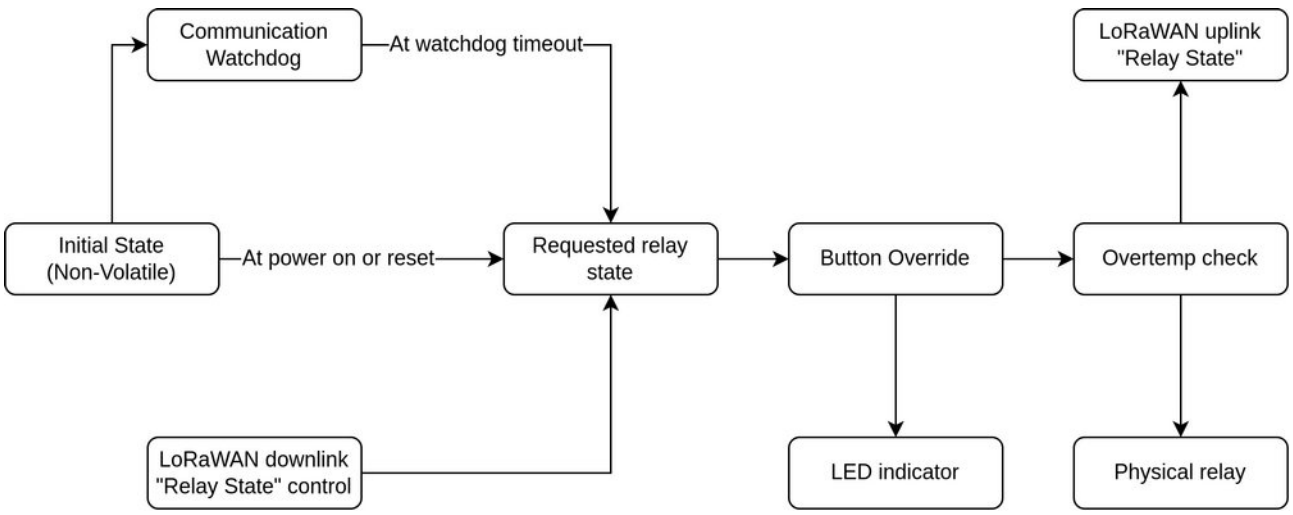
RELAY OPERATION

On the front panel, each relay channel (“Channel 1” and “Channel 2”) has both an yellow LED indicator and a button for manual relay operation. The relay LED is illuminated when the corresponding relay channel is activated (closing the “C” and “NO” terminals). Button functionality is user programmable (via LoRaWAN downlink command), the selected button mode is stored in non-volatile memory in LR2x0 and will be set at each power on. The following 3 modes of operation is available to be selected independently for each relay channel

- Momentary toggle (default) – Inactive relay becomes active and vice versa.
- Disabled – No button functionality
- Manual override – Button toggles relay between “Auto”, “Active” or “Inactive”

When the device is initially powered on (or reset via downlink command) each relay channel is set to a user programmable initial state, this is useful for many applications to handle for example resuming from power outages. The initial state setting is also stored in non-volatile memory inside LR2x0, factory setting is “Inactive state” on both relay channels.

To handle LoRaWAN network server outages the LR2x0 devices also feature a built-in communication watchdog, this feature is optional and disabled by default. The communication watchdog is common for all relay channels and will restore the requested relay states to the initial state when a watchdog timeout occurs, this timeout is programmable between 5 minutes and 52 hours. Watchdog is reset every time a downlink relay state control message is received (index 0x22) or when a downlink message to set the communication watchdog time is received (index 0x27). Watchdog is disabled by programming “0” minutes timeout, setting is stored in non-volatile memory on LR2x0.



