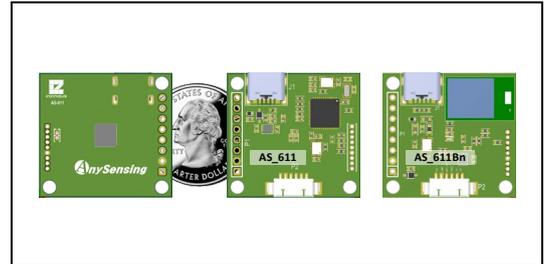# AS_611Bn / AS_611

AnySensing

Distance, Human and Animal's Vital-sign detection Radar
with High performance, Small size, Low-power
GPIO, UART, BLE(option), Indicate LED

# User Manual

1 Features

- 60GHz pulsed radar
- One board solution
- Include antenna and DSP module
- Wide input voltage available: 3.3~7.0V
- Small size and easy to use
- GPIO, UART, BLE(AS_611Bn only) interface
- Depending on the function provided, it is divided into a distance detection model and a vital-sign detection model
- Type of vital-sign provided: Human, Small dog, Large dog, Cat
  BR(Breath rate), BR waveform, HR(Heart Rate), HR waveform, HRV(Heart Rate Variability)
- Detection of more than 90% accurate vital-signs in steady state. At a steady state, the respiratory rate is more than 95% accurate
- 3 types of power source input possible: USB-C, 2.54mm pin-header, connector

2 Specification

Content		Definition
Model name		AS_611Bn : BLE-enabled model (basic model) AS_611 : MCU Based model
Hardware size		32.0 x 30.0 x 3.35 mm (No connector) 32.0 x 30.0 x 5.1 mm (Applying connector)
Transmit frequency		60GHz
Antenna		1 TX (EIRP : 10dBm), 1 RX / Antenna gain : 2dBi
RF pattern (-3dB width)		Horizontal 65° / Vertical 55°
Supply voltage / current		3.3 ~ 7 VDC / 0.3W
Operating / Storage temperature		-40 ~ 85 ℃ / -55 ~ 125 ℃
Interface		GPIO, UART(TTL level), BLE(just AS_611Bn)
Function		Motion, Distance, Vital-sign(BR, HR, HRV), Indicate LED
Distance	Range	Distance : 1m, 2.5m, 5m, 7.5m, 10m mode Vital-sign : near mode (0.15 ~ 0.5 m) far mode(0.4 ~ 2.0m)
	Resolution	Vital sign : under 1.0m more than 90% over 1.0m more than 80%

3   Pin description
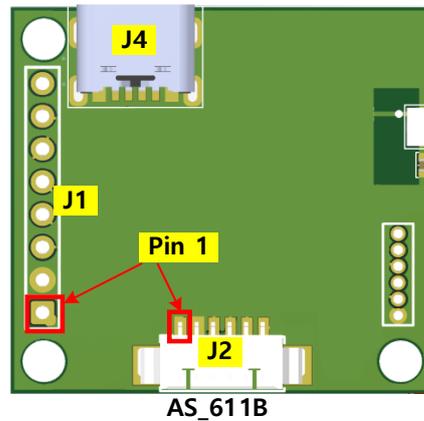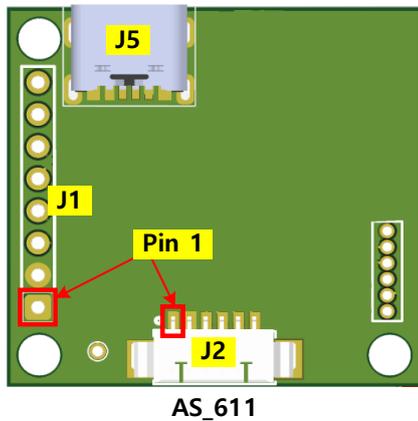
PIN	Name	J1	J2
1	VCC	Power + (3.3 ~ 7V)	Power + (3.3 ~ 7V)
2	GND	Power -	Power -
3	GPIO	In/out	In/out
4	NRST	N.C or High : Normal operation Low : Reset	N.C or High : Normal operation Low : Reset
5	UART TX 1	UART 1 data transmit	UART data transmit
6	UART RX 1	UART 1 data receive	UART data receive
7	UART TX 2	UART 2 data transmit	Not used
8	UART RX 2	UART 2 data receive	Not used

\# J1   :   2.54mm Pin header
\# J2   :   12505WR-06
\# J4, J5   :   USB-C type connector only supplies power

4   Dimension

Top

Bottom

No connector

Install connector (12505WR-06)

