Special documentation

Special Documentation for LPWAN communication protocol, model NETRIS®2

EN

EN	Special documentation Model NETRIS®2	Page 3 - 31

Prior to starting any work, read the operating instructions!
Keep for later use!

14699055.02 06/2024 EN

Contents

14699055.02 06/2024 EN

1. General information

1.1 Abbreviations and definitions

LPWAN	Low-power wide-area network, a category of wireless digital data network.
Network	In this document, LPWAN for which a specific radio unit is designed, and configured to communicate with.
Packet	A unit of radio transmission; it can contain LPWAN network management data, as well as zero, one, or several messages following the application protocol described in the present document.
Instrument	Physical object in charge of measuring a physical parameter, with a 4…20 mA analog interface for powering and reading data.
Start-up time	Time it takes for an instrument to deliver an accurate measurement after power is applied to the current loop by the radio unit.
Radio unit	NETRIS®2, physical electronics object in charge of reading values measured by one or two instruments, and also in charge of the LPWAN communications.
Platform	Generic term for the data processing and storage system that will bring meaning to the data sent by a radio unit.
Channel	Each parameter measured by an instrument is associated with a channel. Channels are defined by a channel number, the physical parameter they measure and a physical unit.
Alarm	In this document, “alarm” is used as a generic technical term for condition-based packets sent by the radio unit and do not assume any level of severity.
Process Alarm	Alarm related to the value of measurements on a channel
Technical Alarm	Alarm related to the reliability of the measurements of each channel

1.2 Scope of this document

This technical guide gives a description of the wireless communication protocol used by the NETRIS®2 radio unit connected to one or two 4 … 20 mA analog instrument. It is targeted towards developers who wish to design a protocol interpreter for the product, and for those seeking a comprehensive understanding of the capabilities of this WIKA product.

1.3 Conventions

As a convention, all the traffic that is sent wirelessly from a connected radio unit to the network (via one or several gateways) is called “upstream traffic”, and all the traffic that is sent wirelessly by the network to a radio unit is called “downstream traffic”.

Multi-byte fields are encoded following a “big-endian” convention (“network order”). The order for the transmission of bytes is the same as the left-to-right reading order, and bytes are numbered starting with 0.

Bits are numbered from left-to-right, starting at 7 and ending at 0, with bit 7 representing the most significant bit (MSB). Example:

Bytes	0								1								2…		
Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	…
	MSB							LSB	MSB							LSB	MSB	…	

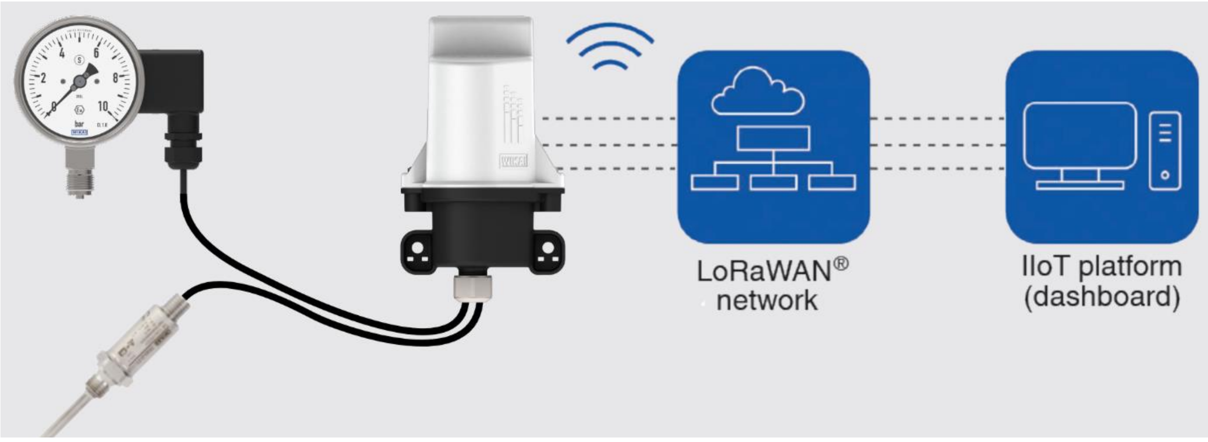
The digits in the document are written in English notation using ‘.’ as decimal separator and ‘,’ as a separator for large numbers. Example: 1,023.42

14699055.02 06/2024 EN

2. Application protocol description

2.1 Purpose

The purpose of the application protocol is to enable the radio unit to communicate with an IIoT platform in order that one or several users are able to use all the features of the product remotely.



The protocol was designed to be compact in order to minimise the energy consumption (for longer battery life) and also use the shared radio spectrum more efficiently to enable more instruments to be connected to a given network.

The translation, in the upstream and downstream directions, between this optimised, binary, context-dependent protocol, and a more versatile high-level protocol chosen by the customer for data processing, storage and display is carried out by a software component called a “protocol interpreter”. This document contains all the information that is needed by a customer to implement the “radio unit application protocol” interpreter.

Here are the key points of the functional model for the application protocol:

- A single radio unit is wirelessly connected to an LPWAN network, and wired to one or two instruments that each have a single data channel measuring a physical value.
- The radio unit “wakes up” at a fixed period (user defined) to take a set of measurement points, one on each enabled data channel sequentially. The instrument or instruments are powered one after the other by the radio unit only during the user-configurable “start-up time” before taking a measurement.
- After that, the measurement or measurements are checked for specific user-defined conditions (process alarms). Should instruments encounter any anomaly, then technical alarms can be generated and transmitted.
- 1 out of every N (user defined) set of measurement points is transmitted to the platform.
- The radio unit and instrument sleep most of the time to save energy; the radio unit can receive one or more user-defined commands to change its configuration at the end of each transmission.

Configuring different periods for measurement and transmission (ie. a transmission multiplier that is not equal to 1) without configuring any process alarms increases energy usage with no practical benefit.

To allow for fine-tuned behaviour, the measurement period and transmission multiplier can be different when the radio unit has no alarm ongoing, and when at least an alarm is ongoing. Both pairs of values are part of the “main configuration” (see sec. 4.3) and the switching is automatic.

2.2 Data channel

For the NETRIS®2, channels are defined as follows:

Channel number	Physical measurement	Note
0	Electrical current	First 4…20 mA channel: measure of the current sank by a compatible instrument connected between Supply1 and Signal1 terminals.
1	Electrical current	Second 4...20 mA channel: measure of the current sank by a compatible instrument connected between Supply2 and Signal2 terminals.

Only the first channel is enabled by default.

2.3 Radio unit measurement encoding

Channel data, i.e. radio unit measurements, are expressed on a generic unitless scale [2,500 … 12,500] (encoded as a 16-bit integer) corresponding to the measurement range of the radio unit. One unit of measurement is equivalent of 0.01 % of the span of the radio unit. Process alarm thresholds are expressed on the same scale.

The conversion between unitless digital data and the real physical value is performed using the following formula:

$$physical\ value = \left(\left(\frac{digital\ value - 2{,}500}{10{,}000}\right) * span\right) + start\ of\ measuring\ range$$

Where the span of a radio unit channel is defined using the following formula:

$$span = end\ of\ measuring\ range - start\ of\ measuring\ range$$

From a protocol standpoint, data is considered valid between 0 and 15,000 (decimal) allowing values of -25 % to 125 % of the radio unit’s measurement range to be encoded.