Picture above show an overview of the different relay state control functions available for each relay channel. The requested relay state is what the LoRaWAN application normally changes,

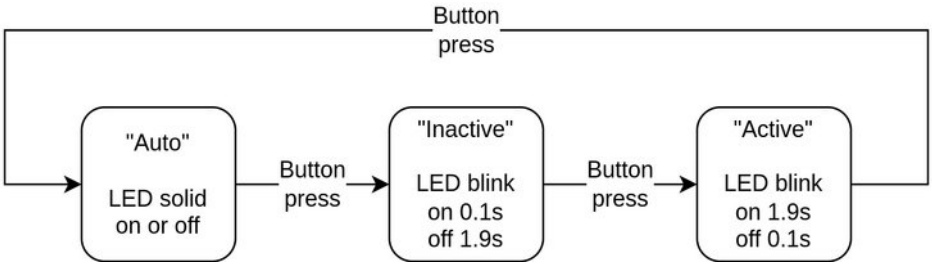
the requested state is set at power on to the programmed initial state. Communication watchdog also restores the requested relay state to the initial state when a communication watchdog timeout occurs. This requested relay state can subsequently be overridden using the front panel button for manual operation, the LED indicates the result after manual override. Regardless of both button and requested relay state the overtemp check always sets the relay to inactive state if LR2x0 is overheated (see separate chapter for details). Relay state reported over LoRaWAN uplink always follows the actual physical relay state, including overtemp check.

Whenever the physical relay state changes an additional LoRaWAN uplink “relay state” message is scheduled.

MANUAL OVERRIDE

Button functionality can be programmed to a “manual override” mode where the relay channel can be permanently set to a state which ignores the state requested via LoRaWAN downlink control. This is intended to handle the relay during for example LoRaWAN network outages where service personnel on site would like to manually control the relay state. To use this mode the user must first program the button functionality to “manual override” (default is “momentary toggle”), this is done via LoRaWAN downlink (see protocol chapter in this manual).

When the button is in manual override mode, the user can request 3 different relay states via a short button press according to the picture below.



In mode “Auto” the relay state follows the state requested via downlink control message, this is the default state after power on or reset of the device. LED will be either solid on or off in auto mode which reflects active versus inactive relay state. Inactive and active modes are indicated via LED blink patterns according to the picture, a relay channel where the LED blinks will thus not follow the requested state via either LoRaWAN downlink control or the initial state restored via the communication watchdog.

The selected mode (“auto”, ”inactive” or ”active”) is not saved in non-volatile memory on the LR2x0, it is restored to “auto” at power on or device reset. To restore a LR2x0 controller remotely which has a manual override mode of either ”inactive” or “active” the device should be reset via LoRaWAN downlink control (see protocol chapter in this manual). For the LoRaWAN application to know which mode is currently selected via the buttons the normal periodic LoRaWAN uplink “relay state” message is extended with another 32-bits once either relay channel has the button programmed for manual override, these bits contains information which out of the 3 modes (“auto”, ”inactive” or ”active”) each relay channel is currently in.

Every time the user press the button to alter the mode an additional LoRaWAN uplink “relay state” is sent to allow LoRaWAN application to know new status without long delays.

OVER-TEMPERATURE DETECTION

LR2x0 is monitoring the internal circuit board temperature to detect abnormal internal device temperatures which can result from relay overloading for example. The temperature threshold

is currently fixed at 60C +/- 5C hysteresis. If the internal circuit board temperature rises above 65C both relay channels will be shut off immediately regardless of what relay state the LoRaWAN server has requested, when the temperature has fallen below 55C the relay channels will be restored to the currently requested state. Any relay state changes requested by the LoRaWAN server during the over-temperature state will be stored internal to the LR2x0 and be used as the requested state when normal temperature condition is restored. When the LR2x0 transitions into or out of over-temperature state and additional uplink is sent (normal periodic data on port 2, see protocol description) where the relay state reflects the actual relay states.

ACTIVATION

The LR2x0 is delivered in a deactivated state where no radio communication in either direction is possible, before LoRaWAN operation is possible to device needs to be activated and successfully joined on a LoRaWAN network. A deactivated state is indicated by the LoRaWAN LED being constantly off.

Ensure that the device is provisioned as a LoRa Class C device on the network server with the correct credentials, each device has a unique activation key which is provided at the time of delivery. The DevEUI is printed on the device label, and is also available in a machine readable data matrix format. For the special LR260 low power mode configuration the device shall be provisioned as a LoRa Class A device.

