Special documentation

LoRaWAN® communication specifications, models A2G-500, A2G-520 and A2G-540

EN

Differential pressure sensor, model A2G-500
Differential pressure air flow sensor, model A2G-520
Differential pressure and air flow controller, model A2G-540

WIKA

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

40454297.01 03/2025 EN

Contents

EN

40454297.01 03/2025 EN

Supplementary documentation:
- This special documentation for LoRaWAN® communication specifications applies in conjunction with the operating instructions “Differential pressure sensor, models A2G-500, A2G-520 and A2G-540” (item number 40452360).

EN

1. General information

1.1 Object

This document describes the protocol specification for communication between the web app and an A2G instrument. It describes only the specific implementation of the TULIP protocol.

1.2 Abbreviations, definitions

LPWAN	Low Power Wide Area Network, a wireless digital data network category.
Network	In this document, LPWAN, for which a specific radio unit is designed and configured for communication.
Packet	A unit of radio transmission; it can contain LPWAN management data, as well as zero, one, or several messages following the application protocol described in the present document.
Instrument	Differential pressure sensor with wireless transmission, model A2G-5x0. This is an electronic differential pressure sensor. It contains radio modules for low-energy communication with a dedicated “myWIKA wireless device” mobile application available on PlayStore (Android) and App store (iOS) as well as LoRaWAN® communication version 1.0.3.
Platform	Generic term for the data processing and storage system that conveys 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.
FS	Full Scale, refers to the instrument's “full scale”, a.k.a. the instrument's nominal measurement scale defined by a lower boundary, an upper boundary, and a physical unit. A linear scale is assumed.

1.3 Convention

As a convention, all the traffic that goes from the instruments to the server (via the gateways) is called “upstream traffic”.
The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY" and "OPTIONAL" in this document are to be interpreted as described in RFC 2119.
Multi-octet fields are encoded following a “big endian” convention, a.k.a “network order”. That order of octet transmission is the same as the left-to-right reading order.

40454297.01 03/2025 EN

Bits are numbered from left to right, starting with bit 7 representing respectively the most significant octet (a.k.a MSb).

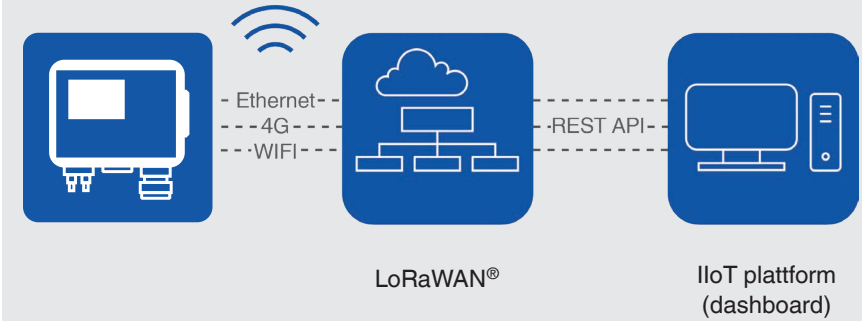
Example

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	...

2. Application protocol description

Purpose

The purpose of the application protocol is for the instrument to be able to communicate with an IIoT platform in order for one or several users to use all the features of the instrument remotely.



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

LoRaWAN® specification	
LoRaWAN® specification	LoRa® 868 MHz EU
Version	1.0.3
Frequency range	863 ... 870 MHz
Transmission power	12 dBm
Range [1)]	≤ 10 km [≤ 6.2 mi]
Max. output power	14 dBm

1) The range depends on the topography. 10 km [6.2 mi] can be achieved in free field conditions and with a spreading factor of 12.

3. Principle

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3.1 Power modes and LoRaWAN® class

The power mode of the A2G defines the communication class for LoRaWAN®.
Battery mode: LoRaWAN® class A

3.2 Join procedure

At power on, the module will try to join the network using a join sequence (1 try and 1 retry 3 minutes later if the first try didn't succeed). In the case of fail, it goes to sleep for a defined interval time and then launches a new join sequence.

The join procedure sleep intervals are defined in the LoRa® board firmware as:

- T0 = 0 min and +3 min (first attempt)
- $T = T_{first\ attempt}$ + 10 min and +13 min (second attempt)
- $T = T_{second\ attempt}$ + 55 min and + 3 min (third attempt)
- $T = T_{third\ attempt}$+8 h and + 3min (fourth attempt)
- $T = T_{fourth\ attempt}$ + 8xN h and + 3min

It increases the last period infinitely, until join success or reboot.