Please be aware: This does not imply the radio unit is actually capable of covering this extended span.

14699055.02 06/2024 EN

Accuracy outside of the radio unit's measurement range will typically be degraded or unspecified. For both channel 0 and 1, the span is fixed at 16 mA and start of measurement range is fixed at 4 mA.

As an example, for a digital value of 0x1DC3, the data is interpreted as follows:

$$span = (20 \text{ mA}) - (4 \text{ mA}) = 16 \text{ mA}$$
$$digital\ value = 0x1DC7 = 7{,}623$$
$$real\ physical\ value = \left(\left(\frac{7{,}623 - 2{,}500}{10{,}000}\right) * 16\ mA\right) + 4\ mA$$
$$real\ physical\ value = 12.1968\ mA$$

For translating the current measured by the radio unit as a physical value measured by the instrument, the formula supplied by the instrument manufacturer should be used.

2.4 Resolution and accuracy

The resolution of the encoding used for data transmission (expressed in 0.01 % of span) is generic and must not be confused with the resolution and accuracy of the instrument and radio unit.

Refer to the documentation of your instrument and radio unit for technical specifications and information about accuracy, usable range, safety limits, etc.

2.5 Process alarms

Process alarms are a feature of the radio unit: Each time a valid measurement is taken on a data channel, the measured value and slope (defined as: $\text{current measured value} - \text{previous value}$) can be compared to user-defined thresholds. In the event of a value exceeding a threshold, with the configured dead band being taken into account, a message will immediately be transmitted to the network without waiting for the normal transmission period.

14699055.02 06/2024 EN

There are 3 types of process alarms, each in 2 “directions” that can be configured for each data channel. This section gives a description of the 3 types of alarms and corresponding parameters:

Process alarm	Parameters		
	Threshold	**Dead band**[1]	**Delay**
High threshold	Value [2,500 … 12,500] 0.01 % of span	Value [0 … 2,000] 0.01 % of span	n/a
Low threshold			n/a
High threshold with delay			Value [1 … 65,535] in units of 1 s
Low threshold with delay			
Rising slope	Value [0 … 5,000][2] 0.01 % of span/minute	n/a	n/a
Falling slope		n/a	n/a

Slope alarms can only be configured for a maximum of 50% of the radio unit measuring range.

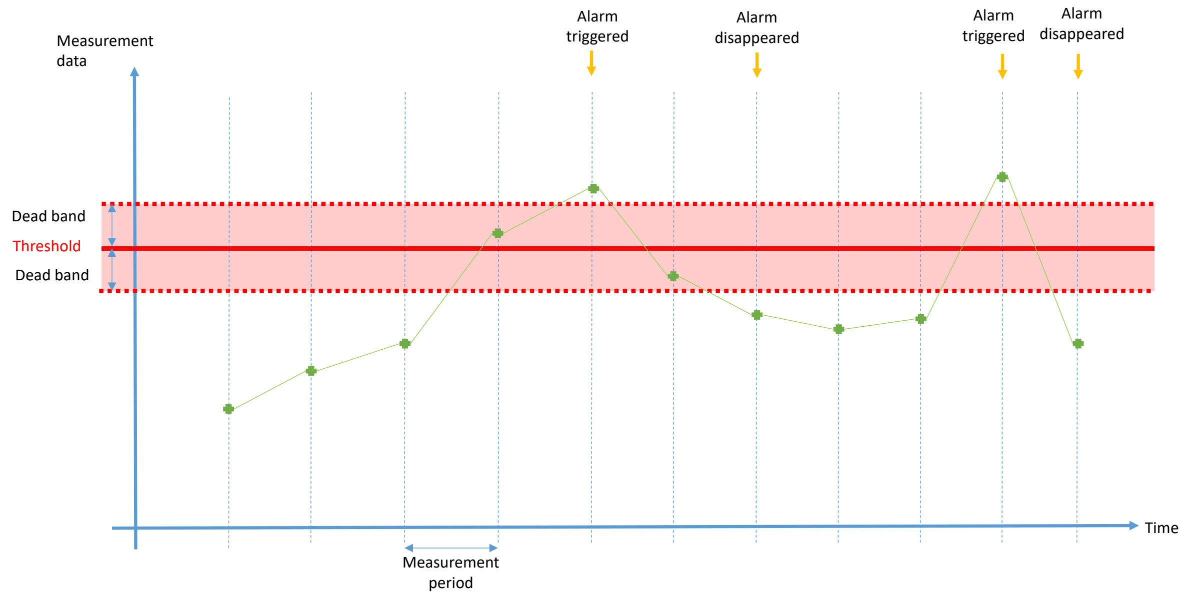
Dead Band setting is limited to maximum of 20% of the radio unit measuring range. An invalid dead band value makes the whole channel process alarm configuration invalid.

As an example, for a high threshold alarm, the alarm appears for a measurement above threshold + dead band and disappears for a measurement below threshold – dead band.

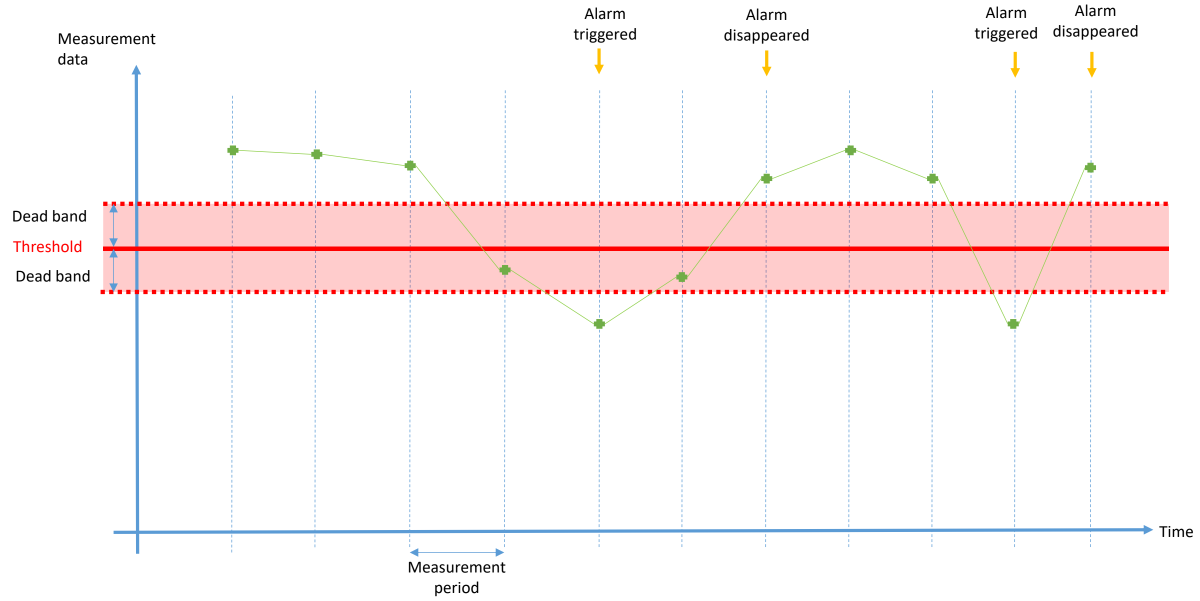
The delay of delayed alarms must be a multiple of both the measurement period without alarm and the measurement period with alarm (see sec. 4.3). A “set process alarm” command that do not respect this constraint will be rejected. After a threshold alarm with delay is set, “a set main configuration” command that do not respect this constraint will be rejected.

