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1. Introduction

Sensor provides the data by UART interfaces.

Data that provided by sensor is indicating about moving target inside of detecting zone and measured relative speed of detected objects/objects.

By default, the sensor ignores targets that move in direction away from the sensor and provides data only for targets that move toward the sensor. But optionally it can be changed by command and sensor will provide data for all objects that move from and toward the sensor.

The speed measured by sensor is not an absolute speed of the target but relative speed between target and sensor.

The accuracy of speed measurement is $\pm 1\text{km/h}$.

2. UART interface

UART interface is available on 4-pin connector on the sensor's PCB. Pinout of this connector is shown on the figure 1:

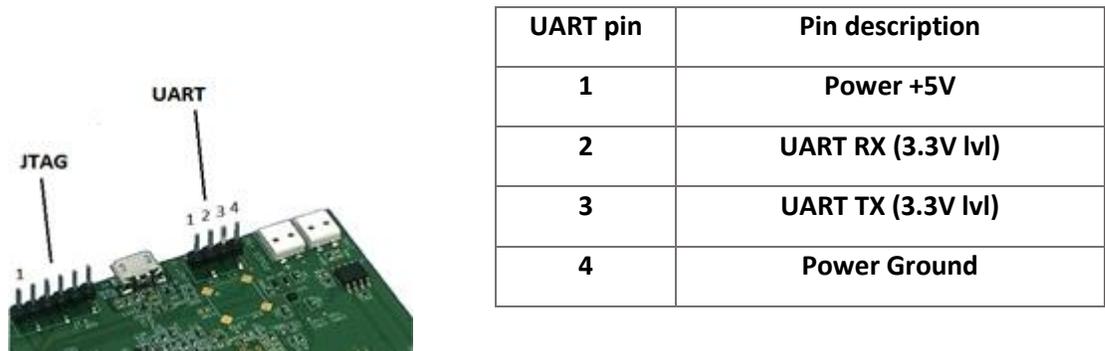


Fig. 1 – UART connector pinout

UART interface is used for sensor's data receiving and for changing sensor's parameters as well. In case of moving object detection sensor sends "Alarm" message that also contains relative speed of the detected object. When there is no detection sensor sends "Ping" message every 1 minute to indicate that sensor is "online".

Sensor's data format:

Sensor type 0x5A	Sensor ID	Command ID	Value	CRC8
------------------	-----------	------------	-------	------

Data format: HEX

Sensor type – common header for 24GHz radar, always 0x5A

Sensor ID – individual sensor identifier in range from 1 to 250. Default value is 1.*

Command ID and Value – command identifier and parameter.

Example: 5A 01 C4 10 C2 – Setup sensor with id 0x01 to change minimum interesting speed to 10km/h;

* The sensor's ID is responsible for sensor frequency sub band. If ID is odd – sensor has type 1 sub band, if ID is even – type 2. Read about sub bands in detail in sensor user manual.

2.1 Commands description

2.1.1 Alarm

<i>Command:</i>	C1
<i>Possible values:</i>	Value indicates the speed of detected object or average speed if several objects are moving inside of detection zone.
<i>Comment:</i>	One directional. Can be sent only from sensor.

2.1.2 Ping

<i>Command:</i>	C2
<i>Possible values:</i>	N/A
<i>Comment:</i>	Ping command to indicate sensor is active. One directional. Can be sent only from sensor.

2.1.3 Set sensor ID

<i>Command:</i>	C3
<i>Possible values:</i>	0x02 ... 0xFF – set sensor ID respectively
<i>Comment:</i>	0x01 – default ID value of new sensor. The frequency sub band of the sensor is changed by changing sensor ID. If ID is odd – sensor has type 1 sub band, if ID is even – type 2. After enabling power or after changing ID, sensor takes about 20 seconds to tune and fit its frequency into sub band that has been programmed. Sensor stores received value in flash memory; sensor answers same packet if it received without errors.

2.1.4 Set minimum interested speed

Command:

C4

Possible values:

0x04 – 0xC8 – New minimum speed value in kilometers per hour.
Possible values from 4km/h to 200 km/h.

Comment:

Value by default – 10 km/h.

Sensor indicates by “alarm” messages detection of target only if it’s speed is higher than this value.

The values lower than 10 would allow to detect pedestrians but direction for slow (under 10km/h) targets not always can be clearly distinguished. Also, the relative speed of fast object can be low when it moves on the relatively big angle to the sensor.

As result when you setup the speed limit lower than 10km/h it can cause false alarms and alarm messages with low speed should be treated separately.

The accuracy of speed measurement is ± 1 km/h.

Sensor stores received value in flash memory; sensor answers same packet if it received without errors.

2.1.5 Sensitivity coefficient

Command:

C5

Possible values:

0x00 – 0xFA

Comment:

Value by default – 17 (0x11).

