UMAIN Thunder Series UWB Radar Sensor User Manual

UMAIN Thunder Series UWB Radar Sensor

Contents

Introduction

Sensor “Thunder Series” is an impulse radar based on Ultra-Wide Band technology in high band areas (7GHz-9GHz), which can be used to detect the presence of person or animals within detection range. US Federal Communications Commission (FCC) authorized the definition of UWB and the use of frequency bands and limited uses in February 2002.

Using a very wide frequency band compared to conventional systems, low-power signal energy is distributed to spectra of several GHz bandwidth.

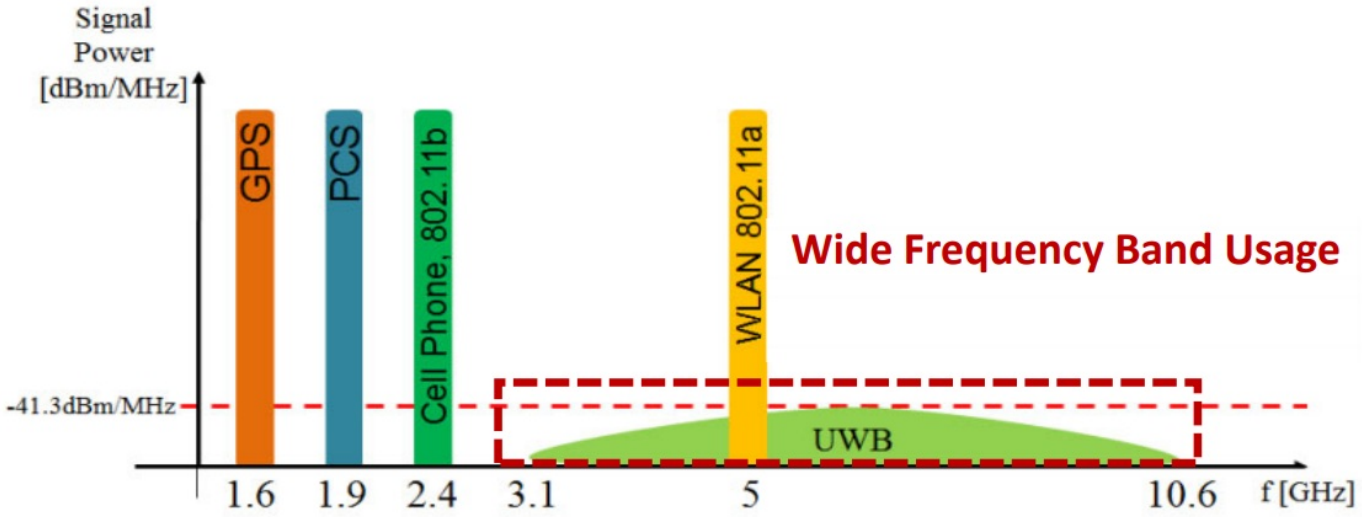
Sensors can detect a person’s respiration signal also have reliable capture performance and are designed to reduce false alarms for commercial use.

For this purpose, sensor contain two fields in detection solution: Doppler detector and Vital Signal detector. Doppler detector allows to detect movements of person’s inside of area, Vital Signal catch signals when body is unmoved (sleeping, reading book or watch tv etc.).

Sensor “Thunder Series” provides the data by UART interface. Sensor’s maximum working distance can be adjusted through UART interface or using IR remote controller.

Data that provided by sensor is indicating about area occupancy. Two numbers are representing motion detection and respiration detection.