Install USB-C connector

5   Function

Function Model	Mode	Function
Distance detection	**D**istance	Mode that detects the distance of an object Can detect motionless objects Detects up to 10 objects
	Presence detection	Divide the detection distance into 10 zones and output whether an object is detected in each zone
Vital-sign detection	**V**ital-sign	Mode that detects vital-signs from people or animals Output breath, heartbeat, HRV information Short-range mode less than 50cm, supporting long-distance mode that can detect up to 2m

6   Distance detection model

- The distance measurement model offers two modes: D mode, which measures and outputs the distance for each object, and Z mode, which divides the set measurement distance into 10 equal parts, sets up 10 zones, and outputs whether an object is detected in each zone.
- The detectable distances support 1m mode, 2.5m mode, 5m mode, 7.5m mode, and 10m mode. Both distance measurement D mode and zone-based measurement Z mode can be used in each mode, and it is possible to detect up to 10 objects.
- The supported features are as follows:

  - Removal function through UART commands

  - Detection distance setting feature: 1m ~ 10m

  - Distance measurement mode, zone detection mode

  - Ability to measure both stationary and moving objects

  - Surveillance time interval setting feature: 1 ~ 15 times per second

  - Output only when there is a change in detected objects

  - Ability to change the number of detectable objects: 1 ~ 10

  - Object detection level change feature

  - Output data format change feature: Three options provided

  - System reset feature

- Setting values for each configured distance

Distance mode	Detection distance	Resolution
1 m (distmode 1)	150 mm ~ 1,000 mm	10 mm
2.5 m (distmode 2)	150 mm ~ 2,520 mm	30 mm
5 m (distmode 5)	300 mm ~ 5,040 mm	60 mm
7.5 m (distmode 7)	500 mm ~ 7,580 mm	120 mm
10 m (distmode 10)	500 mm ~ 10,100 mm	120 mm

- **In the following cases, detection is not possible or accuracy is low**

  - In environments where detection is good, such as in a conference room where there are no obstacles around and the object to be detected is moving, the detection performance is high. In environments where detection is difficult, there are many obstacles around the radar.

  - By using the "sengain" option, you can increase the detection gain of the radar, which improves the detection performance of objects. However, if it is set too high, there is a high probability of false detection, detecting even small objects in the surroundings.

  - The "senlevel" option sets the level of object detection. Increasing the value helps to detect objects with a higher reflectivity or larger movements. Decreasing the value allows detection of even small objects or small movements. Setting it too high may result in poor object detection, while setting it too low may result in unnecessary object detection.

  - The "complevel" option compares the energy between detected objects and neighboring surrounding objects to determine detection. A higher value ensures that only objects with a significantly higher energy difference compared to the surroundings are detected.

  - The "sensum" option determines how many times objects are detected per second. By default, the data is output as set in the sensum option per second. The "dispdiff" option reduces the

amount of data output by only outputting when the detected result differs from the previous one.

- The "dispmove" option is used when only moving objects are to be detected, not stationary ones. In environments with many surrounding objects, electromagnetic waves reflected from surrounding objects can cause objects to be detected even around moving objects.

- Depending on the usage environment, various options should be set appropriately to achieve the best detection performance.

-

- **Recommended configuration sequence**

Sequence	Command	Description
1	distmode n	Set the maximum detection distance desired. The available distances are 1m, 2.5m, 5m, 7.5m, and 10m, with a default setting of 2.5m.
2	objnum n	Set the number of objects to be detected. Range from 1 to 10, with a default setting of 5
3	sennum n	Set the detection frequency per second of the sensor. Range from 1 to 15, with a default setting of 1
4	sengain n	Set the amplification ratio of the energy reflected from objects. The setting range is from 0 to 10, with a default setting of 2. You can use the default setting or increase the number until small objects in the surroundings are not detected. If small objects in the surroundings are detected, decrease the number to adjust.
5	senlevel n	Set the level of detection from the reflected energy of surrounding objects. The setting range is from 10 to 500, with a default setting of 30. Increase the setting value if small objects in the surroundings are detected.
6	complevel n	Set the energy difference between the object to be detected and surrounding objects. A larger value means that there must be a larger energy difference with surrounding objects to trigger detection. The default setting is suitable for general cases. The setting range is from 1 to 9, with a default setting of 3.
7	dispzone dispdiff dispmove offspace	Additional settings for data output method can be configured as needed.

