Special Documentation, LoRaWAN® communication protocol for model GD-20-W

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Contents

Prior to starting any work, read the operating instructions!

Keep for later use!

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Firmware version history

The firmware version of the device is transferred to the IIoT platform via LPWAN with the “Identification message”.

Firmware version	Initial release / Modifications
Starting from firmware version 1.0.7	Initial release

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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 connected device 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.
Platform	Generic term for the data processing and storage system that will bring meaning to the data sent by a connected device.
Channel	Each parameter measured by a connected device is associated with a channel. Channels are defined by a channel number call Channel ID, 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 connected device and do not assume any level of severity.
Process Alarm	User-defined alarm related to the value measured on a channel
Technical Alarm	Alarm related to the reliability of measurements of each channel
Device Alarm	Alarm related to the system health in general

1.2 Scope of this document

This technical guide gives a description of the wireless communication protocol used by the GD-20-W. It is targeted towards developers who wish to design a protocol interpreter for the product, and users that want to get a deeper understanding of the capabilities of this WIKA product.

1.3 Conventions

As a convention, all the traffic that is sent wirelessly from a connected device 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 connected device 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.

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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	…
Value	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	2^7	2^6	…

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

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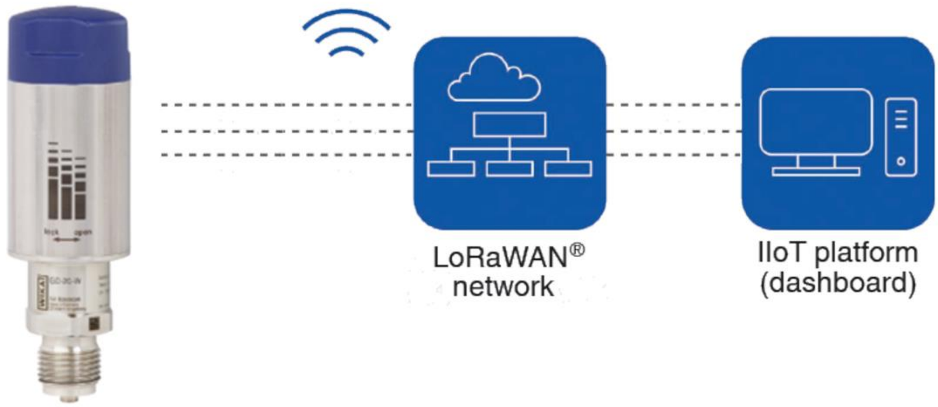
2. Application protocol description

2.1 Purpose

The purpose of the application protocol is to enable the connected device 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 minimize the energy consumption (for longer battery life) and also use the shared radio spectrum more efficiently to enable more devices to be connected to a given network.

The translation, in the upstream and downstream directions, between this optimized, 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 “connected device application protocol” interpreter.

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

- A single connected device is connected to an LPWAN network, and has one or more data channel(s), each measuring a physical value.
- The connected device “wakes up” at a fixed period (user defined) to take a set of measurement points, one on each enabled data channel, more or less at the same time. After that, all channels are checked for specific user-defined conditions (process alarms). Should the connected device encounter any anomaly, technical or device alarms can be generated and transmitted.
- One out of every N (user defined) set of measurement points is transmitted to the platform.
- The connected device sleeps most of the time to save power; it can receive one or more user-defined commands to change its configuration at the end of each transmission.

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Configuring different periods for measurement and transmission (i.e. 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 behavior, the measurement period and transmission multiplier can be different when the connected device has no alarm ongoing, and when at least an alarm is ongoing. Both pairs of values are part of the “main configuration” and the switching is automatic.

2.2 Data channels

For the GD-20-W, up to 6 channels can be enabled starting from channel 0 to channel 5. Information of the physical measurement can be retrieved into device identification message and extended identification message.

2.3 Measurement encoding

Channel data, i.e. connected device 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 connected device. One unit of measurement is equivalent of 0.01 % of the span of the connected device. 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 connected device 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 connected device ’s measurement range to be encoded.

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

Accuracy outside of the connected device’s measurement range will typically be degraded or unspecified.

For GD-20-W, the span and start of measurement range for channels are variable. Starting and ending value can be retrieved from the extended device identification message.

As an example, for a temperature range of -40 … 80 °C and a digital value of 0x2DD2, the data is interpreted as follows:

$$span = (80\ °C) - (-40\ °C) = 120\ °C$$
$$digital\ value = 0x2DD2 = 11{,}730$$

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$$physical\ value = \left(\left(\frac{11{,}730 - 2{,}500}{10{,}000}\right) * 120\ °C\right) + (-40\ °C)$$

$$physical\ value = 70.76\ °\mathrm{C}$$

The following table gives more examples of data interpretation:

Device measurement range	16-bit data value (or alarm threshold)			
	0x09C4 = 2,500 decimal	0x30D4 = 12,500 decimal	0x099E = 2,462 decimal (2,462 – 2,500) * 0.01 % = -0.38 % of span	0x2DD2 = 11,730 decimal (11,730 – 2,500) * 0.01 % = 92.30 % of span
-40 … 80 °C temperature	min => -40 °C	max => 80 °C	(-0.38 % * span) + min. = -40.47 °C	(92.3 % * span) + min. = 70.76 °C
0 … 8 bar pressure	min => 0 bar	max => 8 bar	(-0.38 % * span) + min. = -0.0304bar	(92.3 % * span) + min. = 7.384 bar

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 connected device.