[1] Dead band setting is common to all alarms for a given channel
[2] Slope threshold is defined as an absolute value, and the direction defined by the rising/falling alarm

2.5.1 High threshold

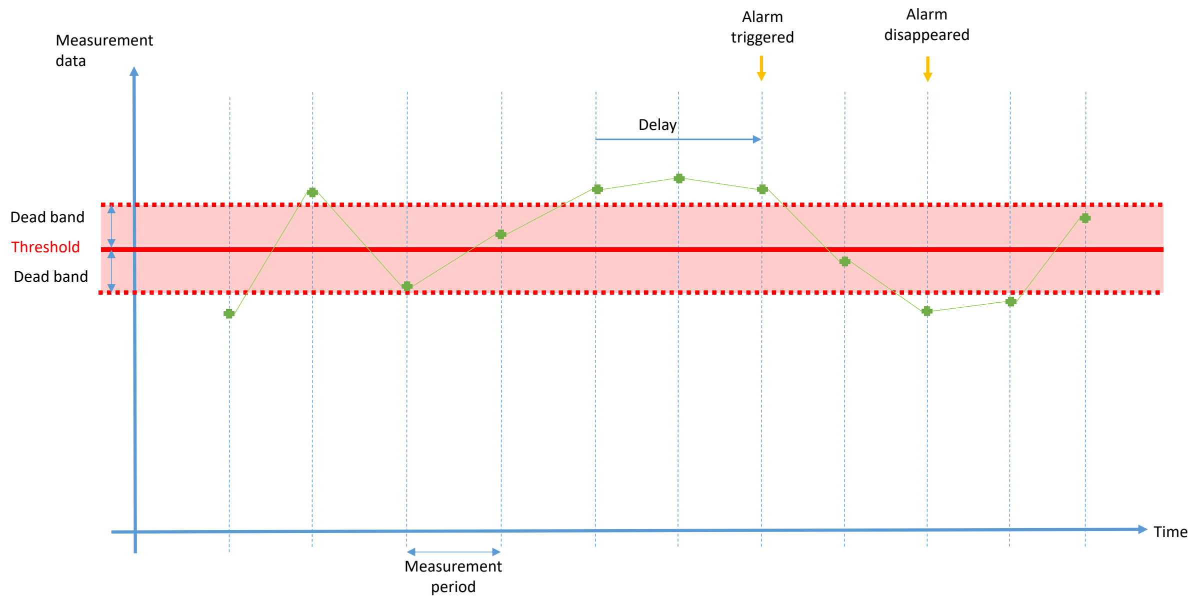


2.5.2 Low threshold

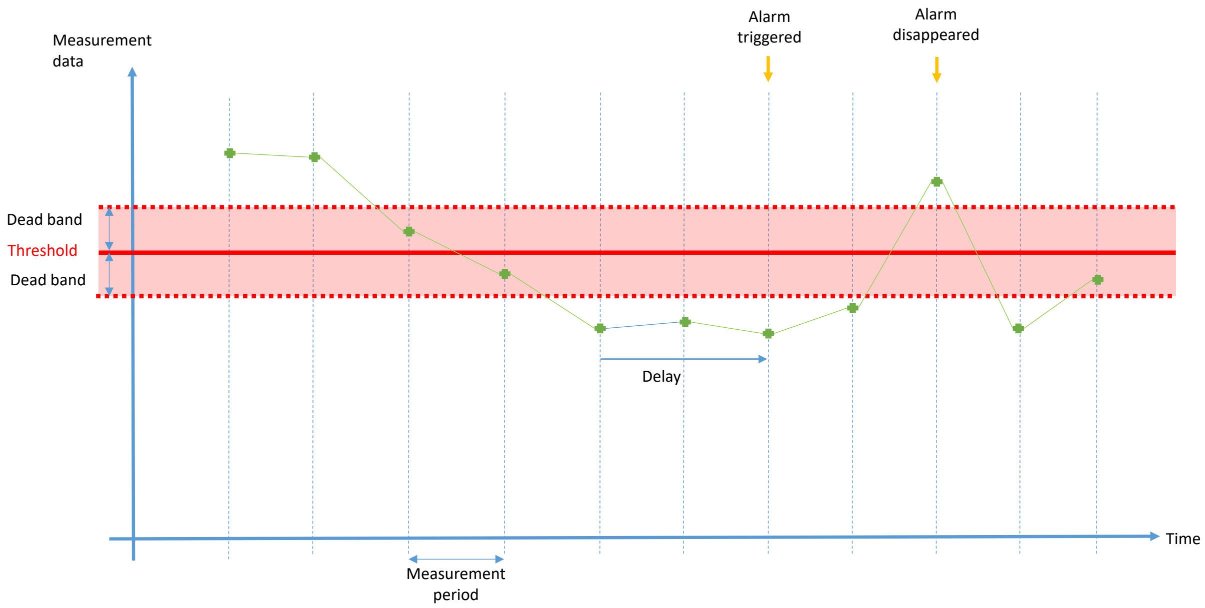


14699055.02 06/2024 EN

2.5.3 High threshold with delay

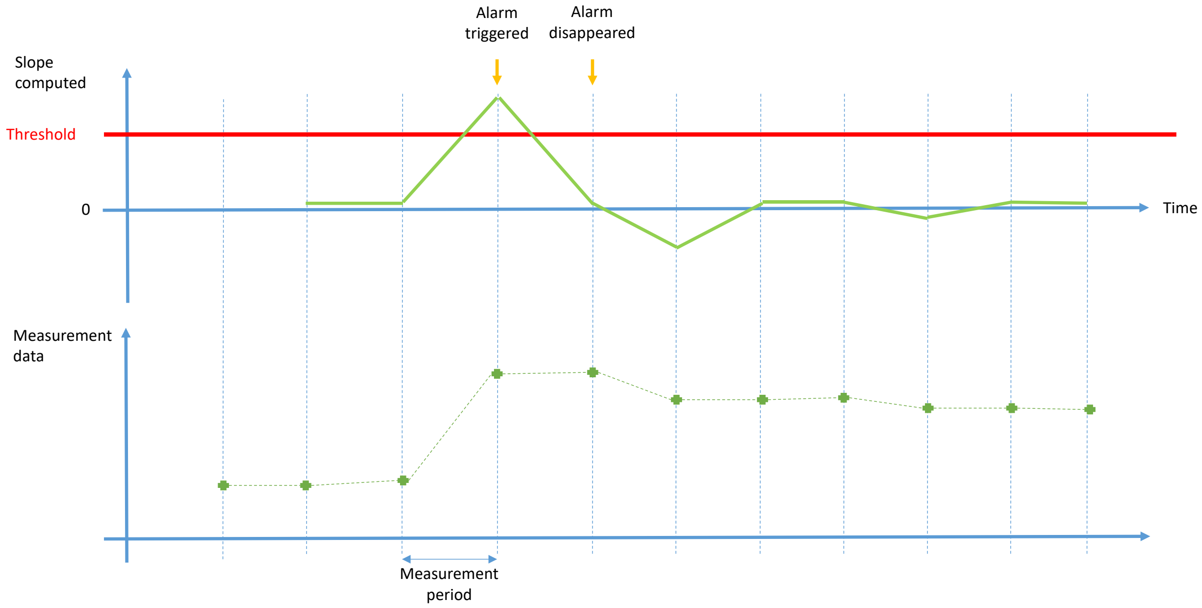


2.5.4 Low threshold with delay

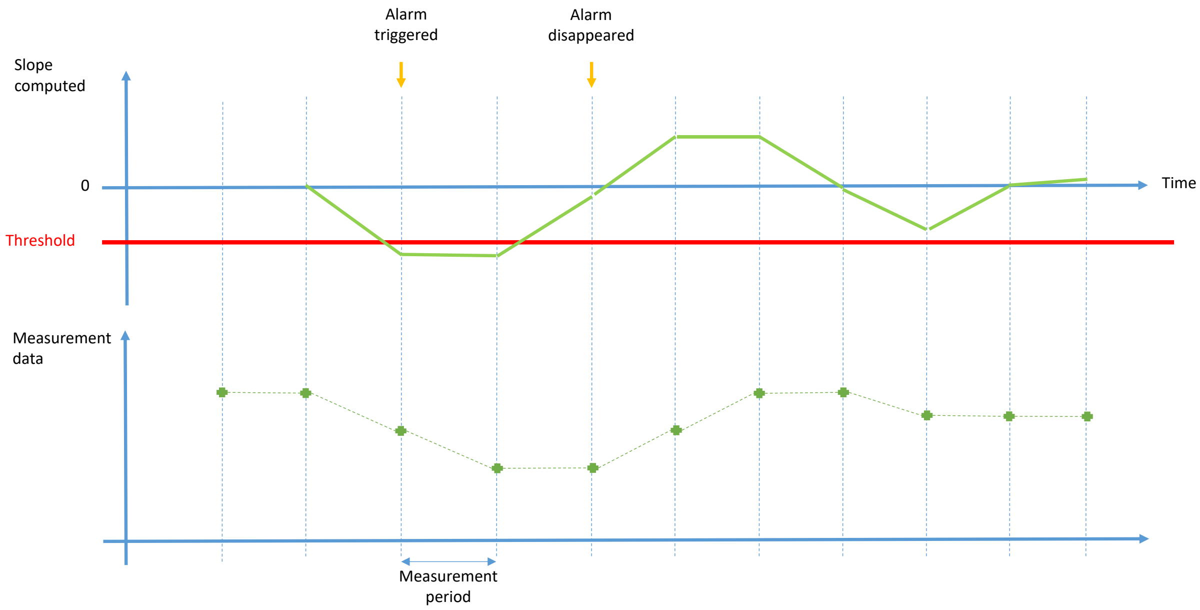


14699055.02 06/2024 EN

2.5.5 Rising slope



2.5.6 Falling slope



2.6 Configuration identifier

A radio unit can be configured remotely by the end user to suit the application, and several parameters can be set such as measurement period, transmission period, alarms, etc.

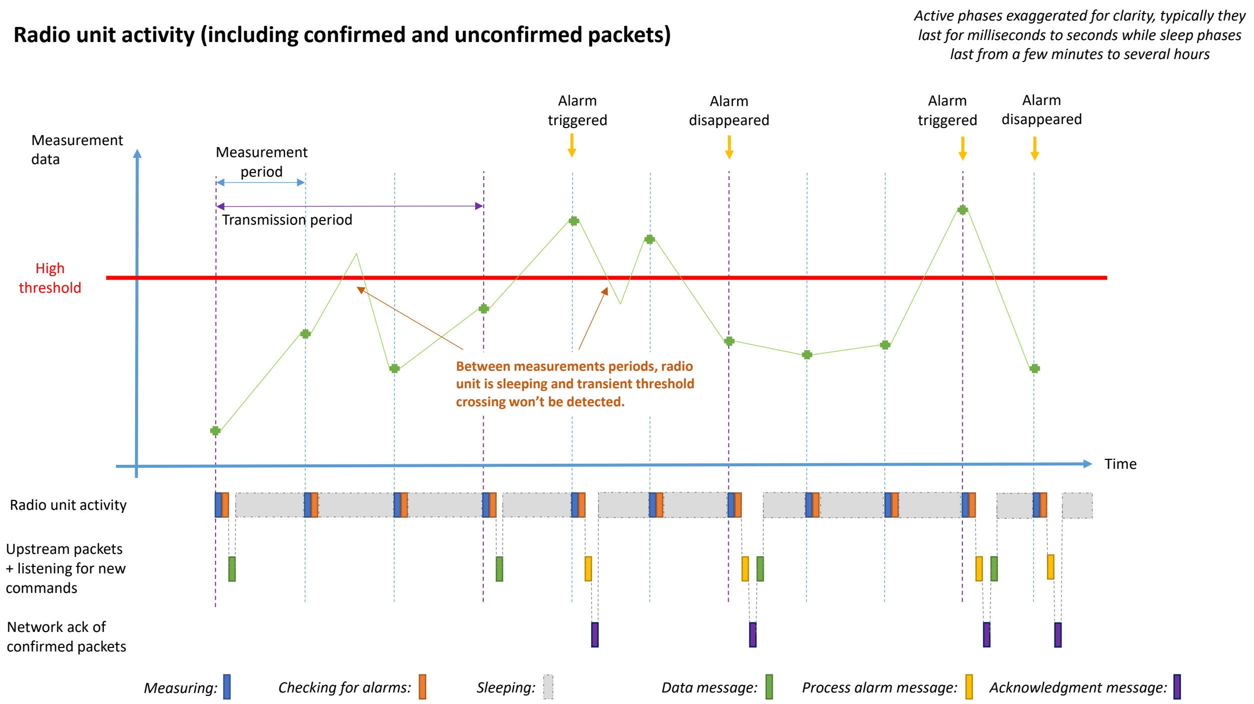
To interpret the meaning of some upstream messages, the IIoT platform needs to know the configuration currently active on the radio unit. This is why all upstream messages include a “configuration identifier” (or “config ID”) and all downstream packets, that can contain several commands changing the radio unit configuration include a “transaction identifier” (“transaction ID”).

When a downstream packet with transaction identifier X results in a change of configuration of the radio unit (configuration successful) then all the following upstream packets will use value X as config ID.

Thus, when sending a new configuration, the platform should pick a value of transaction ID between 1 and 63 that is different from the current radio unit config ID. Using a sequential value is convenient but not mandatory. Value 0 is, by convention, used to indicate the “factory configuration”.

2.7 Typical product behaviour

As a summary, the figure below represents the temporal behaviour of a NETRIS®2 radio unit when a measured value for a data channel is fluctuating and a high threshold process alarm is configured:



It shows that, in practice, a radio unit sleeps most of the time and wakes up only for short moments in order to assess the measured value, check if user-defined alarm conditions are matched or not, and periodically send and receive data from the LPWAN network.

14699055.02 06/2024 EN

3. Upstream messages

3.1 General format

Upstream messages are messages sent wirelessly by the radio unit to the network and interpreted by the IIoT platform. Each upstream LPWAN packet contains a single message as its "payload".

The packet format is as follows:

Byte	Size (bytes)	Note
0	1	Message type, see next table for details
1	1	Current configuration identifier (config ID)*
2…	0 or more	Content of the message, depending on message type

*: for the "configuration status" message (see sec. 3.5), the radio unit uses the transaction ID of the packet it is responding to, instead of the current configuration ID.