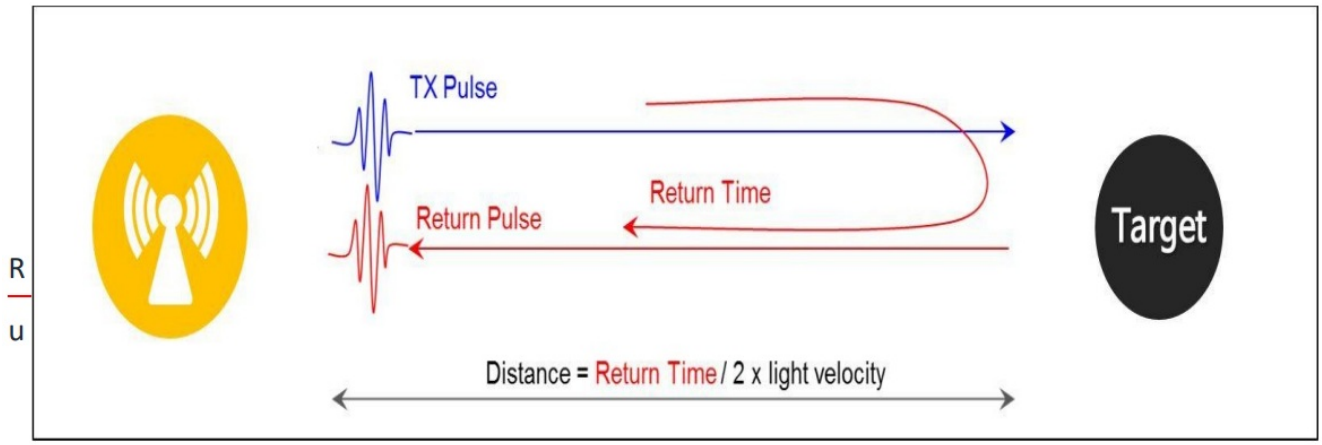
This device complies with Part 15.517 of the FCC Rules. This equipment may only be operated indoors. Operation outdoors is in violation of 47 U.S.C. 301 and could subject the operator to serious penalties.



IR-UWB Radar System

- IR-UWB Radar measures distance using time reflected from the detection object using nano-second or less pulse heat.
- The smaller pulse size, the more precise the measurement and the more information it can contain.
- The precision of the target is improved compared to normal radar and has less impact on the surrounding environment.
- Because it uses short pulses, it can also be used in the security field, and because of its high permeability, distance measurement is possible even if there are obstacles.
- To estimate the distance of an object, we need to eliminate background noise and compensate for signal attenuation

<System of UWB Radar>

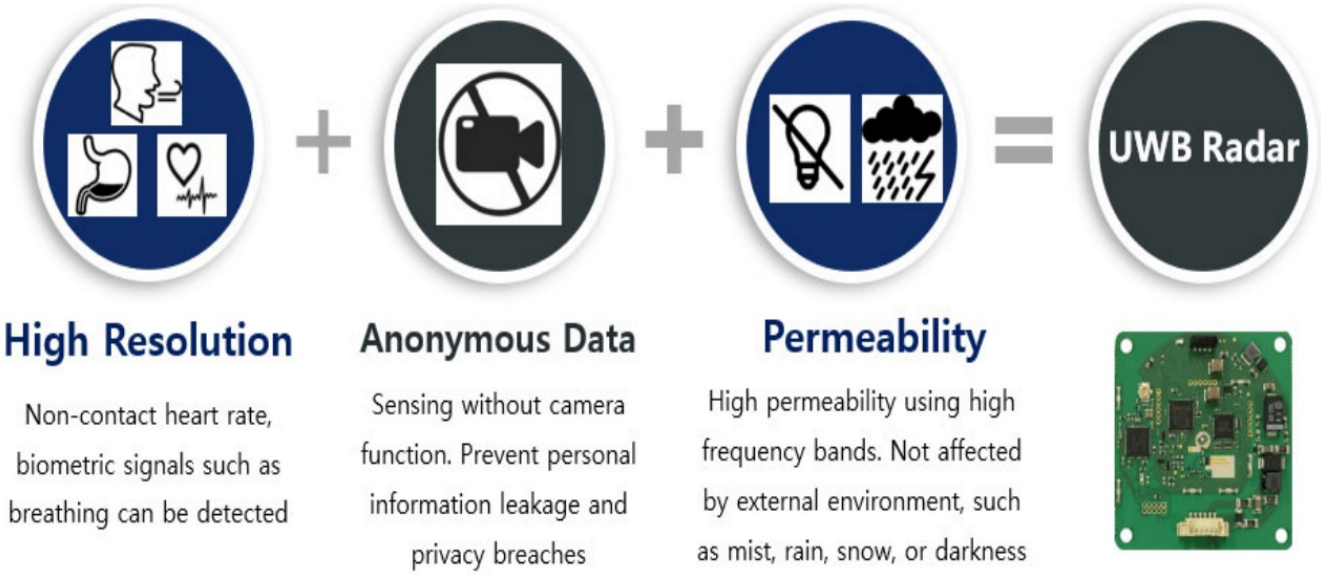


If you look at the figure above, you can see the Tx pulse.