Press and hold the red button to the left of the LoRaWAN LED for around 3 seconds, then release the button. The green LoRaWAN LED will start blinking which indicates that the LR2x0 is attempting to join the LoRaWAN network, when the join procedure is completed successfully the green LoRaWAN LED will be lit constantly.

DEACTIVATION

If the LR2x0 needs to be returned back to the deactivated state (“factory reset”) for any reason this if performed by pressing and holding the “LoRaWAN” button for more than 10 seconds. The reset is indicated by the yellow “Power” LED being shut off for about 2 seconds, when this occurs the “LoRaWAN” button can be released.

LR260 LOW-POWER MODE

This feature is still under development, please contact support in case this feature is of special interest. The current state of development is a LoRa Class A device which draws around 120uA of current (with relay outputs turned off). Periodic uplinks are sent more frequent (by default at a 5 minutes interval) which allows a max latency of 5 minutes when controlling relay outputs. In addition to sending relay states and internal temperature in the periodic data also the supply voltage is included, periodic data is sent on a dedicated port 3 to separate this periodic data from the normal mode periodic data on port 2. Primary target for this mode is battery powered vehicles such as mobile homes, boats, cabins with solar panels etc.

LORAWAN PROTOCOL

OVERVIEW

In this section, uplink refers to all communication from the LR2x0 device to the network server and downlink to all communication from network server to the device.

The LR2x0 relay controller has a LoRa class C receiver by default, which means that the downlink channel is always available. This is in contrast to many battery powered LoRa devices where the downlink channel is only available in a short window after each uplink.

Downlink communication can be used to perform either a “set command”, “query command” or an “action” on the LR2x0. A “set command” is used to change a setting or state on the LR2x0, for example to change relay channel activation. Using “queries” it is possible to retrieve parameter settings or additional status information from the LR2x0 which will be sent on the uplink channel. “Actions” are used to perform operations such as a device reset. Only one command or action is allowed per downlink, all downlink communication is performed on LoRaWAN port 1.

Uplink communication is divided into two different groups, “protocol data” and “periodic data”. Protocol data is sent from the LR2x0 in response the queries performed using the downlink channel or for certain status messages, protocol data is always sent on LoRaWAN port 1. Periodic data is sent on a schedule and contains the current relay activation status and internal temperature sensor reading on the LR2x0, periodic data is always sent on LoRaWAN port 2.

All data is sent in binary form using network byte order (“big endian” or “most significant byte first”).

DOWNLINK DATA

Table 1 shows the structure of a downlink packet sent to LR2x0, a packet consists of at least 2 bytes of data (packet type and index). Only “set packets” have data bytes after the index byte, data bytes are not present for action and query packets.

Byte 0 **Packet Type**	**Byte 1** **Index**	**Byte 2-5** **Data**
0x01 : Set Packet 0x02 : Query Packet 0x03 : Action Packet	See Table 2 for valid indexes	See Table 2, only present for some indexes

Table 1: Downlink packet

Table 2 shows valid combinations of packet types and index bytes, and also the data encoding for the defined set packets. When valid query packets are received by the LR2x0 a response will be sent on the uplink channel after roughly 10 seconds.

Packet type	**Index**	**Data Bytes**	**Data encoding**
Set Packet	0x22: Relay State	4	32-bit data Bits 31:16 : Relay ctrl mask. Bit 16 : ‘1’ Relay 1 state controlled by bit 0 Bit 16 : ‘0’ Relay 1 state not controlled by

