FC0000-2-15-PIR_LoRa-00-DO-1.6

IR868LR - IRUS915LR Programming manual

0.1 Table of Contents

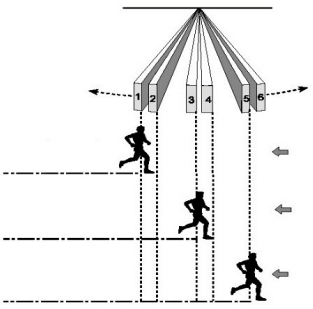
1 Document history

Rev.	FW rev	Author	Note / remarks	Date
1.0	v0.7	R&D laboratory GM	Document created. Preliminary version (DRAFT)	July 15, 2015
1.1	v0.7	R&D laboratory GM	Added new feature on Hardware re. B	March 31, 2016
1.2	v0.7	R&D laboratory GM	Added ACK/NACK messages on port 10 from sensor to server; New structure of message from server to sensor: 1 byte header and 1 byte footer introduced; TMELPS [24bit] increased to 16777215 sec; Added MODE1,2,3 feature; Added CNFGRGST definition; Added CNTELP definition; Added OPCNT definition; Port 20 packet definition changed (from sensor to server) Added TMALIVE	April 23, 2016
1.3	v0.7	R&D laboratory GM	Added FLAGS features: LED always OFF, Stop Blinking LED	May 9, 2016
1.4	v0.7	R&D laboratory GM	Adjusted Inhibition time on table 1 – technical specification Text correction on port 6 and 7 on chapter 4 Added CNFGRGST information on its definition on ch.3 Added more info to parameters in ch.3 Added LED blinking description message on port 20 on ch.4 Added payload information on port 12 specification – ch 5 Added graphical information on message from server to sensor on ch. 5	May, 25 2016
1.5	V0.8	R&D laboratory GM	Changed minimum battery level at 25%	June 27, 2016
1.6	V0.9	R&D laboratory GM	FW v0.9 supports OTAA Added OPCNT parameter into ALIVE Added info on INHIBTIME Amended NACK message length definition and added description of ACK and NACK messages on chapter 5. Amended TMELPS definition Amended MODE 3 message description of 10 Byte on chapter 6	Aug 25, 2016

2 Introduction

The IR868LR is a infrared passive sensor for indoor application.
It integrates a dual element pyroelectric detector for the detection of body heat in order to activate the alarm in case of intrusion. The sensor is suitable for apartments, offices, shops, buildings in general this thanks to the possibility to adjust its sensitivity, even for small areas such as motor homes. It has been designed to fit perfectly with any environment, aesthetically pleasing, compact and remarkably robust.
The use of digital technology obtained by the use of the microcontroller, coupled to the Fresnel optics it provides good accuracy in detecting (37 beams spread over 3 horizontal levels), immunity false alarms and high reliability without reducing the sensitivity of the IR868LR.
During the default inhibition time of 4 minutes, after a stabilization time of the sensor 40 seconds after the power on of the device, the sensor is not able to transmit any alarm.
The device is protected against tampering of the container; in case of manumission it transmits the code that identifies this type of event.
It has a variable coverage from 8 to 20 meters adjustable with a trimmer with an aperture of 100° to adapt to installation requirements and it has a temperature compensation and a white light filter to minimize false alarms.
Of considerable importance is the low power consumption in stand-by mode that allows to obtain a remarkable battery life, minimizing its replacement during operation.
Furthermore, the joint allows to easily obtain the right inclination in order to cover optimally the desired area.
IR868LR and IRUS915LR are equipped with the radio module ACL868x that allows the device to connect to public or private networks that support the protocol LoRaWAN 1.0
PIR sensor is configured as a node of class A (client version 3.4.1)
IR868LR and PBUS915LRH are equipped with an LED that blinks for 100ms every 15s if MODE 2 is set and when the number of detections counter equals the threshold CNTELPS. This gives a visual indication when a certain number of detections set is reached.
This wireless motion sensor includes the following features:

- 16mt coverage area (37 beams on 3 horizontal planes, opening 100 °)
- Adjustable sensitivity detection level
- Adjustable inhibition time from 5sec to 600sec (default 240sec)
- Default four minutes transmitter lockout time after an alarm that helps to extend battery life
- Cover-activated tamper
- Supervisory signals transmitted every 50 minutes (default value, it can be modified) to the receiver system (ALIVE signal)
- Sensor reports Low battery level (trouble) to the receiver system
- Buzzer for low battery indication
- LoRaWAN 1.0 compliant radio module
- Three beams



Three beams feature

2.1 Installation guidelines

This PIR was designed for indoor use in the presence of pets having a combined weight of up to 15 kg.