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

2.5 Process alarms

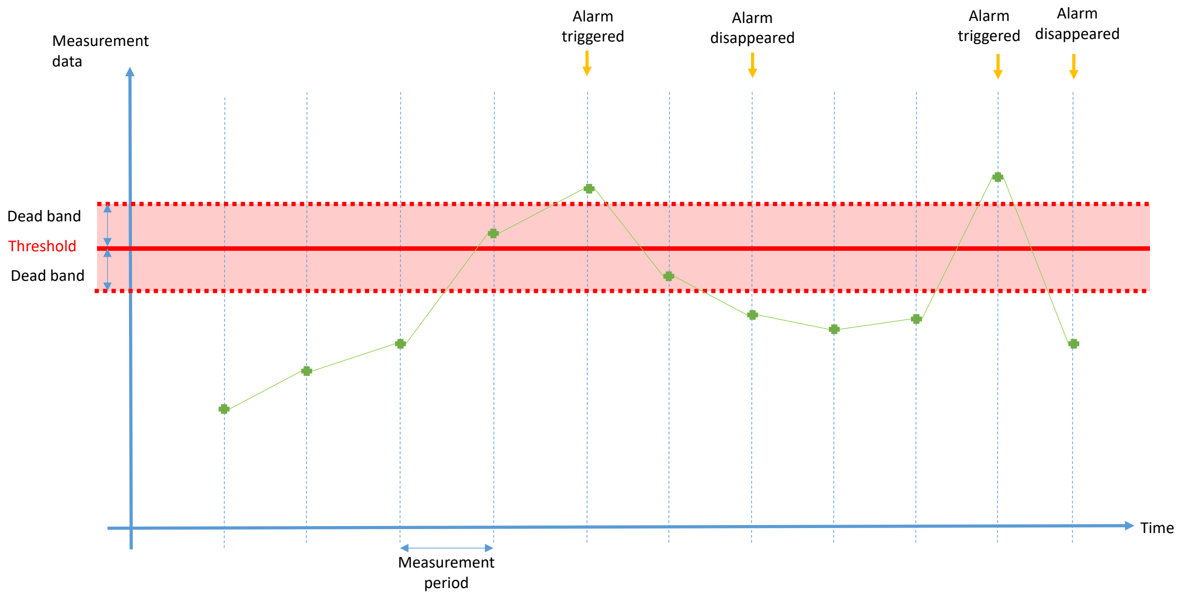
Process alarms are a feature of the connected device: each time a valid measurement is taken on a data channel, the measured value and slope (defined as: $\mathrm{current\ measured\ value} - \mathrm{previous\ value}$) can be compared to user-defined thresholds. In the event of a value exceeding a threshold, 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.

As taking a measurement requires only a fraction of the energy needed for transmitting it, the use of process alarms in combination with measurement and transmission periods that are different from each other enables energy-saving strategies. Configuring alarms when the measurement and transmission periods are