Packet type	Index	Data Bytes	Data encoding
			bit 0 Bit 17 : ‘1’ Relay 2 state controlled by bit 1 Bit 17 : ‘0’ Relay 2 state not controlled by bit 1 Bits 15:0 : Relay state Bit 0 : ‘1’ Relay 1 activated Bit 0 : ‘0’ Relay 1 deactivated Bit 1 : ‘1’ Relay 2 activated Bit 1 : ‘0’ Relay 2 deactivated
Set Packet	0x23: Periodic Interval	2	16-bit unsigned data big endian 1 to 65535 minutes
Set Packet	0x25: Initial state	2	Bits 15:0 : Relay initial state Bit 0 : ‘1’ Relay 1 activated Bit 0 : ‘0’ Relay 1 deactivated Bit 1 : ‘1’ Relay 2 activated Bit 1 : ‘0’ Relay 2 deactivated
Set Packet	0x26: Button functional mode	4	Bits 31:0 : Button functional mode Bit 1:0 : ‘00’ Relay 1 Momentary toggle Bit 1:0 : ‘01’ Relay 1 Disabled Bit 1:0 : ‘10’ Relay 1 Manual override Bit 3:2 : ‘00’ Relay 2 Momentary toggle Bit 3:2 : ‘01’ Relay 2 Disabled Bit 3:2 : ‘10’ Relay 2 Manual override
Set Packet	0x27: Communication watchdog	2	16-bit unsigned data big endian 5 to 3120 minute timeout or 0 to disable
Query Packet	0x03: FW git SHA	None	
Query Packet	0x06: CPU Voltage	None	
Query Packet	0x0A: CPU Temperature	None	
Query Packet	0x20: Status	None	
Query Packet	0x22: Relay State	None	
Query Packet	0x23: Periodic Interval	None	
Query Packet	0x25: Initial state		
Query Packet	0x26: Button functional mode		
Query Packet	0x27: Communication watchdog		
Action Packet	0x05: Device Reset	None	

Table 2: Downlink index and data encoding

Table 3 contains example frames showing valid downlink packets.

Example Packet data	Packet Action
0x01 0x23 0x00 0xB4	Packet type 0x01 (set), index 0x23, data 0x00B4 Set periodic interval to 0x00B3 (180) minutes
0x01 0x22 0x00 0x03 0x00 0x03	Packet type 0x01 (set), index 0x22, data 0x00030003 Set both relay channels to active state

Example Packet data	Packet Action
0x01 0x22 0x00 0x03 0x00 0x00	Packet type 0x01 (set), index 0x22, data 0x00030000 Set both relay channels to deactive state
0x01 0x22 0x00 0x02 0x00 0x02	Packet type 0x01 (set), index 0x22, data 0x00020002 Set relay channel 2 to active state, do not change channel 1
0x01 0x25 0x00 0x03	Packet type 0x01 (set), index 0x25, data 0x0003 Set relay channel 1 and 2 initial state to active
0x01 0x25 0x00 0x02	Packet type 0x01 (set), index 0x25, data 0x0002 Set relay channel 1 initial state to inactive channel 2 to active
0x01 0x26 0x00 0x00 0x00 0x0A	Packet type 0x01 (set), index 0x26, data 0x0000000A Set relay channel 1 and 2 button functional mode to manual override
0x01 0x26 0x00 0x00 0x00 0x05	Packet type 0x01 (set), index 0x26, data 0x00000005 Set relay channel 1 and 2 button functional mode to disabled
0x01 0x26 0x00 0x00 0x00 0x00	Packet type 0x01 (set), index 0x26, data 0x00000000 Set relay channel 1 and 2 button functional mode to momentary toggle
0x01 0x27 0x01 0xE0	Packet type 0x01 (set), index 0x27, data 0x01E0 Set communication watchdog timeout to 480 minutes.
0x01 0x27 0x00 0x00	Packet type 0x01 (set), index 0x27, data 0x0000 Disabled communication watchdog (set 0 minutes)
0x02 0x22	Packet type 0x02 (query), index 0x22 Query current relay state
0x02 0x0A	Packet type 0x02 (query), index 0x0A Query CPU temperature
0x03 0x05	Packet type 0x03 (action), index 0x05 Request LR2x0 device reset

Table 3: Example downlink packets

UPLINK DATA

Table 4 shows the structure of a uplink packet sent by to LR2x0, packet structure is similar to downlink packets with packet type and index bytes followed by data.