The following installation guidelines must be met to provide this false alarm immunity.

- The sensor must be mounted perpendicular to the floor, in particular cases it may be tilted by about 6 degrees towards the floor. The height of installation must be between 2.1 and 2.5 meters. (See fig. 2 & 3)
- The sensitivity trimmer should be typically in the middle of its stroke(fig. 1)
- The pet must not be allowed to climb on objects such as furniture, boxes, etc. within the field of coverage. See Figure 2 & 3 to determine the sensor's field of coverage.
- Room temperature must be kept between 16°C and 49°C (60° and 120° F)
- Do not aim the sensor at windows, fireplaces, air conditioners, area heaters, forced air heating vents, or place it in direct sunlight.
- Windows should be closed in any area which has an armed motion sensor.
- Position the sensor to protect an area where an intruder would be most likely to walk across the detection pattern (see Figure 2 & 3).
- Mount the motion sensor on a rigid surface which is free from vibrations.
- Mount the sensor permanently on a flat wall or in a corner. Do not set it on a shelf.

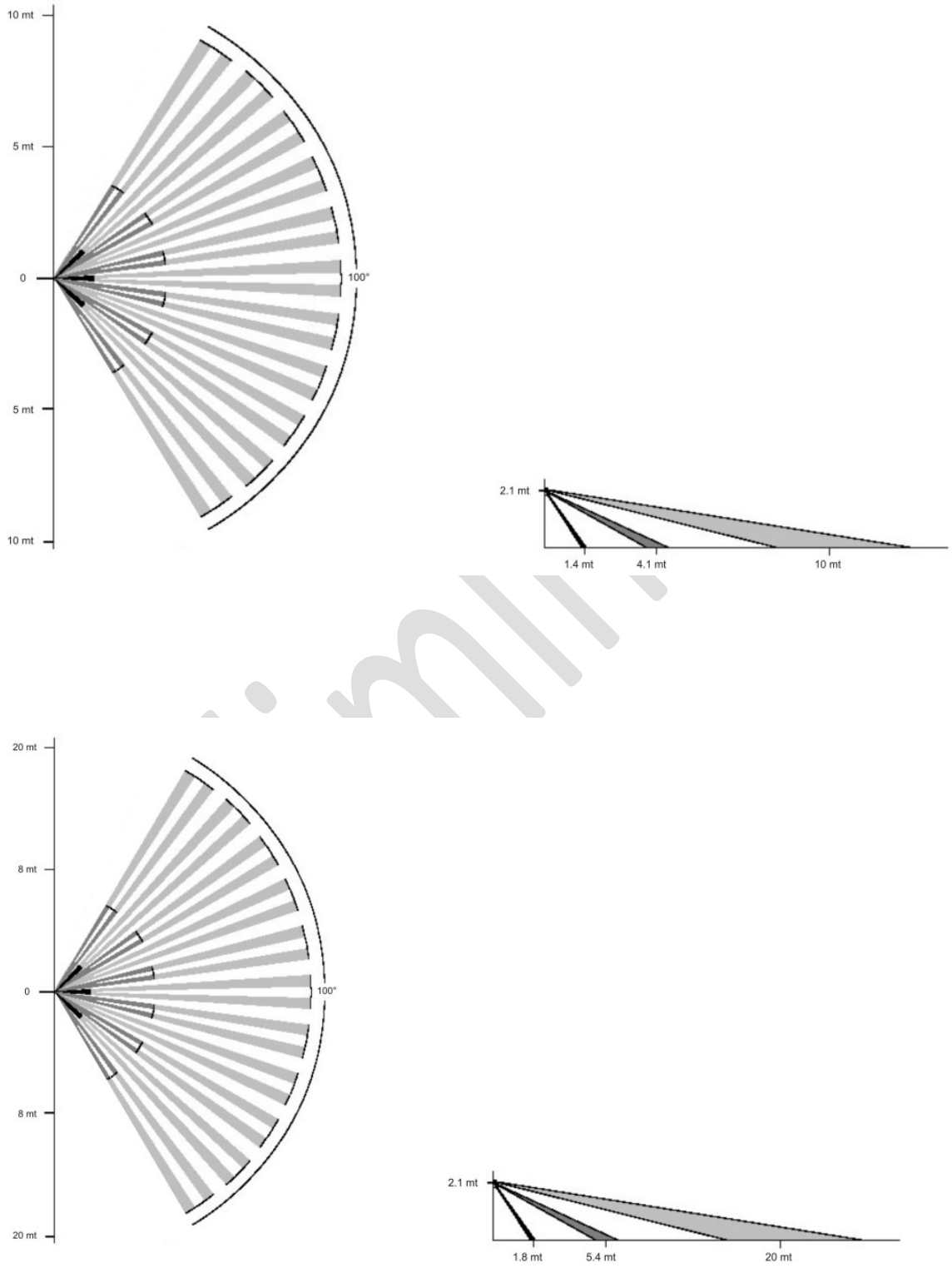


Fig. 3 (sensor mounted perpendicular to the floor)

2.2 Battery replacement

When the system indicates the sensor battery is low, replace it immediately.
Use the recommended replacement batteries (see Table 1 Technical Specification) or contact technical support for more information.
To replace the batteries, do the following:

1. To remove the sensor cover, press a small flathead screw-driver into the slot on both sides of the sensor. This will disengage the clips holding the cover and base.
2. Disconnect the battery cable from the board. Remove the old battery and replace it with another one as per battery specification reported in chapter 2.
3. Insert the replacement battery and plug the cable in to connector (see below picture)

CAUTION
RISK OF EXPLOSION IF BATTERY IS REPLACED BY AN INCORRECT TYPE.