- For biometric purposes at close range (within 10 meters)
- Low power operation according to domestic and international standards
- Key technologies of the fourth industry used in biometric signal detection and human detection technologies at home and abroad, which are harmless to the human body (from 1/700 to 1/1,500 levels of first-class mobile phones)
- Small objects, small motion detection, and strength

UWB Technical Advantages

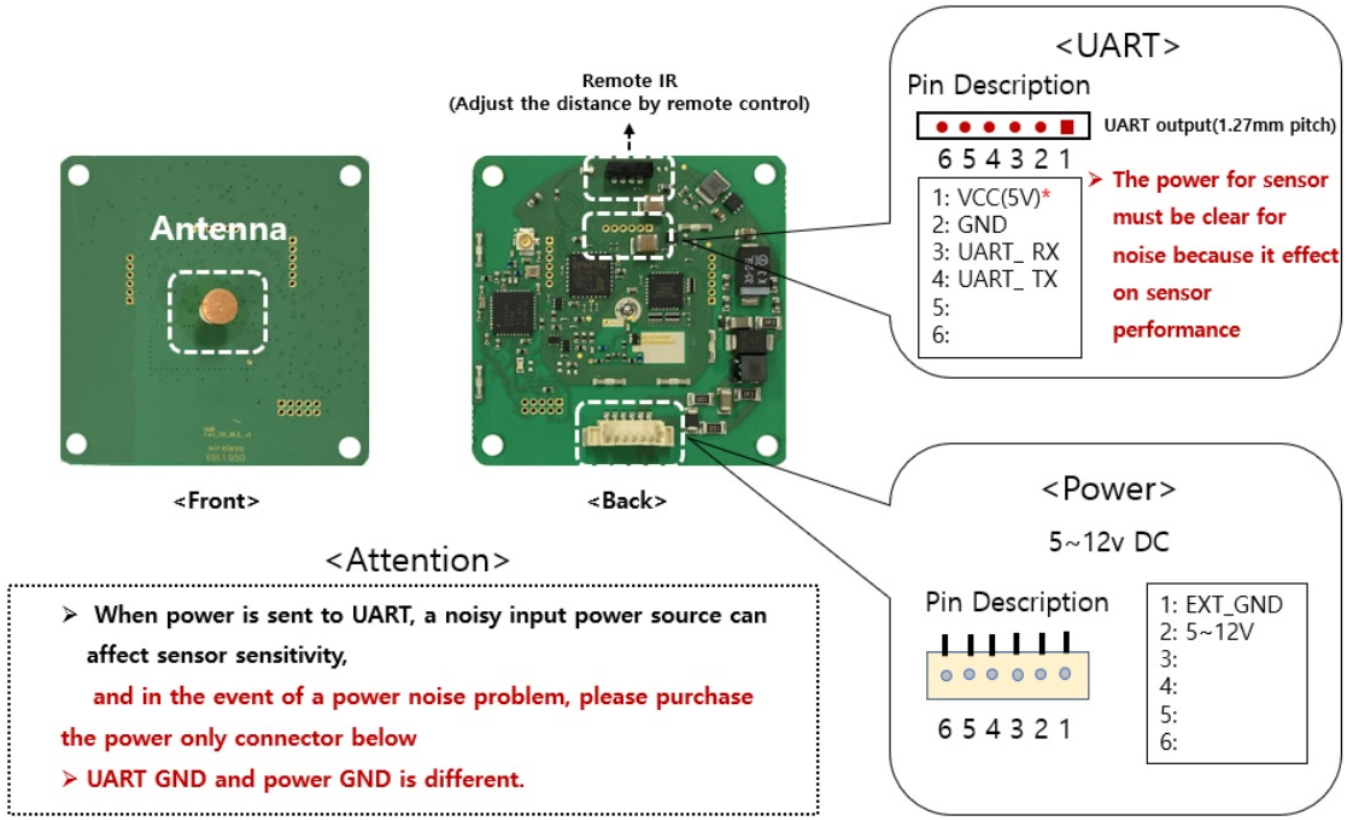
- Radar technology is harmless to the human body for 24 hours a day (most important)
- Low power of radio waves compared to other electronic devices
- The size of the pulse is very short, allowing precise measurements
- Use in security because of short pulses
- Good permeability, allowing distance measurements even with obstructions
- Low power output, available for low power use