The coefficient sets the amplitude threshold and can be used to adjust detection / false-alarm rate.

The default value has been calibrated for detection car on the road up to 100m away from the sensor.

For other conditions, this coefficient should be adjusted empirically if necessary.

Small values (<10) rather leads to not adequate behavior and constant alarm.

Sensor stores received value in flash memory; sensor answers same packet if it received without errors.

2.1.6 Enable backward objects detection

Command:

C6

Possible values:

0x00 or 0x01 to Disable/Enable detection of objects that moves away from the sensor.

Comment:

Value by default – 0x00 (Disabled, backward targets are ignored).

By default, sensor ignores targets that move in direction away from the sensor and provides data only for targets that move toward the sensor.

If enable this parameter sensor will provide “alarm” messages for all moving targets inside of detection zone.

Other values are ignoring.

Sensor stores received value in flash memory; sensor answers same packet if it received without errors.

2.1.7 Wrong command or CRC

Command:

C7

Possible values:

0xC7 if the requested command is not existing.
Or correct CRC value if it is wrong in received message.

Comment:

If sensor receives this command, then sensor repeats last message one more time.

2.2 Error-detecting code description

The last byte of message to and from sensor should contains error-detecting code calculated according to CRC8 rules.

CRC8 calculation parameters: initial value 0x00; polynomial value 0x07.

Computation code for reference:

```
crc = gencrc(&data[0], 4);

uint8_t gencrc(uint8_t * data, uint8_t len)
{
    uint8_t crc8 = 0x00;

    for (uint8_t i = 0; i<len; i++)
    {
        crc8 ^= *data;
        for (uint8_t j = 0; j < 8; j++)
        {
            if ((crc8 & 0x80) != 0)
                crc8 = (uint8_t)((crc8 << 1) ^ 0x07);
            else
                crc8 <<= 1;
        }

        data++;
    }

    return crc8;
}
```

For checking crc8 value you can refer to website <https://crccalc.com/>.

3. Demo software

Currently Umain provides same demo software for car detection as for security application and it can be simply used to evaluate the sensor potential and for tests. Software should be connected to sensor through UART interface.

GUI Software for security application is shown on the figure 2.