Sequence	Explanation	Difference
0 min	T0 = 0 min (startup)	0 min
3 min	T1 = T0 + 3 min	3 min
13 min	T2 = T1 + 10 min	10 min
16 min	T3 = T2 + 3 min	3 min
1 h 11 min	T4 = T3 + 55 min	55 min
1 h 14 min	T5 = T4 + 3 min	3 min
9 h 14 min	T6 = T5 + 8 h	8 h
9 h 17 min	T7 = T6 + 3 min	3 min
17 h 17 min	T8 = T7 + 8 h	8 h
17 h 20 min	T9 = T8 + 3 min	3 min
25 h 20 min	T10 = T9 + 8 h	8 h
25 h 23 min	T11 = T10 + 3 min	3 min
...	...	-

40454297.01 03/2025 EN

3.3 Upstream traffic

All upstream traffic generated by the instrument is sent on LoRaWAN® port 10.

An A2G instrument sends messages in five cases:

- Data message, without LoRaWAN® confirm
- Technical alarm message, without LoRaWAN® confirm
- Instrument alarm message, without LoRaWAN® confirm
- Keep alive message for data at least once a day, without LoRaWAN® confirm
- Instrument identification message, without LoRaWAN® confirm

The application server will check the periodic uplink of standard data, depending on the current configuration.

4. Upstream format

The LoRa®-transmitted frame is limited in length to 51 bytes (including FOpts bytes). When the length of data exceeds this limit, data is transmitted in multiple frames, otherwise it is transmitted in a single frame containing all data.

► Single transmission

Upstream messages are defined by their type and contents.

Byte	Size (bytes)	Field	Note
0	1	Upstream message type	-
1	1	Configuration ID	Current configuration identifier
2		Data	Data depending on message type
-		...	-
-		...	-
n		Data	-

4.1 Upstream message type

Decoding message contents depends on its type:

Hex	Message types
0x00	--Unused and must not be used--
0x01	Data message
0x04	Technical alarm
0x05	Instrument alarm
0x07	Instrument identification
0x08	Keep alive

4.2 Data message

The messages are formatted as described in the following table:

Byte	Size (bytes)	Field	Note
0	1	Message type	Data message type = 0x01
1	1	Configuration ID	Current configuration identifier
2-5	4	Pressure	Float (IEEE 754) Example: 110.2 [Pa]
6-9	4	Flow [1)]	Float (IEEE 754) Example: 650.1 [m^3/h]
10-13	4	IN1 [1)]	Float (IEEE 754) Example: 96.2 [kPa]
14-17	4	IN2 [1)]	Float (IEEE 754) Example: 65.6 [% r. h.]
18-21	4	IN3 [1)]	Float (IEEE 754) Example: 23.5 [°C]
22-25	4	IN4 [1)]	Float (IEEE 754) Example: 1 = true [Binary]
26	1	Relay status [1)]	(Bit 0) = 0 Relay 1 OFF (Bit 0) = 1 Relay 1 ON (Bit 1) = 0 Relay 2 OFF (Bit 1) = 1 Relay 2 ON

1) These bytes are not sent from a battery instrument to save energy.

4.3 Technical alarm message

The transmission of technical alarm messages is event based. When a new alarm occurs and when an alarm disappears a message is sent.

The messages are formatted as described in the following table:

Byte	Size (bytes)	Field	Note
0	1	Message type	Technical alarm message type = 0x04
1	1	Configuration ID	Current configuration identifier
2	1	Alarm	These bits are set when the input or output range is exceeded or a bus communication error is present. 0x00 = No technical alarm message pending Bit 7: Temperature input 4 signal overload Bit 6: Temperature input 3 signal overload Bit 5: Voltage input 2 signal overload Bit 4: Voltage input 1 signal overload Bit 3: Modbus communication error Bit 2: Analogue output 2 signal overload Bit 1: Analogue output 1 signal overload Bit 0: Pressure signal overload

4.4 Instrument alarm message

The transmission of instrument alarm messages is event based. When a new alarm occurs and when an alarm disappears a message is sent.