DISPOSE OF USED BATTERIES ACCORDING TO THE INSTRUCTIONS

Only authorized and qualified personnel may do any of the assembly, disassembly, installation and commissioning work.

3 Technical Specification

Specifications				
Parameters	**Min**	**Typ**	**Max**	**unit**
Frequency band IR868LR	-	867.1 < f < 868.5	-	MHz.
IRUS915LR	-	902 < f < 928	-	MHz
RF power (EU868)	2	-	14	dBm EIRP
RF power (EN915)	2		18	dBm EIRP
Modulation		LoRa ™		
Protocol		LoRaWan 1.0 Class A Client 3.4.1		
RX sensivity			-138	dBm
Battery		1pz AA 3.6V lithium-thionyl 2700mA By EVE P/N ER14505V		
Temperature range	-20	+25	+55	°C
Antenna	-	PCB printed	-	
Power supply	2.1	3	3.6	Vdc
Consumption standby	13	15	17	uA
Consumption TX	60	70	80	mA
Alarm inhibit time	5	240 (default)	600	s
Dimension		120 x 60 x 45		mm
Reference standards		EN 60950-1:2006 + A11:2009 + A1:2010 + A12:2011 - EN 62311:2008 EN 301 489-1 V1.9.2 EN 301 489-3 V1.6.1; Part 3 EN 300 220 V2.4.1		

Table 1 Technical Specification

4 Parameter Definition

ALIVE

The payload is in raw format.

The 4Byte ALIVE message is composed by:

Name	Type	Function
BATTERY	Unsigned char (8 bits)	Report type and percentage of battery level
EVENT	Unsigned char (8 bits)	Event flag. See below
OPCNT	Unsigned char (16 bits)	Total number of detections

The ALIVE message is sent spontaneously to the server every 50min. This timing interval can be changed modifying TMALIVE from the server (see chapter 6)

BATTERY

	MSB 7	*6*	*5*	*4*	*3*	*2*	*1*	*0 LSB*
Bit value	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**

[7] Battery Type
1 = 3.6V Lithium-thionyl
0 = 3.0V Alkaline Battery

[6:0] battery level expressed as a percentage of charge

The battery voltage can be derived as follows:

Batt_LOW_LVL + (((Batt_HIGH_LVL - Batt_LOW_LVL) * percentage)) / 100)

Where:

Batt_LOW_LVL = 2100mV
Batt_HIGH_LVL = 3000mV if battery type is Alkaline
Batt_HIGH_LVL = 3600mV if battery type is Lithium-thionyl
Percentage = the value of bit [6:0] *(cannot have the value 0)*

CNTELPS

16 bit unsigned counter.