Product Specification

Hardware Specification	
RF central frequency	7.9GHz +/- 0.15GHz
RF bandwidth	>500MHz
RF power	<-42dBm/MHz
Antenna type	Omni directional, Directional
Range resolution	50cm
Detecting range	5m max
Detecting speed of motion	0.2 ~ 1.0m/s
Detecting vital signs	0.13 ~ 0.7Hz
Warm-up period	<30 sec (calibration time)
Alarm Delay	1sec (min)
Interface Specification	
Outputs (default/optional)	UART
Communication output (optional)	9600bps, 57600bps, 115200bps, 230400bps
Inputs (default/optional)	IR remote control
R compatible decoder	NEC (10keys)
Communication input (optional)	Remote control
Electrical Specification	
Current supply	Standby 10mA / Max. 20mA
Voltage input	VDC 12V/Class B 9.6V ~ 14.4V
Functional Extra Low Voltage	VDC 5V (min)
Time of power interrupt	<1sec (max)

Terminal Information

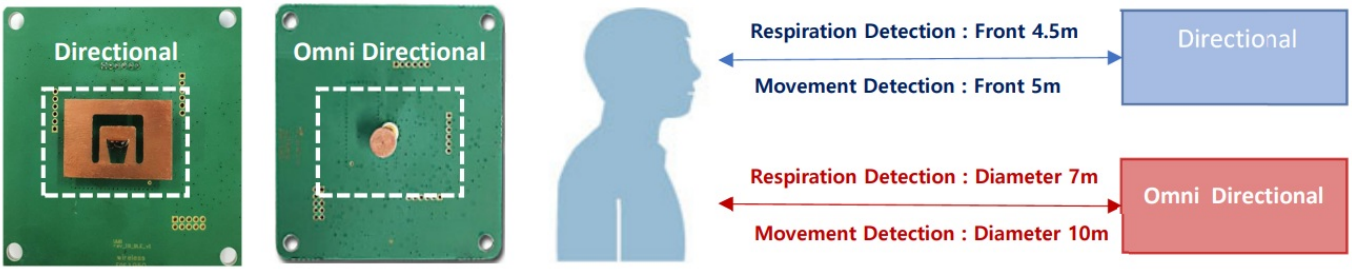


Difference between Omni Directional and Directional

There are two types of Thunder series products, Omni Directional and Directional. The table below shows the difference between Omni Directional and Directional based on the antenna specifications.

Parameter	Value	Value
Antenna Type	Omni directional	Directional
Antenna Angle	X-Z Plane: 360º Y-Z Plane: 60º	X-Z Plane: 50º~80º Y-Z Plane: 60º
Antenna Gain	XZ Plane: 4.91(min.) dBi YZ Plane: 4.66(min.) dBi	XZ Plane: 7(min.) dBi YZ Plane: 7(min.) dBi

Figure below shows the model of an Omin Directional antenna and Directional antenna and the difference in respiration detection distance.