The first byte of the message describes its type:

Value (hex)	Upstream message types	Content (bytes)
0x01	Data message with no alarm ongoing	3 to 5
0x02	Data message with at least one alarm ongoing	3 to 5
0x03	Process alarm message	4 to 31
0x04	Technical alarm message	2 to 3
0x06	Configuration status message	1
0x07	Radio unit identification message	22
0x08	Keep alive message	10

3.2 Data message with or without ongoing alarm

The data message contains the latest values measured on data channels.

The message is formatted as follows:

Byte	Size (bytes)	Value	Note
0	1	0x01 or 0x02	In accordance with upstream messages type table
1	1	Config ID	Current configuration identifier
2	1	Channel bit mask	Indicates the presence of a valid data for one, or both, channels: ▪ bit 0 (0x01) is for channel 0, ▪ bit 1 (0x02) is for channel 1
3…	2 or 4	Data (16b)	1 or 2 data fields, depending on sensor mask

The “data” bytes contain the value of each enabled channel, in their order from channel 0 to 1. If only one channel is enabled, the sensor enable mask field will indicate which channel is activated.

In case an error (typically, an ADC error) prevents one channel to be measured, but the other channel has a valid measurement, the sensor mask will only indicate the presence of the data for the valid channel. A technical alarm message will also have been generated.

In case there is no valid data to transmit (eg. ADC error on both channels, or on the only channel enabled), no data message is sent.

3.2.1 Example

Upstream packet payload: 0x01 20 01 1807

Decoding	
01	Data message, no alarm is ongoing
20	Config ID = 32
01	Bit mask indicating the message contains data for channel 0
1807	Channel 0 measurement = 36.51% of span = 9.842 mA

Upstream packet payload: 0x02 00 03 08D3 1F90

Decoding	
02	Data message, at least one alarm is ongoing
00	Config ID = 0 (factory configuration)
03	Bit mask indicating the message contains data for channel 0 and channel 1
08D3	Channel 0 measurement = -2.41% of span = 3.614 mA
1F90	Channel 1 measurement = 55.80% of span = 12.928 mA

3.3 Process alarm message

A process alarm message contains one or more process alarms that have been triggered or disappeared after a measurement. The message is event-based and depends on user configuration.

14699055.02 06/2024 EN

The message is formatted as follows:

Byte	Size (bytes)	Value	Note
0	1	0x03	Process alarm has been triggered and/or disappeared
1	1	Config ID	Current configuration identifier
2	1	0x00	Reserved
3	1	Alarm type	See alarm type table below
4-5	2	Related value	See related value table below
X	1	Alarm type	If there is more than 1 process alarm that has been triggered or disappeared simultaneously
X+1, X+2	2	Related value	

Alarm type byte:

Bit	Description	Value
7	Sense	0: The latest measurement has triggered an alarm 1: The latest measurement has made an alarm disappeared
6-3	Channel ID	0 (0b0000) or 1 (0b0001)
2-0	Alarm type	0: Low threshold 1: High threshold 2: Falling slope 3: Rising slope 4: Low threshold with delay 5: High threshold with delay 6-7: Reserved

Related value (always 2 bytes):

Process alarm type	Value
Low threshold	Triggering/disappearing value: 2,500-12,500 value (0.01 % of span)
High threshold	
Low threshold with delay	
High threshold with delay	
Falling slope	Triggering/disappearing slope, absolute value: 0-10,000 value (0.01 % span/minute)
Rising slope	

Slope related value is clipped at 0 when the alarm disappears and the slope measurement that caused it is negative (rising slope alarm) or positive (falling slope alarm).

3.3.1 Example

Upstream packet payload: 0x03 11 00 00 0D73

Decoding	
03	Process alarm message
11	Config ID = 17

00	Reserved
00	An alarm was triggered on channel 0, of the “low threshold” type
0D73	The measurement on channel 0 that triggered the alarm was at 9.43 % of span

Upstream packet payload: 0x03 0F 00 8B 00D9

Decoding	
03	Process alarm message
0F	Config ID = 15
00	Reserved
8B	Alarm disappeared, on channel 1, of the “rising slope” type
00D9	Slope on channel 1 that made the alarm disappear = +2.17 % of span/minute Had it been a negative slope value that made the alarm disappear (eg. -1.73 % of span/minute), related value would have been clipped to 0.

Upstream packet payload: 0x03 01 00 05 2CA8 09 26B8

Decoding	
03	Process alarm message
01	Config ID = 1
00	Reserved
05	Alarm triggered, channel 0, “high threshold with delay” type
2CA8	Channel 0 measurement that triggered the alarm = 89.32 %
09	Alarm triggered, channel 1, “high threshold” type
26B8	Channel 1 measurement that triggered the alarm = 74.12 %

3.4 Technical alarm message

Technical alarms are related to the quality and reliability of the measurements of each channel. They are always enabled and cannot be configured by the end-user. Technical alarms are not processed for channels that are disabled. On NETRIS®2 they’re used to detect analog sensor failure according to the NAMUR-43 specification.

A technical alarm message is transmitted each time there is a change of technical alarm status.

14699055.02 06/2024 EN

The message is formatted as follows:

Byte	Size (bytes)	Value	Note
0	1	0x04	Technical alarm has been triggered
1	1	Config ID	Current configuration identifier
2	1	Channel bit mask	Indicates technical alarm for one, or both, channels: ▪ bit 0 (0x01) is for channel 0, ▪ bit 1 (0x02) is for channel 1
3	1	Status channel 0 or 1	See table below
4	1	Status channel 1 (opt)	

Technical alarm status interpretation:

Bit	Description	Value
7	Sense	0: on the latest measurement, alarm was triggered 1: on the latest measurement, alarm disappeared
6-3	0b0000	Reserved
2-0	Failure type	0: no technical alarm on that channel 1: open condition (NAMUR, < 3.6 mA) 2: short condition (NAMUR, > 21 mA) 3: saturated low (3.6 mA ≤ Value < 3.8 mA) 4: saturated high (20.5 mA < Value ≤ 21 mA) 5: ADC communication error 6-7: Reserved

For each channel, the definition of failure type are exclusives with one another. In case the failure type of a channel changes, a message indicating the triggering of a new failure type implicitly replace the previous failure type.

E.g. first channel value is read at 3.7 mA, this triggers a “saturated low” technical alarm message. If, after that, the value drops to 3.5 mA, another technical alarm message will signal the triggering of “open condition”, implicitly signalling that “saturated low” has disappeared.

3.4.1 Example

Upstream packet payload: 0x04 00 03 02 01

Decoding	
04	Technical alarm message
00	Config ID = 0
03	Bit mask indicating technical alarms for channel 0 and 1
02	Channel 0 is in “short” condition according to NAMUR definition
01	Channel 1 is in “open” condition according to NAMUR definition

Upstream packet payload: 0x04 06 02 80

Decoding	
04	Technical alarm message
06	Config ID = 6
02	Bit mask indicating a technical alarm for channel 1
80	Previous technical alarm on channel 1 has disappeared

3.5 Configuration status message

The configuration status message is sent by the radio unit after receiving a command or configuration in order to inform the platform whether the message received was valid or not.