Specify the number of intrusions detected before to send an uplink event.

OPCNT

16 bit unsigned counter.

Number of intrusions detected.

This counter can be reset at the end of the transmission using CNFGRGST.

EVENT

1 Byte unsigned char.

	MSB 7	6	5	4	3	2	1	0 LSB
Bit value	0	0	0	0	0	x	x	x

[7:3] reserved

[2] **Battery status**
1 = low battery event (25%)
0 = battery OK

[1] **Tamper**
1 = Tamper alarm
0 = No Tamper alarm

[0] **Intrusion Alarm detected**
1 = Intrusion alarm detected
0 = No Intrusion alarm detected

If Low battery event occurred, the sensor will transmit a spontaneous message on port 20 (see ch 4)
More events are possible at the same time

FLAGS

16 bit parameter.
First byte is for settings, the second one is for requested command to be set.

	MSB 15	14	13	12	11	10	9	8 LSB
Bit value	0	0	0	0	0	0	0	x
	MSB 7	6	5	4	3	2	1	0 LSB
Bit value	0	0	0	0	0	0	x	x

[15:9] Unused - To be defined

[8] Setting LED always OFF
1: always OFF
0: if MODE 2 has been set the LED will blink when OPCNT=CNTELPS

[1] Setting Stop Blinking LED
1: stop blinking

[0] Reboot firmware
1 = reboot request

INHIBTIME

3 Byte unsigned counter.

Specify the inhibition time to be set to get an alarm.

Minimum is 5 seconds and maximum is 600 seconds. Default value is set at 240 seconds (4 minutes).

During this timing interval the sensor can not transmit information any message to the server.

TMELPS

24 bit unsigned seconds counter ONLY for MODE 3.

It specifies the sampling period on MODE 3.

Once TMELPS is elapsed, the sensor sends a message on port 20 to the server and then it is reset to 0 ready for a new counter period.

Programmed values below 15 sec, will be forced to 15. Values above n*15 and below (n+1)*15 will be forced to (n+1)*15 [sec] so the minimum setting timing period is 15 seconds with multiple of 15 seconds.

Allowed TMELPS value is comprised from 15 to 16777215 sec (about 194 days)

Example:

- The server send TMELPS at 10 seconds then the sensor will force this at 15 seconds
- The server send TMELPS at 31 seconds then the sensor will force this at 45 seconds

TMALIVE

16 bit unsigned seconds counter.

It specifies the number of seconds between two ALIVE events.

TMALIVE counter is set to 0 at the end of every transmission of the ALIVE event.

Programmed values below 15 secs, will be forced to 15

Values above n*15 and below (n+1)*15 will be forced to (n+1)*15 [sec] so the minimum setting timing period is 15 seconds with multiple of 15 seconds.

Allowed TMALIVE value is comprised from 15 to 65536 seconds

Default TMALIVE of IR868LR and IRUS915LR is 50 minutes (3000 sec)

E.g.:

- The server sets TMALIVE at 9 seconds then the sensor will force this at 15 seconds
- The server sets TMALIVE at 40 seconds then the sensor will force this at 45 seconds

ACK/NACK

3 bytes Char <ACK> and 4 bytes Char <NACK>)

Acknowledgement signal sent by the sensor to server. It can be ACK or NACK depending whether or not the message received from the server is fine. It also specifies on which protocol port the message has been received from the server. This message is sent every time the sensor receive a setting message from the server on ports 9, 11, 12 and 13

CNFGRGST

16 bit total.

This parameter is used in order to reset the OPCNT counter and to send the OPCNT value if the CNTELPS threshold is reached (only MODE 3)

	MSB 15	14	13	12	11	10	9	8 LSB
Bit value	0	0	0	0	0	0	0	0
	MSB 7	6	5	4	3	2	1	0 LSB
Bit value	0	0	0	0	0	0	x	x

[15:2] Unused
To be defined

[1] OPCNT value (only for MODE 3)
1 = send OPCNT value if OPCNT=CNTELPS
0 = OPCNT value is NOT sent (defaut value)

[0] OPCNT counter reset (MODE 2 and MODE 3)
1 = reset request
0 = OPCNT is not reset (default value)

MODE

Unsigned char (8 bits).