UART interface

UART interface is available on 6-pin connector inside of the sensor PCB. Pinout of this connector is described on picture below:

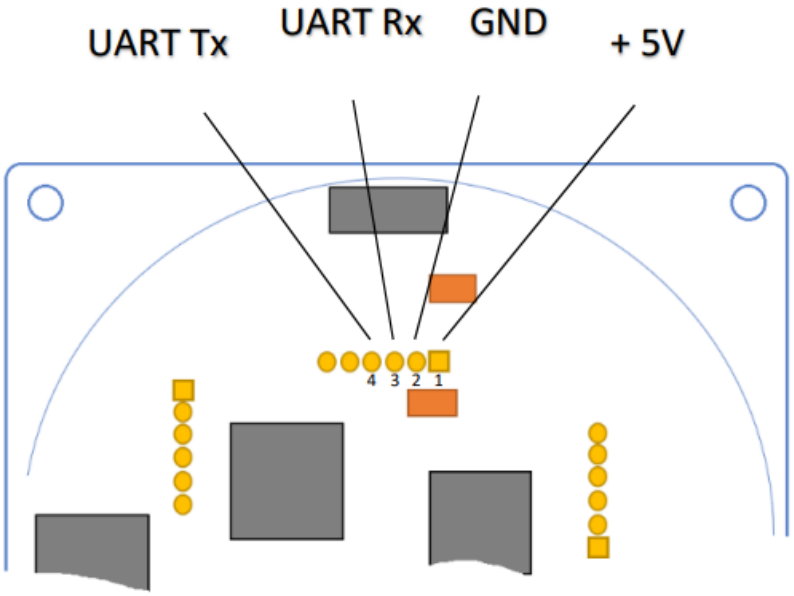


Fig. 1 – UART connector pinout

UART interface can be used for sensor's data receiving and for changing sensor's parameters as well. Result of sensor detection is represented in two values: "motion marker" and "respiration marker".

Table 1 – Description of sensor output variables

Situation:	Not occupied	Occupation detected (Motion detected)	Occupation detected (Respiration detected)
First value "Motion marker"	0	Min:100 Max:4800 Value represents how strong the environment was changed since previous measurements.	–
Second value "Respiration marker	0	–	Min:6 Max:40 Value represents estimated respiration rate (BPM).

Default settings

By default, data provided in event driven mode. Which means that sensor sends the data when motion or respiration detected. The message after first detection is sending during 1 second. For continuous event sensor sends messages with delay around 3 second.

In case of no detection, sensor sends zero values every 1 minute to indicate that sensor is "online".

Data format is ASCII and represented as "val1, val1". Default communication speed is 9600 bps. Default sensor's ID is 0x00.

Optional settings

Parameters of serial communication can be adjusted as follow:

- Communication speed:
    1. 9600 bps.
    2. 57600 bps.
    3. 115200 bps.
    4. 230400 bps.
- Sending method:
    1. Event driven.

       Sensor sends the data when motion or respiration detected. The message after first detection is sending during 1 second. For continuous event sensor sends messages with delay around 3 second. In case of no detection, sensor sends zero values every 1 minute.
    2. Continuously sending.

       Sensor sends the data continuously with fixed time interval from 1 to 180 seconds.
    3. By request.

       Sensor sends the data when host request it.
- Data format:
    1. ASCII.

       Data format is represented as “val1, val1” (in C: printf(%d, %d\r\n, val1, val2);)

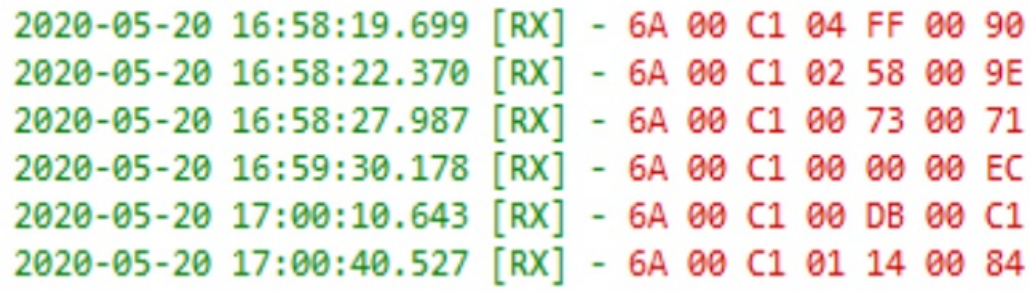
       val1 is movement value and respiration value.