the same provide little to no benefit since all measurement points will be available on the platform, and various condition-based triggers can be implemented there. Similarly, configuring different periods for measurement and transmission, without configuring any process alarms, increases energy usage with little to no gain.

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 … 10,000] 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 … 10,000][2] 0.01 % of span/minute	n/a	n/a
Falling slope		n/a	n/a

2.5.1 High threshold



[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

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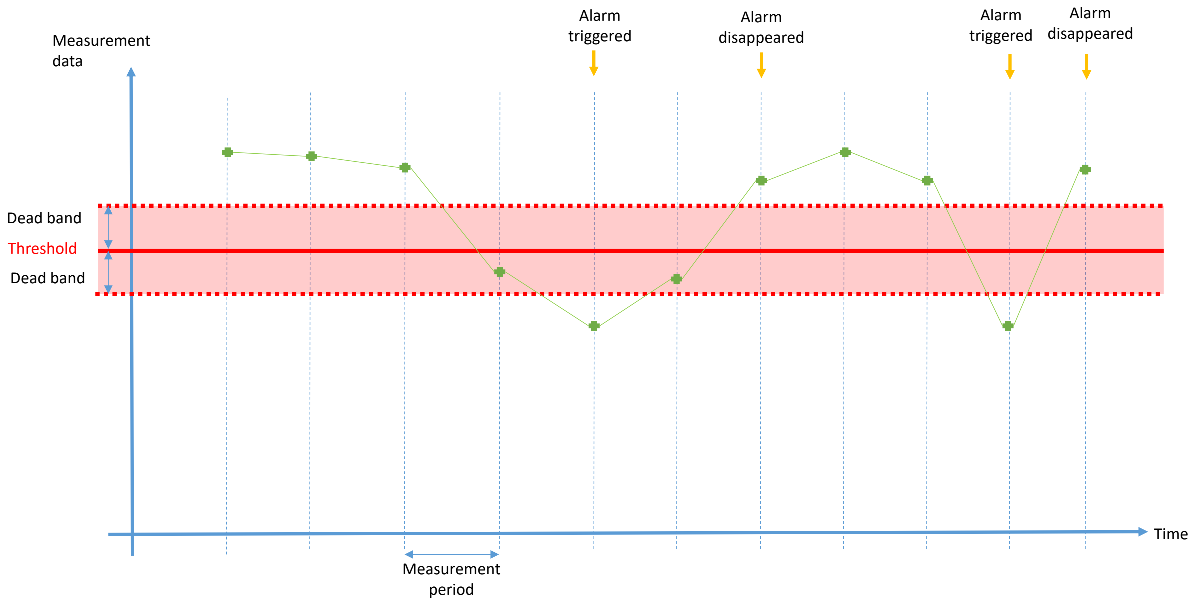
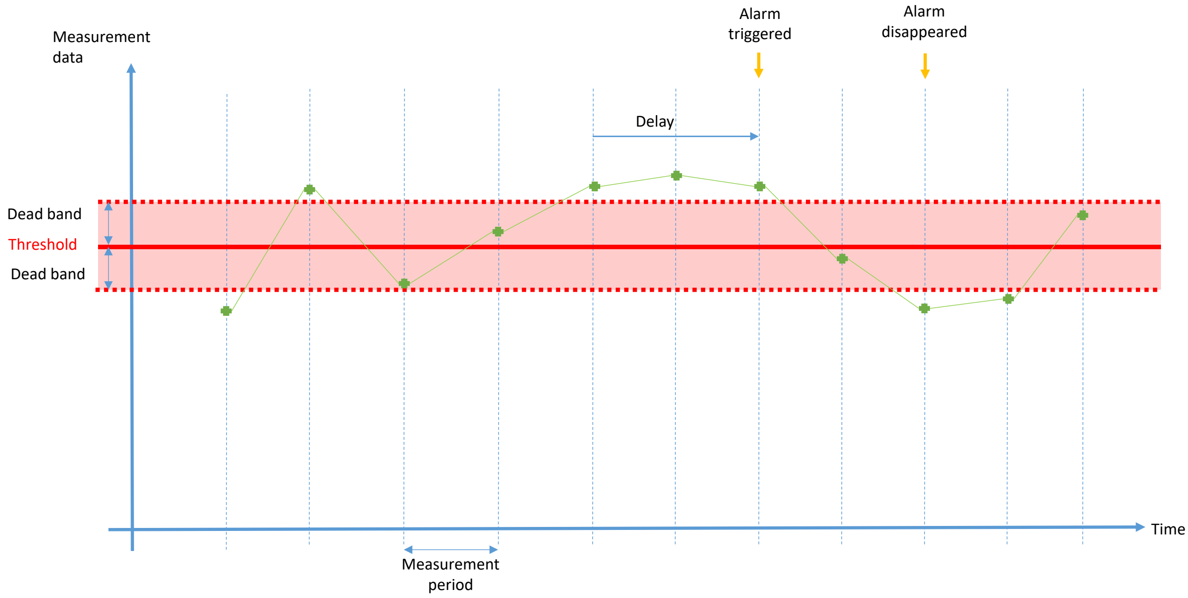
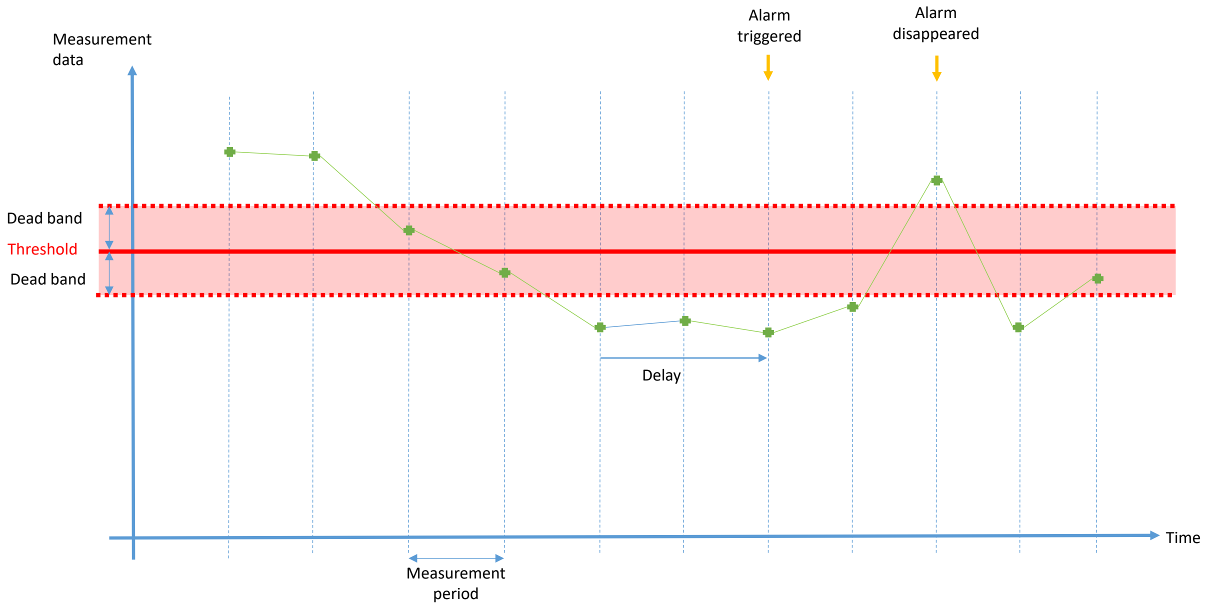
2.5.2 Low threshold