The messages are formatted as described in the following table:

Byte	Size (bytes)	Field	Note
0	1	Message type	Instrument alarm message type = 0x05
1	1	Configuration ID	Current configuration identifier
2-3	2	Instrument alarm	These bits are set when an instrument alarm occurs. 0x00 = No instrument alarm message pending Byte 2 Bit 7: ADC error Bit 6: Pressure sensor no-response error Bit 5: Pressure sensor timeout error Bit 4: Factory options write error Bit 3: Factory options delete error Bit 2: Invalid factory options error Bit 1: User settings invalid error Bit 0: User settings read/write error Byte 3 Bit 7: Zero offset over-range error Bit 6: Invalid signal source specified error Bit 5: Analog output 2 over-temperature error Bit 4: Analog output 2 load fault error Bit 3: Analog output 2 over-range error Bit 2: Analog output 1 over-temperature error Bit 1: Analog output 1 load fault error Bit 0: Analog output 1 over-range error

4.5 Instrument identification message

The sensor is able to provide its identification.
Generally, this message is sent after the join with a confirm message.

The message is formatted as described in the following tables:

Byte	Size (bytes)	Field	Note
0	1	Message type	Identification message type = 0x07
1	1	Configuration ID	Current configuration identifier
2	1	Wireless product ID	Instrument identification A2G = 13
3	1	Wireless product sub-ID	Protocol LoRaWAN® = 00
4-5	2	Sensor module firmware revision	MAJOR.minor.PATCH = v[0-15].[0-15].[0-255] Hex-Coded: 0xMmPP

4. Upstream format

Byte	Size (bytes)	Field	Note
6	1	Sensor module hardware revision	HW revision code as read from pins
7	1	Hardware assembly type	See below
8-23	16	Serial number	Alphanumeric (ASCII), example: 2Y00001HGHZ
24-27	4	Min. measuring range pressure	Float (IEEE 754) Example: Pressure: -1245.0 [Pa]
28-31	4	Max. measuring range pressure	Float (IEEE 754) Example: Pressure: 2487.0 [Pa]
32	1	UNIT main pressure	See measuring unit enum Example: Pressure: Pa = 1
33	1	UNIT main flow [1)]	See measuring unit enum Example: Flow: m^3/h = 11
34	1	UNIT IN1 [1)]	See measuring unit enum Example: kPa = 2
35	1	UNIT IN2 [1)]	See measuring unit enum Example: % r. h. = 20
36	1	UNIT IN3 [1)]	See measuring unit enum Example: °C = 40
37	1	UNIT IN4 [1)]	See measuring unit enum Example: Binary = 46

1) These bytes are not sent from a battery instrument to save energy.

4.5.1 Wireless module type

Code	Description
13	A2G

4.5.2 Wireless module subtype

Code	Description
00	LoRaWAN®

4.5.3 Hardware assembly type enum

Code	Description
0	Full
1	1 analogue output
2	Bus
3	Modular
4	1 analogue output & 1 relay
5	2 analogue outputs
128	1 analogue output (24 V)
129	Current transmitter
130	Battery

4.5.4 Measuring unit

Code	Unit	Comment
1 **2** **3** **4** **5**	**Pa** **kPa** **mbar** **mmWC** **inWC**	Pressure
10 **11** **12** **13** **14** **15**	**m^3/s** **m^3/h** **l/sec** **cfm** **m/sec** **ft/min**	Flow
20 **21** **22** **23** **24**	**% r. h.** **g/m^3** **g/ft^3** **kJ/kg** **BTU/BLD**	Various
31 **32**	**ppm** **%**	Relative
40 **41**	**°C** **°F**	Temperature
45	**Volt**	Voltage
46	**Binary**	Digital

40454297.01 03/2025 EN

4.6 Keep alive message

Note: The keep alive transmission will occur afer a period of 24 h.

Byte	Size (bytes)	Field	Note
0	1	Message type	Keep alive message type = 0x08
1	1	Configuration ID	Current configuration identifier
2	1	Battery level indicator	Battery level indicator [7]: ■ 0: no new event ■ 1: new event – the instrument has restarted since the last keep alive transmission Battery level indicator [6…0] = current estimated battery level in percent (from 0 to 100). 0x7F is returned if an error occurred during battery capacity computing (typically an estimated load greater than the battery load)

5. Frame examples

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5.1 Data converter

There are many online converters available for the conversion from decimal to hexadecimal, HEX to ASCII or for the interpretation of float values according to IEEE 754.

5.2 Data message frame example

Example message (hex):
01 01 BE5CF94C 00000000 3B834000 3B548000 43974D76 41BBA348 02

Byte	Size (bytes)	Field	Message	Decoded
0	1	Message type	0x01	Data message
1	1	Configuration ID	0x01	Configuration identifier
2-5	4	Pressure	0xBE5CF94C	-0.215794742
6-9	4	Flow [1)]	0x00000000	0]
10-13	4	IN1 [1)]	0x3B834000	0.004005432
14-17	4	IN2 [1)]	0x3B548000	0.00324249268
18-21	4	IN3 [1)]	0x43974D76	302.605164
22-25	4	IN4 [1)]	0x41BBA348	23.4547272
26	1	Relay status [1)]	0x02	0000 0010 -> Relay 1 OFF; Relay 2 ON

1) These bytes are not sent from a battery instrument to save energy.