       ```
       2020-05-20 16:10:07.970 [RX] - Motion Marker, BPM<CR><LF>
       2020-05-20 16:10:08.583 [RX] - 0, 0<CR><LF>
       2020-05-20 16:10:17.148 [RX] - 362, 0<CR><LF>
       2020-05-20 16:10:29.764 [RX] - 481, 0<CR><LF>
       2020-05-20 16:10:32.434 [RX] - 260, 0<CR><LF>
       2020-05-20 16:10:35.114 [RX] - 209, 0<CR><LF>
       2020-05-20 16:10:41.473 [RX] - 102, 0<CR><LF>
       2020-05-20 16:10:50.410 [RX] - 170, 0<CR><LF>
       2020-05-20 16:11:00.450 [RX] - 520, 0<CR><LF>
       2020-05-20 16:11:04.230 [RX] - 325, 0<CR><LF>
       ```

       In the figure above, the received data is in ASCII format, left values 362, 481 are movement values, and right values 0 are respiration values. Respiration is zero because it is an environment that measures the state of movement.
    2. Hex format.

       Data is packed in message that contains header, sensor id, motion and respiration markers and checksum:

0x6A	Sensor ID	0xC1	Value 1 MSB	Value 1 LSB	Value 2	CRC8



In the figure above, the data received is Hex format. For example “6A 00 C1 01 14 00 84” data has been received

1. 6A is always a common type of sensor
2. 00 is a default sensor ID (selectable, ref. P17)
3. C1 is alarm signals that the sensor has detected movement or respiration
4. 01,14 is the value of movement value
5. 00 is the respiration value
6. 84 is a CRC8 value

The sensor working range and option settings can be set using the command in hex format as follow:

Sensor type	Sensor ID	Command	Value	CRC8
0x6A	0x00	0xC2	0x01	0x09

Commands description

Sensor range C4

Possible values:

0x00 – no changes, return current range
0x01 – set 1.5m
0x02 – set 2.0m
0x03 – set 2.5m
0x04 – set 3.0m
0x05 – set 3.5m
0x06 – set 4.0m
0x07 – set 4.5m
0x08 – set 5.0m

Comment:

Distance in meters means the maximum detection range from sensor.
As soon as sensor’s detection range can be changed by IR remote controller as well, we would recommend controlling sensor’s settings periodically by sending 0x00 value.
After changing of working range, the sensor starts to recalibrate.

Example:

Change range to 3.5m for sensor with id 0:

Host request: 0x6A 0x00 0xC4 0x06 0x62
Sensor reply: 0x6A 0x00 0xC4 0x06 0x62

Communication speed C8

Command

Possible values:

0x00 – no changes, return current speed
0x01 – set 9600
0x02 – set 57600
0x03 – set 115200
0x04 – set 230400

Comment:

Sensor replies on the same communication speed. Then communication speed is changed for requested one.

Example:

Change UART speed to 115200 for sensor with id 0:
Host request: 0x6A 0x00 0xC8 0x03 0x85
Sensor reply: 0x6A 0x00 0xC8 0x03 0x85

Sending method

Command: CA

Possible values:

0x00 – no changes, return current setting
0x01 – event driven
0x02 – continuous sending with fixed interval
0x03 – sending by request

Comment:

- Event driven – sensor sends the data when motion or respiration detected. The message after first detection is sending during 1 second. For continuous event sensor sends messages with delay around 3 second. In case of no detection, sensor sends zero values every 1 minute.
- Continuously sending – sensor sends the data continuously with fixed time interval from 1 to 180 seconds. Time interval can be changed by command “CC”
- By request – sensor sends the data when host request it by command “CB”.

The data format is set by command “C9”.

Example:

Change sending method to “continuous sending” for sensor with id 0:
Host request: 0x6A 0x00 0xCA 0x02 0xA8
Sensor reply: 0x6A 0x00 0xCA 0x02 0xA8

Data format

Command: C9

Possible values:

0x00 – no changes, return current setting
0x01 – ASCII
0x02 – Hex

Comment:

When ASCII format is set, sensor sends the header text “Motion marker, respiration” after calibration finished.