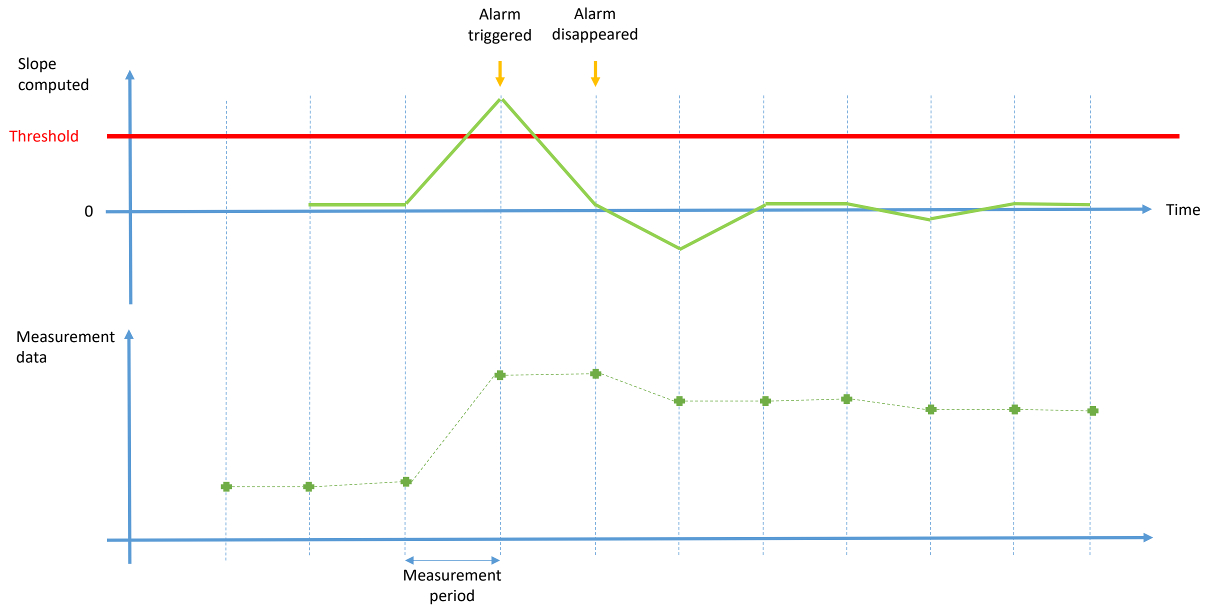
2.5.3 High threshold with delay



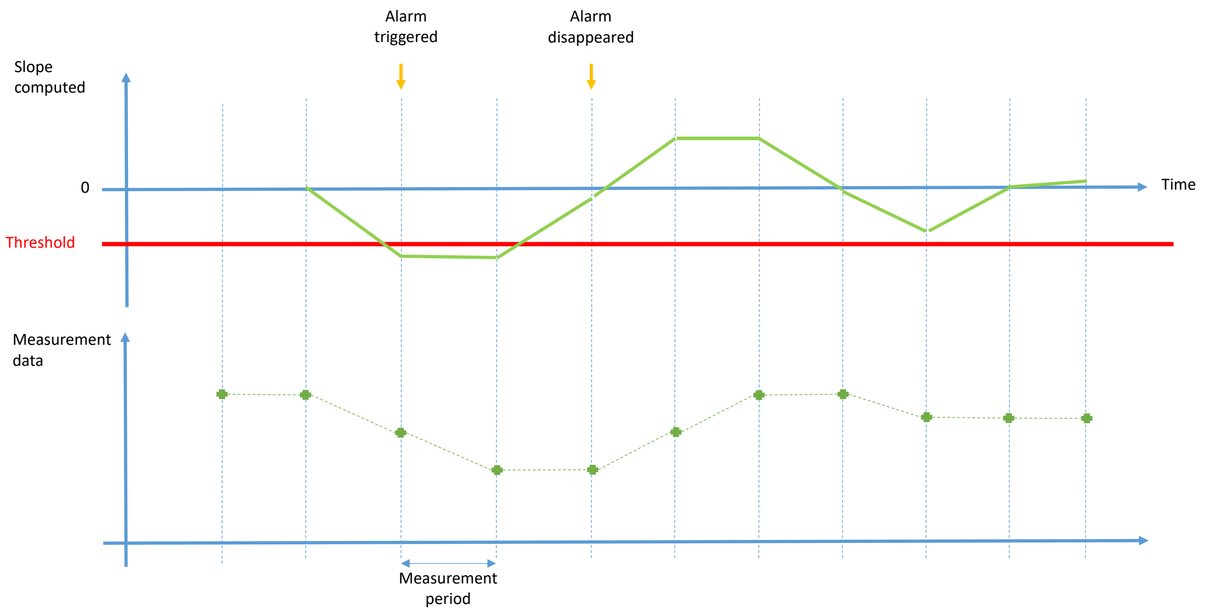
2.5.4 Low threshold with delay



2.5.5 Rising slope



2.5.6 Falling slope



2.6 Configuration identifier

A connected device 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 connected device. This is why all upstream messages include a “configuration identifier” (or “config ID”) and all downstream packets, that can contain several commands changing the connected device configuration include a “transaction identifier” (“transaction ID”).

When a downstream packet with transaction identifier X results in a change of configuration of the connected device (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 31 that is different from the current connected device config ID. Using a sequential value is convenient but not mandatory. Value 0 is, by convention, used to indicate the “factory configuration”, and thus shall be used as a transaction ID when sending a “reset to factory configuration” command. **Values above 31 are reserved and must be avoided. After value 31 is reached, next value should be 1 (roll-over) by convention.**

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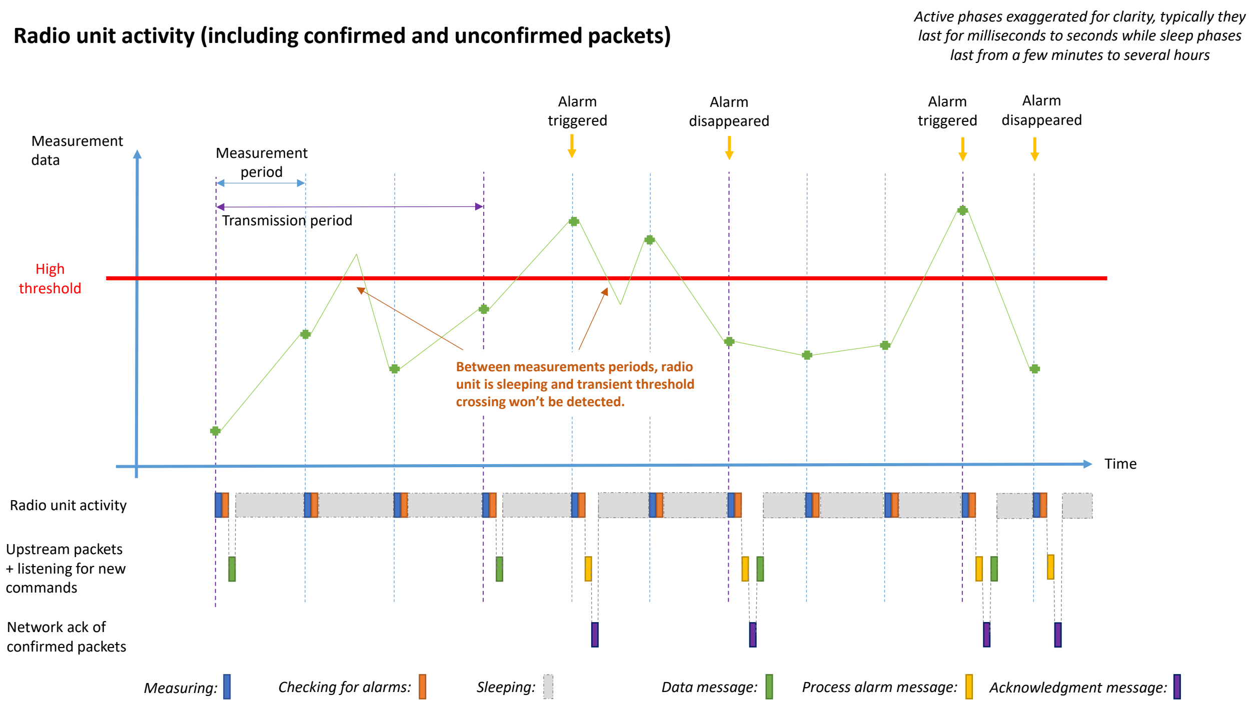
2.7 Typical product behavior

As a summary, the figure below represents the temporal behavior of a GD-20-W connected device when a measured value for a data channel is fluctuating and a high threshold process alarm is configured:



It shows that, in practice, a connected device 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.