MODE is defined as following:

- **MODE 1** (<01>): In this mode every intrusion detected generates an uplink message. The opening counter OPCNT on the transmitted message is incremented by 1 and never reset.

- **MODE 2** (<02>): In this mode, the sensor generates an uplink message only when the specified counter CNTELPS is reached. Allowed CNTELPS number is comprised from 1 to 65535.
  At the end of the uplink message, the OPCNT counter can be reset using CNFGRGST

- **MODE 3** (<03>): In this mode, the sensor generate an uplink message when the specified time TMELPS is elapsed. Allowed TMELPS (24bit) number is comprised from 15 to 16777215 seconds. Programmed values below 15 secs, will be forced to 15. Minimum setting timing period is 15 seconds with multiple of 15 seconds.
  The uplink message can be generated also based on CNTELPS, this means the sensor will send a message when OPCNT=CNTELPS, so independently from TMELPS.
  At the end of any uplink message, the OPCNT counter can be reset using CNFGRGST.

5 Message from PIR sensor to server

Different ports on LoRaWAN protocol are used to transmit messages to the server.

Port assignments as follow:

From sensor to server	Port #
Presentation	5
Serial Number	6
FW release, library release, HW release	7
Battery level	8
Alive	9
ACK	10
Specific Sensor Information message	20

Port 5 message specification:

The payload contains a string with the model of the sensor in ASCII format (e.g. IR868LR)
The presentation message is sent every times the PIR sensor performs a reboot.
The reboot is caused by a power-on or by a server command.
The presentation message is provided also if the server send an "Enq" on port 5. See chapter 6.

Port 6 message specification:

The payload contains the serial number string in ASCII format. 8 bytes length
(e.g. AA112233445566FF)
The Serial Number message is provided if the server send an "Enq" on port 6. See chapter 6.

Port 7 message specification:

The payload of 11 bytes ASCII format contains:

- the FW release (3 bytes; e.g.: 0.5);
- the LoRaWAN client library release (5 bytes; e.g.: 3.4.1);
- the HW release (1 byte; e.g.: B)
- Fields are separated by char comma ","

Example:
the HEX payload for the above examples is
30 2e 35 2c 33 2e 34 2e 31 2c 42 (ASCII: **0.5,3.4.1,B)** → 11bytes total
The FW release, LoRaWAN client library version, HW release message message is provided if the server send an "Enq" on port 7. See chapter 5.

Port 8 message specification:

The payload of 1 byte contains battery type and current percentage charging level. Refer to BATTERY parameter definition at chapter 3.
The battery Level message is sent spontaneously on port 8 if the battery charging level is below 25%.
The Battery Level message is provided if the server send an "Enq" request on port 8. See chapter 6.

Port 9 message specification:

The payload contains the ALIVE message. Refer to ALIVE parameter definition at chapter 3
The ALIVE message is sent every 50 minutes as default timing value. Refer to chapter 6 to change this value from the server.

Port 10 message specification:

Ack and Nack messages by the sensor to the server to confirm that a good or corrupted setting message is received by the sensor on ports 9, 11, 12 and 13 from the server.
If the message received from the server is fine then Ack message is sent otherwise a Nack message is transmitted.
The total message contains also the port number on which the sensor received the message from the server.

- The Ack message has the following structure (4 Byte total):

Name	Type	Function
Ack	Unsigned char (24 bits)	Ack message
PORTNUMB	Unsigned int (8 bits)	Specify the port number where the message has been received

E.g.:
- 41636b0c → 4 Byte total message
- 41636b HEX → <Ack> ASCII 3Byte
- 0c → <12> Int Dec 1Byte

In this case the sensor is acknowledging the server to have received a good message on port 12

- The Nack message has the following structure (5 Byte total):

Name	Type	Function
Nack	Unsigned char (32 bits)	Nack message
PORTNUMB	Unsigned int (8 bits)	Specify the port number where the message has been received

E.g.:
- 4e61636b0b → 5 Byte total message
- 4e61636b HEX → <Nack> ASCII 3Byte
- 0b → <11> Int Dec 1Byte

In this case the sensor is acknowledging the server to have received a corrupted/bad message on port 11

Port 20 message specification:
The payload is in raw format (3 Bytes)

Name	Type	Function
EVENT	Unsigned char (8 bits)	Event flag. See chapter 3
OPCNT	Unsigned int (16 bits)	Intrusions detected. See chapter 3

The sensor sends **spontaneously** a message with the above structure to the server if :

- If the tamper switch change its status (from CLOSE to OPEN and vice versa)
  The tamper status is reported into the EVENT parameter transmitted

- If the battery level reaches the 25% of the full charge. If this the case the sensor will transmit every 60min the battery value after the first advise.