5.3 Technical alarm message frame example

Example message (hex):
04 01 23

Byte	Size (bytes)	Field	Message	Decoded
0	1	Message type	0x04	Technical alarm message
1	1	Configuration ID	0x01	Configuration identifier
2	1	Alarm	0x23	0x23 → 0010 0011 Bit 7: Temperature input 4 signal overload = No overload Bit 6: Temperature input 3 signal overload = No overload Bit 5: Voltage input 2 signal overload = Overload Bit 4: Voltage input 1 signal overload = No overload Bit 3: Modbus communication error = No error Bit 2: Analogue output 2 signal overload = No overload Bit 1: Analogue output 1 signal overload = Overload Bit 0: Pressure signal overload = Overload

5.4 Instrument alarm message frame example

Example message (hex):
05 01 4821

Byte	Size (bytes)	Field	Message	Decoded
0	1	Message type	0x05	Instrument alarm message
1	1	Configuration ID	0x01	Configuration identifier
2-3	1	Alarm	0x4821	Byte 2 = 0x48 → 0100 1000 Bit 7: ADC converter error = No error Bit 6: Pressure sensor no-response error = Error Bit 5: Pressure sensor timeout error = No error Bit 4: Factory options write error = No error Bit 3: Factory options delete error = Error Bit 2: Invalid factory options error = No error Bit 1: User settings invalid error = No error Bit 0: User settings read/write error = No error Byte 3 = 0x21 → 0010 0001 Bit 7: Reserved for future use Bit 6: Invalid signal source specified error = No error Bit 5: Analogue output 2 over-temperature error = Error Bit 4: Analogue output 2 load fault error = No error Bit 3: Analogue output 2 over-range error = No error Bit 2: Analogue output 1 over-temperature error = No error Bit 1: Analogue output 1 load fault error = No error Bit 0: Analogue output 1 over-range error = Error

5.5 Instrument identification message frame example

Example message (hex):
07 01 0D 00 1203 05 00 3259303030303314847485A0000000000 C49BA000 451B7000 01 0B 2D 03 28 29

Byte	Size (bytes)	Field	Message	Decoded
0	1	Message type	0x07	Instrument identification message
1	1	Configuration ID	0x01	Configuration identifier
2	1	Wireless module type	0x0D	13 → A2G
3	1	Wireless module subtype	0x00	00 → LoRaWAN®
4-5	2	Sensor module firmware revision	0x1203	MAJOR.minor.PATCH → Firmware version 1.2.3
6	1	Sensor module hardware revision	0x05	Hardware revision 5
7	1	Hardware assembly type	0x00	Full assembly
8-23	16	Serial number	0x32593030 3030314847 485A000000 0000 (5 bytes reserved)	2Y00001HGHZ
24-27	4	Min. measuring range pressure	0xC49BA000	-1245
28-31	4	Max. measuring range pressure	0x451B7000	2487
32	1	UNIT main pressure	0x01	1 = Pa
33	1	UNIT main flow [1)]	0x0B	11 = m^3/h
34	1	UNIT IN1 [1)]	0x2D	45 = V
35	1	UNIT IN2 [1)]	0x03	3 = mbar
36	1	UNIT IN3 [1)]	0x28	40 = °C
37	1	UNIT IN4 [1)]	0x29	41 = °F

1) These bytes are not sent from a battery instrument to save energy.

5.6 Keep alive frame example

Example message (hex):
08 01 CB

Byte	Size (bytes)	Field	Message	Decoded
0	1	Message type	0x08	Keep alive message
1	1	Configuration ID	0x01	Configuration ID
2	1	Battery level indicator	0xCB	(from right to left) Bit 7: 1 → instrument has restarted since last keep alive message Bit 6…0: 75 % battery level 0xCB → 1100 1011 1 → instrument restarted 100 1011 = 75 → 75 % Battery level indicator [7]: ■ 0: no new event ■ 1: new event – the instrument has restarted since the last keep alive transmission Battery level indicator [6…0] = current estimated battery level in percent (from 0 to 100). 0x7F is returned if an error occurred during battery capacity computing (typically an estimated load greater than the battery load)

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40454297.01 03/2025 EN