3. Upstream messages

3.1 General format

Upstream messages are messages sent wirelessly by the connected device 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. 0), the connected device 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	From 5 up to 20
0x02	Data message with at least one alarm ongoing	From 5 up to 20
0x03	Process alarm message	2+4*N(1)
0x04	Technical alarm message	5
0x05	Device alarm message	4
0x06	Configuration status message	From 8 to 17
0x07	Device identification message	From 29 to 39
0x08	Keep alive message	3
0x09	Device extended identification message	From 14 to 50

(1) N is the number of alarms triggered at the same time

3.2 Data message with or without ongoing alarm

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

The message is formatted as follows:

Byte	Size (bytes)	Value	Note
0	1	Data message type	In accordance with upstream messages type table (0x01, 0x02)
1	1	Config ID	Current configuration identifier
2	1	Channel ID	At least one channel is enable

Byte	Size (bytes)	Value	Note
			0: Channel number 0 1: Channel number 1 2: Channel number 2 3: Channel number 3 4: Channel number 4 5: Channel number 5
3-4	2	Data (16b)	data fields, depending on configuration
5	1	Channel ID	Second channel if enable 0: Channel number 0 1: Channel number 1 2: Channel number 2 3: Channel number 3 4: Channel number 4 5: Channel number 5
6-7	2	Data (16b)	data fields, depending on configuration
…			According to the number of channels enable

3.2.1 Example

Frame: 0x01 04 00 1254 01 2135 04 1754

Decoding:
01: data message with no alarm on going,
04: Config,

00: Channel ID 0
1254: data channel 0 = 21.92% of full scale

01: Channel ID 1
2135: data channel 1 = 60.01% of full scale

04: Channel ID 4
1754: data channel 4 = 34.72% of full scale

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.

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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	Channel ID	Channel concerned by the alarm 0: Channel number 0 1: Channel number 1 2: Channel number 2 3: Channel number 3 4: Channel number 4 5: Channel number 5
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	Reserved	0b0000
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	

3.3.1 Example

Frame: 0x03 07 00 01 09BF

Decoding:
03: sensor process alarm,
07: Config ID

00: Channel ID 0

01: Alarm type high threshold alarm is triggered
09BF: data channel 0 = -0.05% of full scale

3.4 Technical alarm message

Technical alarms are related to the overall connected device status as well as the quality and reliability of the measurements of each channel. They are always enabled.

The message is formatted as follows:

Byte	Size (bytes)	Value	Note
0	1	0x04	Technical alarm has been triggered or has disappeared
1	1	Config ID	Current configuration identifier
2	1	0x00	Reserved
3-4	2	Alarm type	See alarm type table below

Alarm type byte interpretation:

Bit	Description
11-15	Reserved
10	Recurring Modbus communication error (internal sensor)
8-9	Reserved
7	Gas density above the upper limit value (based on the full scale of the density measuring range in bar abs. at 20 °C [68 °F]) (internal sensor)
6	Liquefaction of the SF6 gas (internal sensor)
5	Communication error pressure/ temperature sensor (internal sensor)
4	Temperature signal above the upper limit value (> 80 °C [176 °F]) (internal sensor)
3	Temperature signal below the lower limit value (< -40 °C [-40 °F]) (internal sensor)
2	RFU
1	Pressure signal above the upper limit value (internal sensor)
0	Modbus sensor communication error

3.4.1 Example

Frame: 0x04 05 00 0400

Decoding:

04: sensor technical alarm
05: Config ID

00: sensor id
0400: Recurring Modbus communication error

3.5 Device alarm message

Device alarms are always enabled and cannot be configured by the end-user.

Byte	Size (bytes)	Value	Note
0	1	0x04	Technical alarm has been triggered or has disappeared
1	1	Config ID	Current configuration identifier
2-3	2	Device alarm	See Device alarm type table below

Bit	Description
15-8	Device specific alarms
7-4	Reserved
3	Configuration error
2	Duty cycle alarm
1	Unused
0	Low battery

3.5.1 Example

Frame: 0x05 02 0001

Decoding:

05: Device alarm

02: Configuration transaction id

0001: battery very low alarm is triggered

3.6 Configuration status message

The configuration status message is sent by the connected device after receiving a command in order to inform the platform whether the command 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 connected device is responding to
2	1	Status	0x20: Configuration applied with success 0x30: Configuration rejected – At least 1 parameter is incorrect 0x40: Configuration discarded – Never received all packets 0x60: Command success 0x70: Command failed
3	1	Command type	Only applicable for downlink request with command code 0x40 or 0x04
4+X		Returned frame	See table Below, only applicable for downlink request with command code 0x40 or 0x04

The returned frame following a get main configuration request is described in the table below:

Byte	Size (bytes)	Value	Note
4-7	4	Data (32b)	Acquisition time period when all alarms are OFF in seconds 0: non-authorized
8-9	2	Data (16b)	Publication time period factor when all alarms are OFF, value is multiple of of acquisition period when all alarms are OFF (from 1 to 65535) 0: non-authorized
10-13	4	Data (32b)	Acquisition time period when at least one alarm is ON in seconds 0: non-authorized
14-15	2		Publication time period factor if at least one alarm is ON, value is multiple of of acquisition period when one alarm is one (from 1 to 65535) 0: non-authorized
16	1	0x00	Reserved

The returned frame following a get Channel alarm configuration request is described in the table below:

Byte	Size (bytes)	Value	Note
4	1		
5-6	2		
7	1	Bit 7: Low alarm Bit 6: High alarm Bit 5: Low slope alarm Bit 4: High slope alarm Bit 3: Low alarm during a period Bit 2: High alarm during a period Bit 1 and 0: Reserved	For each alarm, bit value is Enabled (1) or disabled (0)
8+X	2	Threshold value for Alarm 1	Optional field: Must be set if Alarm 1 Enabled
	2	Threshold value for Alarm 2	Optional field: Must be set if Alarm 2 Enabled
	2	Slope value for Alarm 3	Optional field: Must be set if Alarm 3 Enabled
	2	Slope value for Alarm 4	Optional field: Must be set if Alarm 4 Enabled
	2	Threshold value for Alarm 5	Optional field: Must be set if Alarm 5 Enabled
	2	Period value for Alarm 5	Optional field: Must be set if Alarm 5 Enabled, 1-65535 value in 1s unit. *0: the alarm will act as a standard alarm*
	2	Threshold value for Alarm 6	Optional field: Must be set if Alarm 6 Enabled
	2	Period value for Alarm 6	Optional field: Must be set if Alarm 6 Enabled, 1-65535 value in 1s unit. *0: the alarm will act as a standard alarm*

3.6.1 Example

Frame: 06 01 20 04 0000003C 0005 0000003C 0001 00

<u>Decoding</u>:

06: Configuration status identifier

01: Transaction Id

20: configuration was applied with success

04: get main configuration request

0000003C: acquisition period when alarms are OFF is set to 60 seconds

0005: publication period when alarms are OFF is set to 360 seconds (60 * 5)