- Data Output Format : ASCII
  - **Distance output mode**

Comma-separated mode	**#A,BBBB,CCCC,DDDDD,EEE,FFF,GGG!** (31 byte)	
Space-separated mode	**#A BBBB CCCC DDDDD EEE FFF GGG!**	
Minimal data mode	**#ABBBBCCCCDDDDDEEEFFFGGG!** (25 byte)	
Item	**Byte**	**Content**
#	1	Character that initiates the output of distance-based data
A	1	Number distinguishing detected objects, e.g., 1: first object, 2: second object.
BBBB	4	X coordinate, indicates the position to the left or right of the radar, unit in cm. The first byte is the sign, + for right direction, - for left direction. **Note. Not supported by this model.**
CCCC	4	Y coordinate, indicates the position up or down the radar, unit in cm. The first byte is the sign, + for upward direction, - for downward direction. **Note. Not supported by this model.**
DDDDD	5	Z coordinate, indicates the frontal distance from the radar, unit in mm
EEE	3	Reflected energy of the detected object
FFF	3	Temporary data
GGG	3	Temporary data
!	1	Character indicating the end of data.

  - **Detection zone output mode**

#ZAAAAAAAAAA! (13 byte)		
Item	**Byte**	**Content**
#	1	Character that initiates the output of distance-based data
Z		Starting character indicating the detection zone output mode

AAAAAAAAAA		Divided into 10 zones, each zone displays the detection status, 1 if an object is detected
!	1	Character indicating the end of data.

7   Vital sign detection model

- Detecting steady-state human and animal vital-signs

  - The default state is set to human, and animals support small dogs under 13 kg (30 lb), large dogs over 13 kg (30 lb), and cat mode.

  - Over 80 ~ 90% accuracy in steady state

  - Short range mode is start 15 cm to maximum range 50 cm, long range mode is 40 cm to maximum range 2 m, detection angle 70°, long range mode defaults to detection up to 1.5m

  - Provides maximum detection distance limit, detection zone setting

  - Detectable motion: basically, the level of mouse manipulation or simple conversation

  - Vital-sign detection is continuously provided even during simple conversations or small movements, but the accuracy is lower than in a stable state.

  - Only one person in front of the radar can be detected

  - Vital-signs can be detected from the front, side and back of a person, and measuring from the front ensures the most accurate results

- In normal response mode, it takes 4 seconds to detect and output biometric signals, whereas in fast response mode, it takes 0.5 seconds. In fast response mode, the likelihood of false detections increases due to the quicker response. If no human biometric signals are detected after a false detection, the output will stop.

- Simple output mode, which outputs only breath rate and heart rate every second.; Complex output mode, which provides 20 breath rates, heart rate, breath waveform, heart waveform, HRV data, and sensed distance information every second.

- Does not guarantee normal detection if there are other people near the detecting person

- **In the following cases, detection is not possible or accuracy is low**.

  - When there is another object between the radar and the person detecting it, or when there is an object such as metal or a moving object nearby.

  - In particular, if the maximum detection distance is set to 1.5 meters or more, vital signs may not be detected if there are highly reflective objects in the vicinity of the radar and the person, or in close proximity to the person. This can be resolved by setting the detection zone to a disappearing distance.

  - When a person is leaning on an object such as a sofa that has high tension

  - Intentionally holding your breath When the radar is not directly facing the chest, but is next to the person and the arm blocks the radar signal

  - When there is a moving object near a person

  - When more than one person is together

- **Detection of the heart rate signal captures the movement of a very small chest area, so detection accuracy can be ensured when the subject is in a stable state. Reliable detection results are guaranteed when the detection starts and the subject remains stable for more than 20 seconds.**

- Data Output Format : ASCII
  - ■   Simple output mode

Comma-separated mode	**@A,B,CCC,DD,EE,FFF!** (19 byte)	
Space-separated mode	**@A B CCC DD EE FFF!**	
Minimal data mode	**@ABCCCDDEEFFF!** (14 byte)	
Item	**Byte**	**Content**
@	1	Starting character indicating the output of biometric signal data
A	1	Number representing object e.g., 1: first object, 2: second object.
B	1	Vital-sign detection status

		0: No target 1: Target, Moving 2: Target, Calculation (Target detection, determining vital-sign) 3: Target, Vital-sign 4: Target, Vital-sign and No Breath
CCC	3	heart rate per minute
DD	2	respiratory rate per minute
EE	2	HRV(Heart Rate Variation), ms
FFF	3	Temporary data
!	1	Character indicating the end of data.

■ Complex output mode : Default mode

Comma-separated mode	@A,B,CCC,DD,EE,FF.FF,GG.GG,HHH!	(31 byte)
Space-separated mode	**@A B CCC DD EE FF.FF GG.GG HHH!**	
Minimal data mode	**@ABCCCDDEEFF.FFGG.GGHHH!**	(24 byte)

Item	Byte	Content
@	1	Starting character indicating the output of biometric signal data
A	1	Number representing object e.g., 1: first object, 2: second object.
B	1	Vital-sign detection status 0: No target 1: Target, Moving 2: Target, Calculation (Target detection, determining vital-sign) 3: Target, Vital-sign 4: Target, Vital-sign and No Breath
CCC	3	heart rate per minute
DD	2	respiratory rate per minute
EE	2	HRV(Heart Rate Variation), ms
FF.FF	5	Heart rate waveform data, the first F is +, - sign
GG.GG	5	Respiration waveform data, the first G is +, - sign
HHH		Temporary data
!	1	Character indicating the end of data.