The message is formatted as follows:

Byte	Size (bytes)	Value	Note
0	1	0x06	Configuration status
1	1	Transaction ID	Transaction identifier used by the downstream packet of the radio unit is responding to
2	1	Status	0x20: Configuration successful 0x30: Configuration rejected, one or more parameters are incorrect 0x60: Command successful 0x70: Command failed

After a configuration is accepted by the radio unit, the “transaction ID” that was used by the server to send commands to the radio unit becomes the new “configuration ID” used by the radio unit to signal to the server the configuration that is currently used.

3.5.1 Example

Upstream packet payload: 0x06 01 20

Decoding	
06	Configuration status message
01	The command, or configuration this is a response to, had a transaction ID = 1
20	Configuration was accepted, so current configuration ID is now = 1

Upstream packet payload: 0x06 17 30

Decoding	
06	Configuration status message
17	The command, or configuration this is a response to, had a transaction ID = 23
30	Configuration was rejected, current configuration ID will not change

3.6 Radio unit identification message

After attaching to a network, the radio unit transmits a message that contains all the metrology information needed to decode data packets, and some identifying information about the radio unit and instrument.

The message is formatted as follows:

Byte	Size (bytes)	Value	Note
0	1	0x07	Radio unit identification message
1	1	Config ID	Current configuration identifier
2	1	0x0E	WIKA wireless product ID for NETRIS®2 = 14
3	1	Wireless product sub-ID	0: LoRaWAN® version 1-255: Reserved
4-5	2	Radio unit modem firmware version	Version number following the “semantic versioning” convention MAJOR.minor.PATCH = v[0-15].[0-15].[0-255] In hexadecimal format: 0xMmPP
6-7	2	Radio unit modem hardware version	
8-9	2	Radio unit firmware version	
10-11	2	Radio unit hardware version	
12-23	12	Wika Serial Number	Null-terminated ASCII string (11 characters)

3.6.1 Example

Upstream packet payload: 0x07 00 0E 00 0106 0001 1000 0001 31413133375539543036 4B00

Decoding	
07	Radio unit identification message
00	Config ID = 0 (factory configuration)
0E	Device is a NETRIS®2
00	LoRaWAN® version of the NETRIS®2
0106	Modem firmware version = v0.1.6
0001	Modem hardware version = v0.0.1
1000	Radio unit firmware version = v1.0.0
0001	Radio unit hardware version = v0.0.1
314131333755395430364B00	Wika Serial number = “1A137U9T06K”

3.7 Keep-alive message

The keep-alive frame is transmitted periodically every 24 hours. This setting is not adjustable. This guarantees that the radio unit will be reachable at least once a day no matter what the configuration is.

The message is formatted as follows:

Byte	Size (bytes)	Value	Note
0	1	0x08	Keep-alive message
1	1	Config ID	Current configuration identifier
2-5	4	Number of measurements	Unsigned 32b integer, sum of measurements on channel 0 and 1.
6-9	4	Number of transmissions	Unsigned 32b integer.
10	1	Battery level indicator	Bit 7: 0: no new event 1: new event; the battery level has been reset since last keep alive transmission Bits 6..0: current estimated battery level in per cent (unsigned, from 0 to 100). 0x7F is returned if an error occurred during battery capacity computing.
11	1	Temperature level indicator	Signed 8 bit integer [°C], this indicative value should only be used for condition monitoring of the radio unit itself.

3.7.1 Example

Upstream packet payload: 0x08 0C 00000013 00000020 63 1A

Decoding	
08	Keep-alive message
0C	Config ID = 12
00000013	Measurement counter = 19
00000020	Transmission counter = 32
63	No new event, battery is at 99%
1A	Indicative radio unit internal temperature is 26°C approximately

4. Downstream messages

4.1 General format

Downstream packets are sent by the IIoT platform to the radio unit via the network in “store and forward” mode: they are scheduled in advance by the platform, stored in the LPWAN central server, and are transmitted to the radio unit just after it sends an upstream packet. They are then interpreted by the radio unit, which is expected to send a “configuration status” response (see section 3.5). This applicative “status” response may also contain a LoRaWAN® acknowledgement if one was asked by the LPWAN server.

Downstream packets are identified using a transaction ID and can contain several commands.

A radio unit configuration is split in 3 parts:

- Main configuration of the radio unit, related to timing,
- Alarm configuration for each channel
- Configuration of start-up times, setting the time instrument supply voltage is applied to each channel sequentially before current is measured.

Configuration can also be reset to factory values.

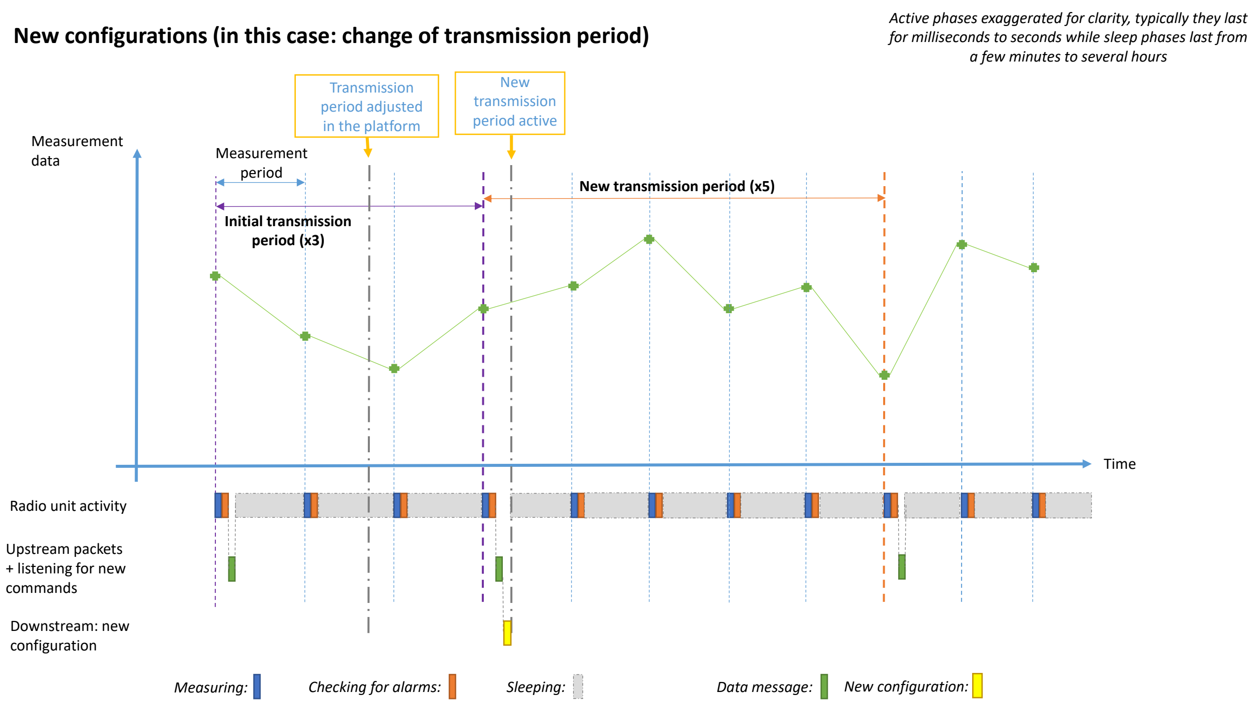
The packet format is as follows:

Byte	Size (bytes)	Note
0	1	Transaction identifier (see sec. 2.6)
1	1	For command type, see next table
2, n+1	n (can be 0)	Command options (size depends on the command type)
n+2	1	Additional commands can be concatenated, one after another.
n+3…	m	

The first byte of the command describes its type:

Value (hex)	Upstream command types	Option size (bytes)
0x01	Reset to factory configuration	0
0x02	Set main configuration	12
0x05	Reset battery indicator	0
0x11	Disable channel	1
0x20	Set process alarm	5 to 21
0x30	Set channel property	3 to 5
0x60	Set instrument start-up time	5

14699055.02 06/2024 EN



4.2 Reset to factory configuration command

This command will force the radio unit to return to the factory configuration that is defined in the table below. It must not be sent with other commands in the same packet.