0000003C: acquisition period when alarms are ON is set to 60 seconds

0001: publication period when alarms are ON is set to 60 seconds (60 * 1)

00: reserved

3.7 Device identification message

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

The message is formatted as follows:

Byte	Size (bytes)	Value	Note
0	1	0x07	Device identification message
1	1	Config ID	Current configuration identifier
2	1	0x15	WIKA wireless product ID for GD-20-W = 21
3	1	0x40	Wireless product sub-ID Sensor ID: Bit [4...0]: = 0: GD20_W LPWAN ID: Bit [7...5]: = 2 : LoRaWAN®
4-5	2	Wireless module firmware version	MAJOR.minor.PATCH = v[0-15].[0-15].[0-255] Hex-Coded: 0xMmPP
6-7	2	Wireless module hardware version	MAJOR.minor.PATCH = v[0-15].[0-15].[0-255] Hex-Coded: 0xMmPP
8-18	11	Serial number	Alphanumeric (ASCII)
19	1	Measurand Channel 0	See Table of measurand identifiers
20	1	Unit Channel 0	See table of unit identifiers
21	1	Measurand Channel 1	See Table of measurand identifiers
22	1	Unit Channel 1	See table of unit identifiers
23	1	Measurand Channel 2	See Table of measurand identifiers
24	1	Unit Channel 2	See table of unit identifiers
25	1	Measurand Channel 3	See Table of measurand identifiers
26	1	Unit Channel 3	See table of unit identifiers
27	1	Measurand Channel 4	See Table of measurand identifiers
28	1	Unit Channel 4	See table of unit identifiers
29	1	Measurand Channel 5	See Table of measurand identifiers
30	1	Unit Channel 5	See table of unit identifiers

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Byte	Size (bytes)	Value	Note
31	1	Gas mixture SF6	0..100 % integer
32	1	Gas mixture N2	0..100 % integer
33	1	Gas mixture CF4	0..100 % integer
34	1	Gas mixture O2	0..100 % integer
35	1	Gas mixture CO2	0..100 % integer
36	1	Gas mixture Novec 4710	0..100 % integer
37	1	Gas mixture He	0..100 % integer
38	1	Gas mixture Ar	0..100 % integer

Table of unit identifiers

Unit ID	Name	Conversion factor
0x01	[°C] degree Celsius	-
0x02	[°F] degree Fahrenheit	°F = °C * 1.8 + 32
0x03	[K] Kelvin	-
0x07	[bar] Bar	
0x0A	[Pa] Pascal	
0x0C	[kPa] Kilopascal	
0x0D	[MPa] Megapascal	
0x0E	[Psi] Pound per square inch	
0x11	[N/cm²] Newton per square centimeter	
0x6E	[kg/m³] Kilogram per cubic metre	
0x73	[g/l] Gram per liter	

Table of measurand identifiers

Measurand ID	Name
0x01	Temperature
0x03	Pressure gauge
0x04	Pressure absolute
0x17	Density
0x18	Density (gauge pressure at 20 °C)
0x19	Density (absolute pressure at 20 °C)

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3.7.1 Example

Frame: 0x07 00 15 40 0200 0100 50484F454E49585F464200 04 07 03 0A 01 01 17 6E 04 0C 03 07 64 00 00 00 00 00 00 00

Decoding:
07: frame type = device identification,
00: configuration transaction Id,
15: Product ID,

40: Product Sub ID
The next fields are device-dependent and indicative of a typical application:

0200: wireless module firmware version = 0.2.0,
0100: wireless module hardware version = 0.1.0,
50484F454E49585F464200: name = "PHOENIX_FB" (ASCII string, null terminated),

04: measurand channel 0 = Absolute pressure at 20°C
07: unit channel 0 = bar (LPP standard unit table),

03: measurand channel 1 = Gauge pressure based on 1.013 mbar at 20°C

0A: unit channel 1 = Pa (LPP standard unit table),
01: measurand channel 2 = Temperature

01: unit channel 2 = °C (LPP standard unit table),

17: measurand channel 3 = Density

6E: unit channel 3 = kg/m^3 (LPP standard unit table),

04: measurand channel 4 = Absolute pressure

0C: unit channel 4 = kPa (LPP standard unit table),

03: measurand channel 5 = Gauge pressure based on 1.013 mbar

07: unit channel 5 = bar (LPP standard unit table),

64 : Gas mixture SF6 = 100%

00 : Gas mixture N2 = 0 %

00 : Gas mixture CF4 = 0 %

00 : Gas mixture 02 = 0 %

00 : Gas mixture C02 = 0 %

00 : Gas mixture Novec 4710 = 0 %

00 : Gas mixture He = 0 %

00 : Gas mixture Ar = 0 %

3.8 Keep-alive message

The keep-alive frame is transmitted periodically every 24 hours. This setting is not adjustable. This guarantees that the connected device 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	1	Battery level indicator	Bit 7: - 0: no new event - 1: new event – the device has restarted since the last keep alive transmission Bit 6..0 : Current estimated battery level in per cent (from 0 to 100). 0x7F is returned if an error occurred during battery capacity computing (typically an estimated load greater than the battery load)

3.8.1 Example

Frame: 0x08 00 63

Decoding:
08: frame type = keep alive,
00: configuration transaction Id,

63 = 99% of remaining battery capacity

3.9 Extended device identification message

The extended device identification message is transmitted just after the device identification message and contains miscellaneous information that can be used for connected device identification and interpretation.