Byte 0 Packet Type	Byte 1 Index	Byte 2-3 Data
0x01 : Data Packet 0x02 : NACK Packet	See Table 5	See Table 5

Table 4: Uplink packet

Normally uplinks packets are sent with packet type set to 0x01 (data packet), in case a downlink query was sent with an invalid index the uplink packet type will be set to 0x02 (NACK) and the index byte will be the same invalid index.

Table 5 contains valid index bytes and data encoding for uplink data packets. Only periodic data is sent on LoRaWAN port 2, all protocol data is sent on port 1. For periodic data sent on port 2 the packet type and index byte are omitted.

Index	Data Bytes	LoRa Port	Data encoding
0x03: FW git SHA	6	1	6 ASCII characters showing FW revision
0x06: CPU Voltage	2	1	16-bit unsigned data big endian Supply voltage encoded in mV. Note that LR210 will always respond with 0mV, this function is reserved for the DC powered LR260 version.
0x0A: CPU Temperature	2	1	16-bit unsigned data big endian Temperature (celsius) encoded: (data / 100) – 50.0
0x20: Status	1	1	Bit 0: Watchdog reset occurred Bit 1: LR2x0 startup error occurred
0x22: Relay State	2	1	16-bit data Bits 15:0 : Relay state Bit 0 : ‘1’ Relay 1 activated Bit 0 : ‘0’ Relay 1 deactivated Bit 1 : ‘1’ Relay 2 activated Bit 1 : ‘0’ Relay 2 deactivated
0x23: Periodic Interval	2	1	16-bit unsigned data big endian Periodic interval encoded in minutes
Periodic data, index byte not present	4 or 8	2	32-bit or 64-bit data Bits 15:0: 16-bit relay state data Encoding: Identical to index 0x22 Bits 31:16: 16-bit temperature data big endian Encoding: (data / 10) – 80.0 If any of the relay channels has button functional mode as manual override another 32-bits are added: Bits 63:32 : 32-bit button override mode Bit 33:32: ‘00’ Relay 1 “Auto” mode Bit 33:32: ‘01’ Relay 1 “Inactive” mode Bit 33:32: ‘10’ Relay 1 “Active” mode Bit 33:32: ‘11’ Relay 1 Not in manual override Bit 35:34: ‘00’ Relay 2 “Auto” mode Bit 35:34: ‘01’ Relay 2 “Inactive” mode Bit 35:34: ‘10’ Relay 2 “Active” mode Bit 35:34: ‘11’ Relay 2 Not in manual override Note that 32-bits are appended if either relay 1 or relay 2 has button programmed for manual override. Encoding ‘11’ is then only used for a channel which is not in manual override mode.

Table 5: Uplink index and data encoding

Table 6 contains example uplink frames and data decoding.

Example Packet data	Packet Action
0x00 0x01 0x04 0x4c on port 2	Periodic data 0x0001044c on port 2 Relay 1 activate, Relay 2 inactive. Temperature: (0x44c / 10) – 80.0 = 30.0 Celsius

Example Packet data	Packet Action
0x00 0x00 0x04 0x2e 0x00 0x00 0x00 0x05 on port 2	Periodic data 0x0000042e00000005 on port 2 Relay 1 inactive, Relay 2 inactive. Temperature: (0x42e / 10) – 80.0 = 27.0 Celsius Relay 1 manual override mode “inactive” Relay 2 manual override mode “inactive”
0x00 0x03 0x04 0x2e 0x00 0x00 0x00 0x02 on port 2	Periodic data 0x0003042e00000002 on port 2 Relay 1 active, Relay 2 active. Temperature: (0x42e / 10) – 80.0 = 27.0 Celsius Relay 1 manual override mode “active” Relay 2 manual override mode “auto”
0x01 0x20 0x00 on port 1	Packet type 0x01 (Data), index 0x20 (Status) Status = 0x0, ”no errors”
0x01 0x22 0x00 0x03 on port 1	Packet type 0x01 (Data), index 0x22 (Relay state) Relay 1 activated Relay 2 activated.
0x02 0xAA on port 1	Packet type 0x02 (NACK), index 0xAA LR2x0 was unable to respond to a query on index 0xAA

Table 6: Example downlink packets