The command is formatted as follows:

Byte	Size (bytes)	Value	Note
0	1	0x01	Reset to factory configuration command

The radio unit factory configuration is:

Parameter	"Factory" configuration
Measurement period, no alarm active	7200 seconds (2 hours)
Transmission multiplier, no alarm active	1x (2 hours)
Measurement period, ≥1 alarm active	7200 seconds (2 hours)
Transmission multiplier, ≥1 alarm active	1x (2 hours)
Data channel(s)	Channel 0 enabled, 1 disabled
Process alarms, for each data channel	All disabled
Offset, for each data channel	0
Instrument start-up time	3 seconds for channel 0 and 1

4.2.1 Example

Downstream packet payload: 0x00 01

Decoding	
00	Transaction ID = 0
01	Reset to factory configuration command

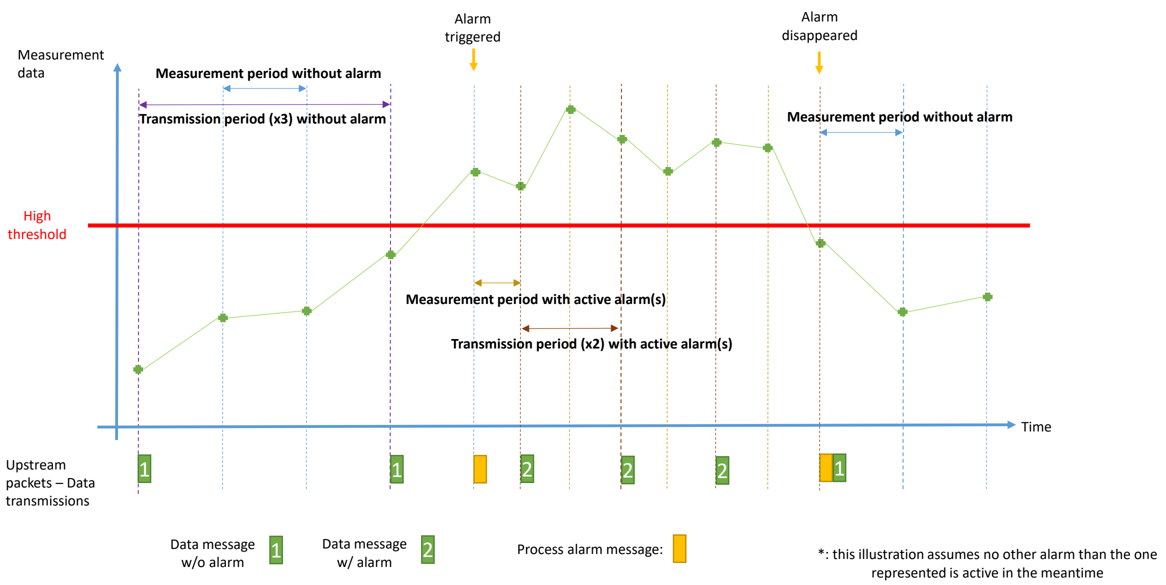
4.3 Set main configuration command

The main configuration of a radio unit defines how often it wakes up to take a measurement, and what ratio of the measurements shall be transmitted to the platform as data messages.

The command is formatted as follows:

Byte	Size (bytes)	Value	Note
0	1	0x02	Set main configuration command
1-4	4	Measurement period when no alarm is active	Period in seconds Min. value = 60 s; max. value = 86,400 s (1 day)
5-6	2	Transmission multiplier when no alarm is active	Min. value = 1; max value = 2,880 Transmission period = measurement period * transmission multiplier ≤ 172,800 s max. (2 days)
7-10	4	Measurement period when ≥1 alarm is active	Same unit, and min./max. values as above
11-12	2	Transmission multiplier when ≥1 alarm is active	

Measurement and transmission periods (different setting when at least one alarm is active or not)*



4.3.1 Example

Downstream packet payload: 0x12 02 00000E10 0002 00000258 000C

Decoding	
12	Transaction ID = 18
02	Set main configuration command
00000E10	3,600 seconds, measurement every hour when no alarm is active
0002	x2, transmission every 2 hours (2 * 3,600 s) when no alarm is active
00000258	600 seconds, measurement every 10 minutes when one or more alarm is active
000C	x12, transmission every 2 hours (12 * 600 s) when one or more alarm is active

4.4 Reset battery indicator command

This command allows to reset the battery indicator that is present in the keep-alive frames to track the energy consumed by the radio unit. It also resets the "number of measurements" and "number of transmissions" counters.

The command is formatted as follows:

Byte	Size (bytes)	Value	Note
0	1	0x05	Reset battery indicator

4.4.1 Example

Downstream packet payload: 0x19 05

Decoding	
19	Transaction ID = 25
05	Reset battery indicator command

4.5 Disable channel command

This command will disable a given data channel. This channel will no longer generate measurement data, nor any process or technical alarm.

The command is formatted as follows:

Byte	Size (bytes)	Value	Note
0	1	0x11	Disable channel command
2	1	Channel bit mask	Channel or channels to disable: ▪ bit 0 (0x01) is for channel 0, ▪ bit 1 (0x02) is for channel 1

To reactivate a channel, send a process alarm configuration command to that channel. This command can possibly be "empty", with all alarm enabling bits set to 0.

4.5.1 Example

Downstream packet payload: 0x0B 11 02

Decoding	
0B	Transaction ID = 11
11	Disable channel command
02	Disable channel 1

Downstream packet payload: 0x06 11 01 20 00 01 0032 00

Decoding	
06	Transaction ID = 6
11	Disable channel command
01	Disable channel 0
20	Set process alarm command (see section 4.6)
00	Reserved
01	Set alarms for channel 1
0032	Dead band of 0.5 % of span; only a valid value is needed as there are no alarms
00	All flags to 0, do not configure any process alarm

This downlink contains two commands, disabling channel 0 and enabling channel 1 in a single transaction.

4.6 Set process alarm command

This command will activate the channel (measure and alarm). Existing process alarm configuration on this channel is totally replaced by the new configuration. Parameters for alarms (byte 6 and more) must be present only if the corresponding alarm is enabled.