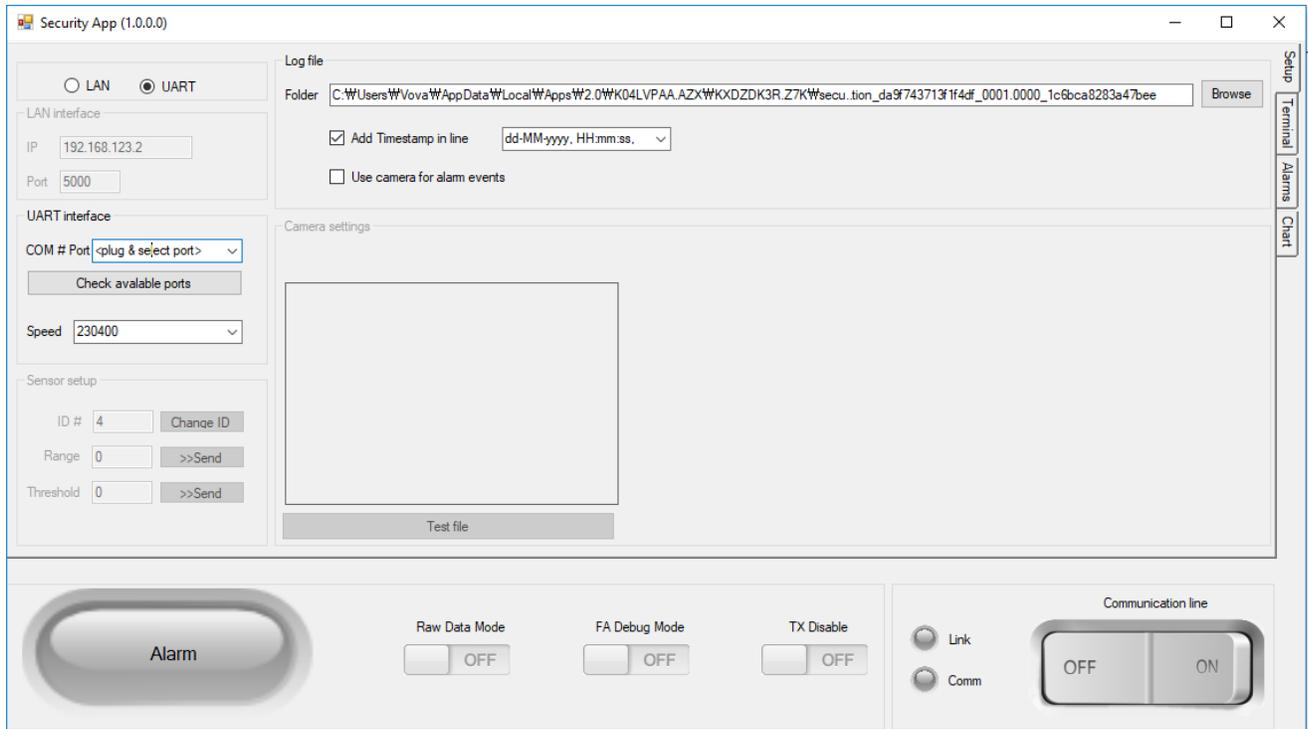


Fig. 2 – GUI Software for security application

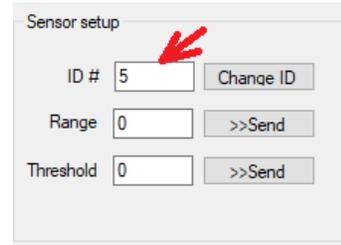
3.1 GUI connection

To setup GUI software follow the steps:

- 1) Connect sensor to PC by USB-UART bridge. Chose port and setup the speed to 230400 baud rate.
- 2) Press switch “Communication line”. If the communication is setup then led “Comm” will change to green.

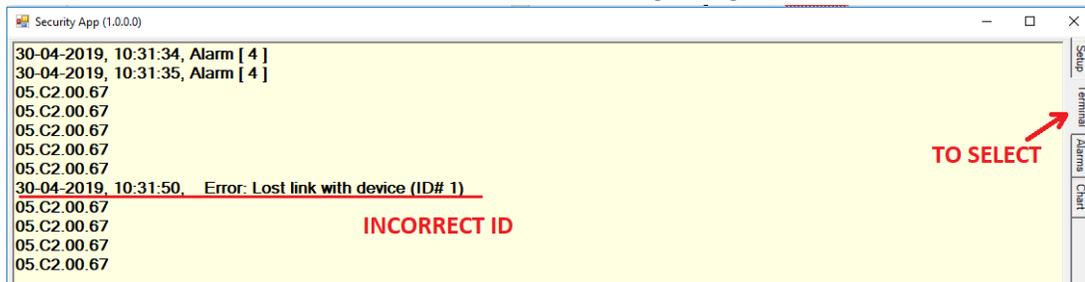


- 3) When communication is open, the menu “Sensor setup” becomes available. Set the correct ID of the connected sensor by input right value to the window (1 by default). Do not push button “Change ID” because it is only for case when you need to change it in the sensor.

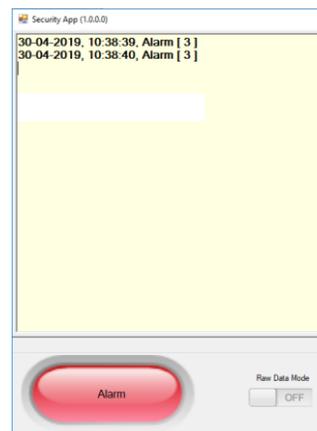


- 4) If ID is correct, then indicator “Link” will blink when sensor sends “Ping” messages. If ID of the connected sensor is different the raw messages will appear in the “Terminal” window*. Also, if sensor is disconnected and ping is lost then software will indicate an error message and “Link” led will be faded. As soon as security demo software is used it often shows error message “Lost link” because for security application ping message came every 3 seconds and for car detection - every one minute.

*To select terminal window, click to folder “Terminal” at right edge of GUI.



- 5) If all preparations are correct, the terminal window will display the “Alarm” messages from the sensor when moving object is detected inside of working zone. Software informs user in terminal window with blinking alarm “lamp” for few seconds and with message that includes event datetime and speed in km/h in square brackets [X].

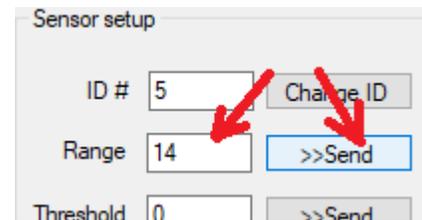


3.2 Sensor setup through GUI

Sensor parameters can be set using GUI software on the “Setup” page of GUI.

- 1) To change sensor ID, press the key “Change ID” then change value in the field and the press Enter.
Default value is “1”.
- 2) To change minimum interesting speed of the sensor input the value in the Range field and press “>>Send”.
Default value is 10km/h.
- 3) To setup additional sensitivity coefficient input the value in the Threshold field and press “>>Send”.

When sensor applies changes, it sends message with applied value back and it can be seen in the Terminal page. Current value can be known if to try to setup “0” value.



4. Errata

- 1) For sensors that provided before 26 August 2020 the setting “**Enable backward objects detection**” should be applied last. Other settings disable this parameter in flash memory of MCU when applied.