The message is formatted as follows:

Byte	Size (bytes)	Value	Note
0	1	0x09	Extended device identification message
1	1	Config ID	Current configuration identifier
2-5	4	Channel 0 min. range	Lower limit of measurement range (32 bits, binary32 IEEE 754 floating-point number, big-endian)
6-9	4	Channel 0 max. range	Upper limit of measurement range (same as above)

Byte	Size (bytes)	Value	Note
10-13	4	Channel 1 min. range	Lower limit of measurement range (same as above)
14-17	4	Channel 1 max. range	Upper limit of measurement range (same as above)
18-21	4	Channel 2 min. range	Lower limit of measurement range (same as above)
22-25	4	Channel 2 max. range	Upper limit of measurement range (same as above)
26-29	4	Channel 3 min. range	Lower limit of measurement range (same as above)
30-33	4	Channel 3 max. range	Upper limit of measurement range (same as above)
34-37	4	Channel 4 min. range	Lower limit of measurement range (same as above)
38-41	4	Channel 4 max. range	Upper limit of measurement range (same as above)
42-45	4	Channel 5 min. range	Lower limit of measurement range (same as above)
46-49	4	Channel 5 max. range	Upper limit of measurement range (same as above)

3.9.1 Example

Frame: 09 00 00000000 41400000 00000000 48435000 C2200000 42A00000 00000000 41200000 00000000 43480000 BF800000 3F800000

Decoding:

09: Sensor / Board identification

00: Transaction ID

00000000: Min range channel 0 = 0 bar (32b big-endian IEEE float),

41400000: Max range channel 0 = 12 bar (32b big-endian IEEE float),

00000000: Min range channel 1 = 0 Pa (32b big-endian IEEE float),

48435000: Max range channel 1 = 200 000 Pa (32b big-endian IEEE float),

C2200000: Min range channel 2 = -40 °C (32b big-endian IEEE float),

42A00000: Max range channel 2 = 80°C (32b big-endian IEEE float),

00000000: Min range channel 3 = 0 kg/mm^2 (32b big-endian IEEE float),

41200000: Max range channel 3 = 10 kg/mm^2 (32b big-endian IEEE float),

00000000: Min range channel 4 = 0 kPa (32b big-endian IEEE float),

43480000: Max range channel 4 = 200 kPa (32b big-endian IEEE float),

BF800000: Min range channel 5 = -1 bar (32b big-endian IEEE float),

3F800000: Max range channel 5 = 1 bar (32b big-endian IEEE float),

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4. Downstream messages

4.1 General format

Downstream packets are sent by the IIoT platform to the connected device 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 connected device just after it sends an upstream packet. They are then interpreted by the connected device, which is expected to send a “configuration status” response (see section 0).

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

The packet format is as follows:

Byte	Size (bytes)	Note
0	1	Transaction identifier (see sec. 2.5)
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 command	0
0x02	Set main configuration command	13
0x04	Get main configuration command	0
0x05	General device command	1
0x11	Disable channel command	From 3 to 11
0x20	Set process alarm configuration command	From 5 to 21
0x40	Get process alarm configuration command	1

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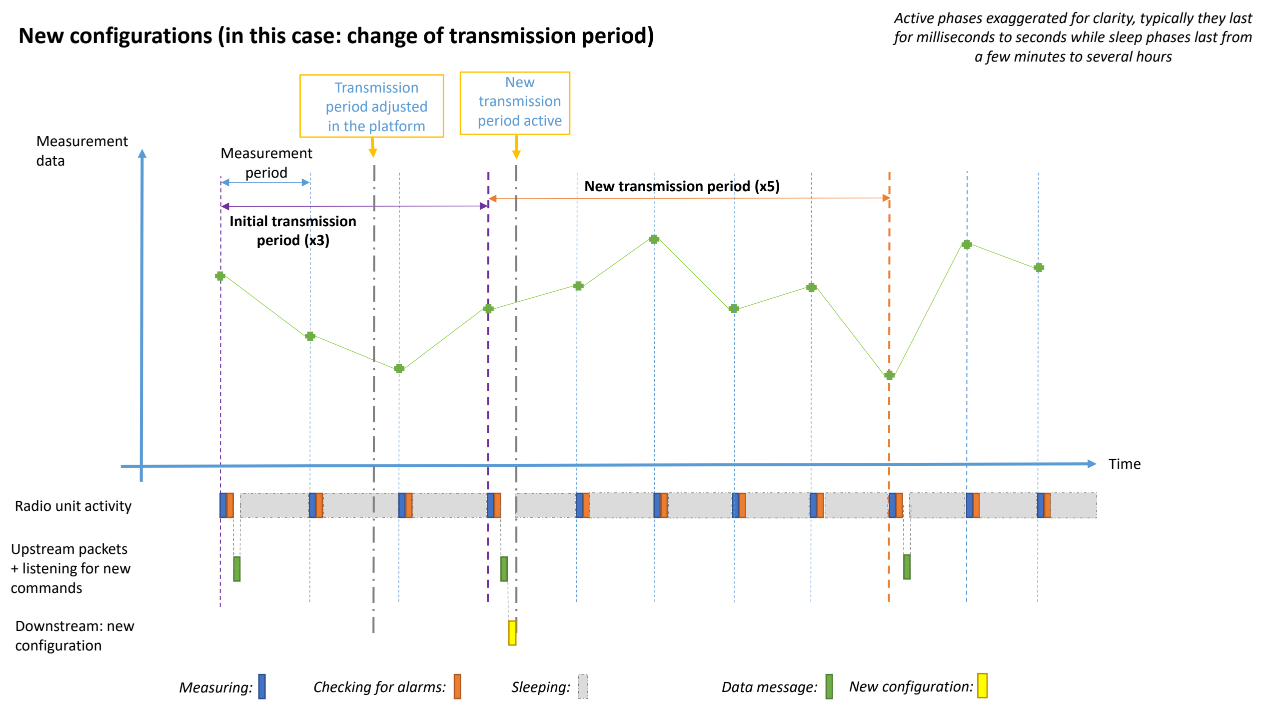


4.2 Reset to factory configuration command

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	3600 seconds (1 hours)
Transmission multiplier, no alarm active	4 x (4 hours)
Measurement period, ≥1 alarm active	3600 seconds (1 hours)
Transmission multiplier, ≥1 alarm active	4 x (4 hours)
Data channel(s)	All enabled
Process alarms, for each data channel	All disabled