The command is formatted as follows:

Byte	Size (bytes)	Bit	Value	Note
0	1		0x20	Set process alarm command
1	1		0x00	Reserved
2	1		Channel ID = 0 or 1	Channel for which alarms shall be configured
3-4	2		Dead band, common to all non-slope alarms	In 0.01 % of span; common to all non-slope alarms; can be zero.
5	1	*7*	Alarm 1: Low threshold	For each alarm, the bit value means: 0: disabled 1: enabled
		6	Alarm 2: High threshold	
		5	Alarm 3: Falling slope	
		4	Alarm 4: Rising slope	
		3	Alarm 5: Low threshold with delay	
		2	Alarm 6: High threshold with delay	
		1-0	0	Reserved
6…	2		Threshold value for alarm 1	Included only if alarm 1 is enabled
	2		Threshold value for alarm 2	Included only if alarm 2 is enabled
	2		Slope value for alarm 3	Included only if alarm 3 is enabled
	2		Slope value for alarm 4	Included only if alarm 4 is enabled
	2		Threshold value for alarm 5	Included only if alarm 5 is enabled
	2		Delay value for alarm 5	Included only if alarm 5 is enabled
	2		Threshold value for alarm 6	Included only if alarm 6 is enabled
	2		Delay value for alarm 6	Included only if alarm 6 is enabled

See table in sec. 2.5 for the definition of threshold, slope and delay.

The slope value parameter is always positive but is interpreted differently for rising and falling slopes. For a rising slope, the alarm will be triggered if the value rises quicker than the value. For a falling slope, the alarm will be triggered if the value falls quicker than the value.

Slope value is set in 0.01% of full range per minute. For example, if measurement period is 1 hour, and two consecutive values have changed by -5.3% of span, the slope is -0.09 of span per minute. A falling slope alarm defined with a setting of 0x0000 (-0% span/min) to 0x0009 (-0.09% span/min) would trigger, an alarm defined with a setting of 0x000A (-0.1% span/min) and above would not.

The delay of delayed alarms must be a multiple of both the measurement period without alarm and the measurement period with alarm.

14699055.02 06/2024 EN

4.6.1 Example

Downstream packet payload: 0x18 20 00 00 0032 80 12FA

Decoding	
18	Transaction ID = 24
20	Set process alarms command
00	Reserved
00	Process alarms for channel 0
0032	Dead band = 50 => 0.5 % of span
80	Alarm mask: low threshold enabled; others disabled
12FA	Threshold = 4858 => 23.58 % of span; alarm will trigger for a measurement below 23.58 – 0.5 = 23.08 % of span and disappear for a measurement above 24.08% of span.

Downstream packet payload: 0x0F 20 00 01 0032 08 1964 0708 20 00 00 0000 70 2EE0 02D0 0064

Decoding	
0F	Transaction ID = 15
20	Set process alarms command
00	Reserved
01	Process alarms for channel 1
0032	Dead band = 50 => 0.5 % of span
08	Alarm mask: low threshold with delay enabled; others disabled
1964	Threshold = 6,500 => 40 % of instrument span
0708	Triggering is delayed by 30 minutes after threshold is crossed
20	Set process alarms command
00	Reserved
00	Process alarms for channel 0
0000	Dead band = 0 => no hysteresis (fine if measurement period >> process dynamic)
70	Alarm mask: high threshold + rising slope + falling slope alarms
2EE0	High threshold = 12,000 => 95 % of span
02D0	Falling slope = 720 => triggers if slope < -7.2 % of span/min.
0064	Raising slope = 100 => triggers if slope > +1 % of span/min.

14699055.02 06/2024 EN

4.7 Set channel property command

For NETRIS®2, this command is used to set the offset of each channel.

The command is formatted as follows:

Byte	Size (bytes)	Value	Note
0	1	0x30	Set channel property command
1	1	Channel bit mask	Channel or channels to configure: ▪ bit 0 (0x01) is for channel 0, ▪ bit 1 (0x02) is for channel 1
2-3	2	Offset channel 0 or 1	16 bit signed value in 0.01 % of span
4..	2	Offset channel 1 (optional)	

The offset is a value (in 0.01 % of the radio unit's span) that is added to a measured value before evaluating process alarms or transmitting a measurement data. Each time this command is used, the previously configured offset is replaced by the new value; this command is not accumulative.

It allows for user-defined, application-specific correction of measured values. The default offset is 0. Offset can be positive or negative, negative values uses two's complement coding ("int16" C encoding). The maximum value for offset is limited to +/-5% of span: [0xFE0C; 0x01F4]

4.7.1 Example

Downstream packet payload: 0x04 30 03 FFE9 0000

Decoding	
04	Transaction ID = 4
30	Set channel property command
03	Mask, set offset for channel 0 and channel 1
FFE9	Set channel 0 offset to -0.23% of span (equivalent to subtracting 36.8 µA from measurements)
0000	Set channel 1 offset to 0

4.8 Set instrument start-up time command

The NETRIS®2 radio unit is battery powered and supplying the instrument(s) only a short "start-up" time before taking a measurement. Because various sensors need various start-up time to output a stable and accurate value, this value can be configured independently for each channel.

14699055.02 06/2024 EN

The command is formatted as follows:

Byte	Size (bytes)	Value	Note
0	1	0x60	Set channel start-up time command
1	1	Channel bit mask	Channel or channels to configure: ▪ bit 0 (0x01) is for channel 0, ▪ bit 1 (0x02) is for channel 1
2-3	2	Time for channel 0 or 1	Start-up time in multiple of 100 milliseconds Min. value = 100 ms; max. value = 15 s
4..	2	Time for channel 1 (optional)	

4.8.1 Example

Downstream packet payload: 0x01 60 03 0028 0001

Decoding	
01	Transaction ID = 1
60	Set channel start-up time command
03	Contains settings for channel 0 and channel 1
0028	Channel 0 start-up time = 40 = 4 seconds
0001	Channel 1 start-up time = 1 = 100 ms

5. Connectivity protocol: LoRaWAN®

5.1 Radio unit network integration

NETRIS®2 is a “class A” battery-powered LoRaWAN® radio end-device using version 1.0.3 of the protocol.

NETRIS®2 uses the OTAA “over–the-air activation” LoRaWAN® procedure. Each radio unit comes configured at the factory with a securely generated random 128-bit secret key. Knowledge of this key is required to enable a network to communicate with the radio unit. Refer to the network service provider for further details on how to integrate your device. In case you are using a network server provided by WIKA, your device is already pre-attached.

5.2 Join procedure

At power-up, the module will start a LoRaWAN® join sequence: 1 try and 1 retry (3 to 4 minutes later) if the first try didn’t succeed. If a LoRaWAN® network is in radio range and has the key of this radio unit, the radio unit will join this network. If joining fails, the radio unit will go to sleep then launches a new join sequence (2 packets with ~3 min in-between). The sleep duration between two join sequences will be defined as:

- 10 to 15 min, the first time,
- 55 to 60 min, the second time,
- 8h00 to 8h05, the following times, until join success or power is cycled.

After joining, the radio unit will send at least 2 messages with no delay between them:

- One radio unit identification message
- Optionally alarm messages if there are some alarm conditions triggered
- One data message

The configuration for measurement and transmission period will then apply.

5.3 Classes of traffic

All upstream traffic generated by the radio unit is sent on LoRaWAN® port 1.

The radio unit will process data downstream traffic sent on any port except the ones reserved for special LoRaWAN® proposes (port 0, and 224 to 255).

The following upstream messages are sent as “confirmed” LoRaWAN® packets:

- Process and technical alarms
- Radio unit identification
- Keep alive

14699055.02 06/2024 EN

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