Example:

Change data format to “Hex” for sensor with id 0:
Host request: 0x6A 0x00 0xC9 0x02 0x97
Sensor reply: 0x6A 0x00 0xC9 0x02 0x97

Continuous sending interval

Command: CC

Possible values:

0x00 – no changes, return current setting
0x01…0xB4 – set interval value from 1 to 180 seconds, in seconds

Comment:

This parameter is meaningful only when sending type is “continuous sending” (command “CA”).
The intervals less then 3 seconds are not recommended.

Example:

Change repetition interval to 5 seconds for sensor with id 0:
Host request: 0x6A 0x00 0xCC 0x05 0xC3
Sensor reply: 0x6A 0x00 0xCC 0x05 0xC3

Request send data

Command: CB

Possible values:
Any

Comment:

Sensor replies to this command with data message. It is working only when sending type is “sending by request” (command “CA”).

Example:

Change repetition interval to 5 seconds for sensor with id 0:
Host request: 0x6A 0x00 0xCB 0x00 0xB3
Sensor reply: 0x6A 0x00 0xC1 0x01 0x12 0x00 0xFA (Motion marker: 274, BPM: 0) 0x01, 0x12 = 274, 0x00 = 0

Change ID

Command: C3

Possible values:

0x00 … 0xFE – set sensor ID respectively

Comment:

This command changing sensor’s id.
If the command refers to 0xFF and value field contains 0xFF then sensor will return current ID.

Example:

Change sensor ID from 0 to 1:
Host request: 0x6A 0x00 0xC3 0x01 0x1C
Sensor reply: 0x6A 0x01 0xC3 0x01 0x77

Get current ID:

Host request: 0x6A 0xFF 0xC3 0xFF 0xC3
Sensor reply: 0x6A 0xFF 0xC3 0x01 0x37

Ping

Command: C2

Possible values:

Any

Comment:

Just returns the same message (To check the connection with the sensor)

Example:

Ping the sensor:

Host request: 0x6A 0x00 0xC2 0x00 0x0E
Sensor reply: 0x6A 0x00 0xC2 0x00 0x0E

Recalibrate the sensor

Command: CD

Possible values:

Any

Comment:

This command pushes the sensor to recalibrate.

Example:

Recalibrate the sensor:
Host request: 0x6A 0x00 0xCD 0x00 0xCD
Sensor replies “0x6A 0x00 0xCD 0x00 0xCD” and starts to recalibrate

Wrong CRC

Command: C7

Possible values:

This is one direction message. Only from sensor to host.

Comment:

If the CRC code in the host’s message is wrong, then sensor returns this command. Value field of returned message contains CRC that calculated in sensor.

Example:

Change sensor ID from 0 to 1:
Host request: 0x6A 0x00 0xC3 0x01 0x53
Sensor reply: 0x6A 0x00 0xC7 0x1C 0x1B
(0x1C is the correct CRC part in the sensor response section)