4.2.1 Example

Frame: 0x00 01

Decoding:
00: transaction id,
01: reset configuration request

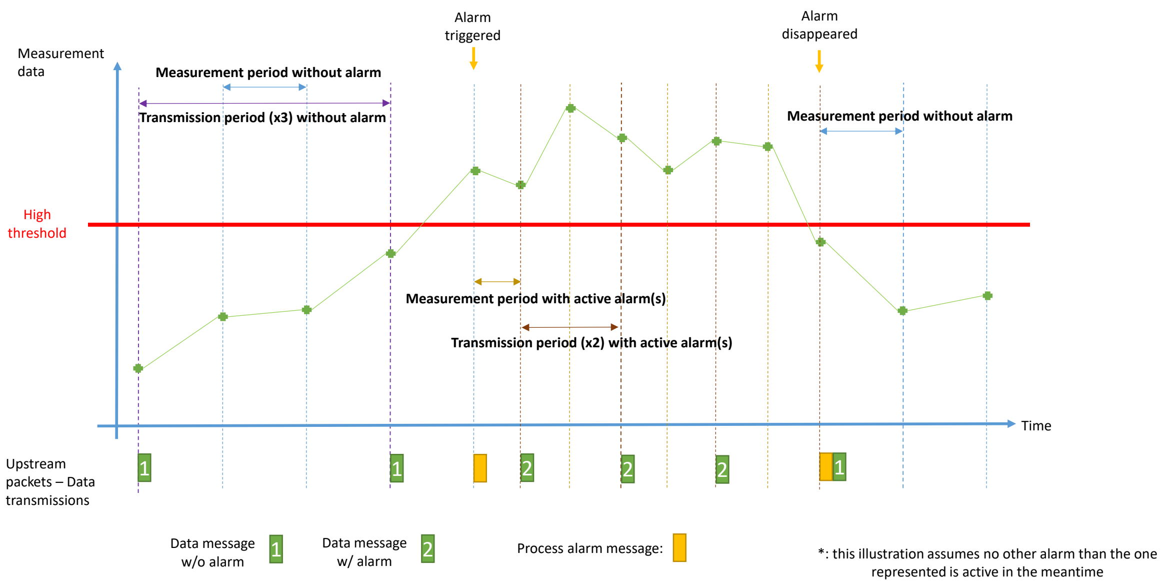
4.3 Set main configuration command

The main configuration of a connected device 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 = 604, 800 s (1 week)
5-6	2	Transmission multiplier when no alarm is active	Min. value = 1; max value = 65,535 Transmission period = measurement period * transmission multiplier ≤ 604, 800 s max.
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	
13	1	0x00	Reserved

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



4.3.1 Example

Frame: 0x07 02 000000B4 0003 0000003C 0012 00

Decoding:
07 : new configuration transaction id,
02 : main configuration request,
000000B4 : acquisition period when no alarm is active = 180 * 1s = 3min,
0003 : transmission ratio when no alarm is active => 3 * 3min = 9min ,
0000003C: acquisition period when at least one alarm is active = 60 * 1s = 1min,
0012 : transmission ratio when at least one alarm is active => 18 * 1min = 18min,
00: alarm retry management.

4.4 Get main configuration command

This command allow to retrieve the current main configuration

Byte	Size (bytes)	Value	Note
0	1	0x04	Value: Get main configuration

4.4.1 Example

Frame: 0x01 04

Decoding:
01 : new configuration transaction id,
04 : get main configuration

4.5 General device command

This command allows to reset the battery indicator

Byte	Size (bytes)	Value	Note
0	1	0x05	Value: Get main configuration
1	1	0x00	Reset batterie indicator

4.5.1 Example

Frame: 0x01 05 00

Decoding:
01: new configuration transaction id,
05: general device command
00: reset battery indicator

4.6 Enable or disable channel command

This command will enable or 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
1	1	Number of channels to disable with a maximum of 5 -m)	At least one channel shall remain active
2	1	Channel ID to disable or enable	
3	1	0x00: disable 0x01: enable	
…			
2 + 2*(m-1)	1	Channel ID to disable or enable	
2 +2*(m-1)		0x00: disable 0x01: enable	

To reactivate a channel, send active channel configuration with or without alarms.

4.6.1 Example

Frame: 0x01 11 02 11 00 13 01

Decoding:
01: new configuration transaction id,
11 : Disable channel command

02: 2 channels to disable/enable

11: sensor 1 - channel 1

00: disable channel

13: sensor 1 - channel 3

01: enable channel

4.7 Set process alarm configuration command

This command will activate the channel (measure and alarm). All previous alarm configurations on this channel are replaced. Parameters for alarms must be present only if the corresponding alarm is enabled.

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The command is formatted as follows:

Byte	Size (bytes)	Bit	Value	Note
0	1		0x20	Set process alarm command
1	1		Channel ID	Channel for which alarms shall be configured
2-3	2		Dead band, common to all non-slope alarms	0 … 10,000 in increments of 0.01 % of span; common to all non-slope alarms
4	1	*7*	Alarm 1: Low threshold	For each alarm, the bit value means: 1= enabled 0= disabled
		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
5…	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, 1-65535 value in 1s unit, *0: the alarm will act as a standard alarm*
	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, 1-65535 value in 1s unit, *0: the alarm will act as a standard alarm*.

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.

4.7.1 Example

Frame: 0x01 20 00 0064 80 2000

Decoding:
01 : new configuration transaction id,
20 : set Channel alarm configuration

00: sensor id 0 / channel 0

0064: dead band = 100

80: low threshold alarm is enabled

2000: threshold is set to 8192

4.8 Get process alarm configuration command

Byte	Size (bytes)	Value	Note
0	1	0x40	Value: Get Channel alarm configuration
1	1	Channel Id	

4.8.1 Example

Frame: 0x01 40 01

Decoding:
01: new configuration transaction id,
40: get Channel alarm configuration

01: Channel 1

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5. Connectivity protocol: LoRaWAN®

5.1 Connected device network integration

GD-20-W is a “class A” battery-powered LoRaWAN® radio end-device using version 1.0.3 of the protocol and EU868 regional parameters.

GD-20-W uses the OTAA “over–the-air activation” LoRaWAN® procedure. Each connected device 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 connected device. 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. If a LoRaWAN® network is in radio range and has the key of this connected device, the connected device will join this network. If joining fails, the connected device will do 2 retries with about 3 minutes interval between. If none of them succeeds, the connected device will enter in a retry sequence after 10 minutes, 1 hour, 10 hours and every 10 hours with 2 tries an additional 5 minutes random time.

After joining a network, the connected device will send 3 messages:

- Device identification
- Extended device identification
- 1 data message, with or without alarm ongoing

After those 3 packets, the normal configuration for measurement and transmission period will apply.

5.3 Classes of traffic

All upstream traffic generated by the connected device is sent on LoRaWAN® port 1.

The connected device will process data downstream traffic sent on any port except the ones re-served for special LoRaWAN® proposes (port 0, and 224 to 255).

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

- Process, technical and device alarms
- Device identification and extended device identification
- Configuration status
- Keep alive

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