- If **MODE 1** has been set by the server (see chapter 3) the sensor sends OPCNT value to the server every time an intrusion is detected. OPCNT is never reset.

- If **MODE 2** has been set by the server (see chapter 3) the sensor sends a message to the server if
  OPCNT = CNTELPS (the measured intrusion detected equals the counter threshold)
  OPCNT can be reset using CNFGRST parameter once the message has been sent to the server.

  Note for MODE 2:
  IR868LR and IRUS915LR are equipped with an LED that blinks for 100ms every 15s when OPCNT=CNTELPS if bit 8 on FLAGS parameter is set to 0

- If **MODE 3** has been set by the server (see chapter 3) the sensor sends a message to the server if:

  1. *OPCNT = CNTELPS* (the measured intrusion detected equals the counter threshold)
     OPCNT can be reset using CNFGRST parameter once the message has been sent to the server.
     TMELPS is not reset.

  OR

  2. If *TMELPS is elapsed*, the sensor sends the message and then it is reset ready for a new counting period.
     OPCNT can be reset using CNFGRST parameter once the message has been sent to the server.

6 Message from server to sensor

The nature of LoraWAN class A permits to exchange messages only when the end-device transmits data to the server (uplink).
After sending the data, the end-device enable two RX windows to receive packets from the server.
In these windows, the server is able to send the data at the end node using specifics LoRaWAN protocol ports.
Downlink communications from the server at any other time different from the above mentioned RX windows, will have to wait until the next scheduled uplink occurs.

Every message from server to sensor has 1 byte header that contains the total length of the message and 1 byte footer that contains the checksum. The checksum is calculated doing a logical XOR of all the bytes on the message except the last one, which is the checksum itself. Refer to Message Builder Toll to create and verify the right message to send to the sensor.

Header (1Byte)	Message on port 5,6,7,8,9,11,12,13	Footer (1Byte)

Port assignments as follow:

Form server to sensor - Request for:	Port #
Presentation	5
Serial Number	6
FW release, library release, HW release	7
Battery level	8
Setting ALIVE interval TMALIVE	9
Setting INHIBTIME	11
Setting MODE	12
FLAGS	13

Ports 5, 6, 7 and 8 message specification:
This message is used by the server in order to have back from the sensor the required information. A text “Enq” message (HEX 456E71) must be sent to one of these ports to ask the sensor for the required information. The sensor will reply with a message on the same port as reported in chapter 5.
Total message length is 5 byte (3Byte for the <ENQ> text message and 1Byte header and and 1Byte footer)

Example:
To send and "Enq" on port 6 in order to receive back the Serial Number of the sensor, the server sends the HEX message:

05456E715F

Where

- 05: total length of the message 5Byte
- 456E71 → <Enq> (HEX to ASCII)
- 5F: Checksum

Port 9 specification:
Setting TMALIVE sampling ALIVE time period (2 Byte). See chapter 4 for parameter definition.
Total message length 4 byte (including header and footer)

Port 11 specification
Setting INHIBTIME (3Byte) from 5 sec to 600 sec. Default value is 240 sec. See chapter 4 for parameter definition.
Total message length 5 byte (including header and footer)

Port 12 specification:
Setting MODE "X" (X=1,2,3).
To set MODE, the server must send to the sensor a message on port 12.
The total length of the message is 9 Byte on MODE 1 and MODE 2: 1Byte header (total length of the message), 1Byte for MODE, 2Byte for CNFGRGST, 2Byte for CNTELPS, 2Byte for TMELPS and 1Byte for footer (checksum).
The payload as per the following table:

Name	Type	Function
Header	Unsigned char (8bits)	Total length of the message in Byte
MODE	Unsigned char (8 bits)	Set the MODE: Mode 1: see chapter 3 for more details Mode 2: see chapter 3 for more details Mode 3: see chapter 3 for more details
CNFGRGST	Unsigned int (16 bits)	Set the way to use OPCNT in MODE 2 and MODE 3
CNTELPS	Unsigned int (16 bits)	Number of intrusions before to send the message
TMELPS	Unsigned int (16 bits)	Sampling period – ONLY MODE 3
footer	Unsigned char (8bits)	Checksum

Refer to chapter 3 for MODE, CNFGRGST, CNTELPS and TMELPS parameters definition.

The total length of the message is 10 Byte on MODE 3: 1Byte header (total length of the message), 1Byte for MODE, 2Byte for CNFGRGST, 2Byte for CNTELPS, 3Byte for TMELPS and 1Byte for footer (checksum).
The payload as per the following table:

Name	Type	Function
Header	Unsigned char (8bits)	Total length of the message in Byte
MODE	Unsigned char (8 bits)	Set the MODE: Mode 1: see chapter 3 for more details Mode 2: see chapter 3 for more details Mode 3: see chapter 3 for more details
CNFGRGST	Unsigned int (16 bits)	Set the way to use OPCNT in MODE 2 and MODE 3
CNTELPS	Unsigned int (16 bits)	Number of intrusions before to send the message
TMELPS	Unsigned int (24 bits)	MODE 3 sampling period
footer	Unsigned char (8bits)	Checksum

Refer to chapter 3 for MODE, CNFGRGST, CNTELPS and TMELPS parameters definition

Example 1:
to set MODE 2, without resetting OPCNT counter after the uplink and when OPCNT=CNTELPS=100 so after 100 intrusions, the HEX message the server must send on port 12 is

09020000006400006F → 9 Byte total

Where
- 09 HEX: total length of the massage (9 bytes) → 1 Byte
- 02 HEX: set MODE 2 → 1 Byte
- 0000 HEX: CNFGRGST all set to 0 → 2 Byte
- 0064 HEX: CNTELPS set to 100 → 2 Byte
- 0000 HEX: TMELPS set to 0 (to be used only in MODE 3. Any value is ignored by the sensor if not in MODE 3) → 2 Byte
- 6F HEX: checksum → 1 Byte

Example 2:
To set MODE 3, resetting OPCNT counter after the uplink, whit a timing threshold of 100 sec, the HEX message the server must send on port 12 is:

0A03000100000000646C → 10 Byte total

Where
- 0A HEX: total length of the massage (10 bytes) → 1 Byte
- 03 HEX: set MODE 3 → 1 Byte
- 0001 HEX: LSB of CNFGRGST register set to 1 to reset OPCNT after the transmission → 2 Byte
- 0000 HEX: CNTELPS set to 0 → 2 Byte
- 000064 HEX: TMELPS set to 100sec → 3 Byte
- 6C HEX: checksum → 1 Byte

Example 3:
To set MODE 3, resetting OPCNT counter after the uplink, with a timing threshold of 120 sec and a threshold of numbers of intrusions CNTELPS=80, the HEX message the server must send on port 12 is:

0A030001005000007820 → 10 Byte total

Where
- 0A HEX: total length of the massage (10 bytes) → 1 Byte
- 03 HEX: set MODE 3 → 1 Byte
- 0001 HEX: LSB of CNFGRGST register set to 1 to reset OPCNT after the transmission → 2 Byte
- 0050 HEX: CNTELPS set to 80 → 2 Byte
- 000078 HEX: TMELPS set to 120sec → 3 Byte
- 20 HEX: checksum → 1 Byte

Notice that if OPCNT=CNTELPS before than TMELPS expires, the sensor sends a message to the server but TMELPS is not reset.

Port 13 specification:
Setting FLAGS parameters. Refer to FLAGS (16 bit) definition at chapter 3.
Total message length 4 byte (including header and footer)
Example:
To set a reboot of the sensor, the server must to sent the following HEX message:

04000105 → 4 Byte

Where:
- 04: total length of the message → 1 Byte
- 0001 → 0000 0001 (HEX to BIN) the LSB 1 indicates the reboot request → 2 Byte
- 05: checksum → 1 Byte

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