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;
```

Host Integration Guide

According to KDB996369 D03 2.0 INTEGRATION INSTRUCTIONS(2.2-2.7)

This module has been assessed against the following FCC rule parts: CFR 47 FCC Part 15 F (15.517, UWB). It is applicable to the modular transmitter.

This radio transmitter FCC ID: 2AN8QUM80M has been approved by Federal Communications Commission to operate with the integrated PCB antenna. Use of any other antenna is strictly prohibited without filing an application for a new system-specific FCC ID.

The module complies with FCC Part 15.517 and applies for single module approval.

Trace antenna designs: Not applicable – the antenna is integrated into the module and cannot be modified. See section 2.3.

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with a minimum distance of 20cm between the radiator & your body. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

Antenna type and antenna gain for UWB:
Antenna Type: Internal U-Slot Antenna
Antenna Gain: 5.36 dBi

Note: U-Slot Antenna is permanently attached and can’t be replaced.

Please note that if the FCC identification number is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. This exterior label can use wording such as the following: “Contains FCC ID: 2AN8QUM80M” Any similar wording that expresses the same meaning may be used.

Testing of the host product with all the transmitters installed – referred to as the composite investigation testis recommended, to verify that the host product meets all the applicable FCC rules. The radio spectrum is to be

investigated with all the transmitters in the final host product functioning to determine that no emissions exceed the highest limit permitted for any one individual transmitter as required by Section 2.947(f). The host manufacturer is responsible for ensuring that when their product operates as intended it does not have any emissions present that are out of compliance that were not present when the transmitters were tested individually. The host product manufacturer is responsible for compliance with any other FCC rules and a C2PC is required for each host when installed in any host.

Any company of the host device which installs this modular should perform the test of radiated & conducted emission and spurious emission etc. according to FCC Part 15C: 15.517 and 15.209 & 15.207, 15B class B requirement, only if the test result comply with FCC part 15F: 15.517 and 15.209 & 15.207, 15B class B requirement. Then the host can be sold legally. The host product manufacturer is responsible for compliance with any other FCC rules and a C2PC is required for each host when installed in any host.

The host manufacture is recommended to use D04 Module Integration Guide recommending as “best practice” RF design engineering testing and evaluation in case non-linear interactions generate additional non-compliant limits due to module placement to host components or properties.

This module is stand-alone modular. If the end product will involve the Multiple simultaneously transmitting condition or different operational conditions for a stand-alone modular transmitter in a host, host manufacturer have to consult with module manufacturer for the installation method in end system.

Manual Information to the End User:

- The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user’s manual of the end product which integrates this module. The end user manual shall include all required regulatory information/warning as show in this manual.

OEM Responsibilities to comply with FCC Regulations

The (your product name) Module has been certified for integration into products only by OEM integrators under the following conditions:

1. The antenna(s) must be installed such that a minimum separation distance of 5mm is maintained between the radiator (antenna) and all persons at all times.
2. The transmitter module must not be co-located or operating in conjunction with any other antenna or transmitter.

As long as the two conditions above are met, further transmitter testing will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed (for example, digital device emissions, PC peripheral requirements, etc.).

IMPORTANT NOTE: In the event that these conditions cannot be met (for certain configurations or colocation with another transmitter), then the FCC authorizations are no longer considered valid and the FCC ID cannot be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC authorization.

This modular transmitter is only FCC authorized for the specific rule parts (i.e., FCC transmitter rules) listed on the grant, and that the host product manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification. If the grantee markets their product as being Part 15 Subpart B compliant (when it also contains unintentional radiator digital circuity), then the final host product still requires Part 15 Subpart B compliance testing with the modular transmitter installed.

Host labelling guidance for the end integrator

This is an advise for host manufacture to provide a physical / e-label on their host product stating, “Contains FCC ID: 2AN8QUM80M”: A permanently affixed label must be used. The modular transmitter must be labeled with its own FCC identification number, and, if the FCC identification number is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. This exterior label can use wording such as the following: “Contains Transmitter Module FCC ID: 2AN8QUM80M ” or “Contains FCC ID: 2AN8QUM80M “.

Any similar wording that expresses the same meaning may be used.

FCC Statement

Compliance Statement

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: 1. This device may not cause harmful interference, and 2. This device must accept any interference received, including interference that may cause undesired operation.

Warning

Changes or modifications not expressly approved by the party responsible for compliance could void the user’s authority to operate the equipment.

RF Exposure

This portable transmitter with its antenna complies with FCC RF exposure limits for general population / uncontrolled exposure.

UWB devices may not be employed for the operation of toys. Operation onboard an aircraft, a ship or a satellite is prohibited.

This device complies with Part 15.517 of the FCC Rules. This equipment may only be operated indoors. Operation outdoors is in violation of 47 U.S.C. 301 and could subject the operator to serious penalties.

FCC ID: 2AN8QUM80M

CUSTOMER SUPPORT

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UMAIN

Documents / Resources

	**UMAIN Thunder Series UWB Radar Sensor** [pdf] User Manual 2AN8QUM80M, 2AN8QUM80M, Thunder Series UWB Radar Sensor, Thunder Series, Thunder Series Radar Sensor, UWB Radar Sensor, Radar Sensor, UWB Sensor, Sensor

References

- Online CRC-8 CRC-16 CRC-32 Calculator
- User Manual