8   Protocol

8.1 Communication Method

- AS_611Bn supports 3.3V level UART communication, AS_611B supports 3.3V level UART and BLE-based UART communications
- Utilizes ASCII character codes for sending and receiving data and supports Command Line Input (CLI)
- The LED on the radar module flashes when data is output.
- UART Settings

Item	Setting value
Baud rate	115,200 bps
Data	8 bit
Parity bit	None
Stop bits	1 bit
Flow control	None

- All commands must be in lowercase
- If you set it to a new command, BLE will be disconnected

8.2 Distance detection model

Command	Example	Default value / Setting range	Explanation
Check operation status	ping ping 60	0 / 60 ~ 1314000	This is the response indicating whether the system is operational. The initial state is 0, during which the system only responds when a ping command is sent. When a value is set, the system automatically outputs '^' at each interval if there is no data output within the specified time. The value is set in seconds, and the possible range is from 60 (1 minute) to 1,314,000 (1 year). If a value is set, the response to the ping command will be the set value.
Start data output	start		Start data output default start state
Stop data	stop		Stop data output

output			
Detection distance	distmode distmode 5	2 / 1, 2, 5, 7, 10	Setting the detection distance: default is 2 (2.5m) 1: 1m, 2: 2.5m, 5: 5m, 7: 7.5m, 10: 10m
Detection distance output method	dispzone dispzone 1	0 / 0, 1	Select the format for outputting distance data of detected objects: 0: Distance output mode, 1: Zone-based output mode Zone-based output mode divides the detection distance into 10 parts and indicates a value of 1 for zones where objects are detected.
Motion detection setting	dispmove dispmove 1	0 / 0, 1	Select the detection of stationary objects: 0: Detect stationary objects as well, 1: Detect only moving objects
Select when to output data	dispdiff dispdiff 1	0 / 0, 1	Select when to output data: 0: Always output, 1: Output only when there is a change Default is 0, always output
Set the sensor detection count	sensum sensum 1	1 / 1 ~ 15	Set the detection frequency per second Default is sensing once per second
Maximum number of detected objects	objnum objnum 5	5 / 1 ~ 10	Set the maximum number of detected objects: It can be set from 1 to a maximum of 15. Default is 5.
Signal amplification ratio setting	sengain sengain 2	2 / 0 ~ 10	The ratio at which the size of the radar signal from objects is amplified. A larger number means even small objects can be detected better, but it also increases noise, leading to a higher possibility of false detections. Default is set to 2.
Setting for the detection level of objects	senlevel senlevel 3	30 / 10 ~ 500	Threshold hold for determining detected objects. A higher value means only large movements or objects with high reflectivity are detected. A lower value means even smaller objects can be detected, but the probability of false detections increases. Default is set to 30.
Setting for the comparison level with surrounding objects	complevel complevel 3	3 / 1 ~ 9	Setting for the comparison ratio between detected objects and surrounding objects. A larger value means only clear objects are detected, reducing the probability of false detections, but if not clearly distinguished from the surroundings, detection may not occur. Default is set to 3.
Set comma separator mode	oncomma		Set data to be separated by commas (,) default mode
Set blank separator mode	onblacnk		Set data to be separated by spaces
Set no separator character mode	offspace		Set to print with spaces between data
Reset	reset		System reset. System returns to initial state
Help	help		Setting command output Changes to stop state when running Requires system start with start additional command

8.3   Vital sign detection model

Command	Example	Default value / Setting range	Explanation
Check operation status	ping		Checking if the system is working "allive" should be returned as the return value.
mode control	mode mode 0	1 / 0, 1	Detection distance mode, default to long range mode 0: Close-range mode, 150 to 510 mm 1: Long range mode, 400~2020mm
Maximum detection distance limit setting	dislimit dislimit 0 dislimit 1000	1500 / 150~510 400~2020	Used when setting the maximum detection distance Only available in ranged mode Default state is set to 1500 mm, possible up to 2020 mm When set to 0, it changes to the default setting value of 1500mm When setting the value, distfixed is automatically changed to 0.
Detection distance fixed setting	distfixed distfixed 0 distfixed 1000	0 / 150~510 400~2020	Limits the detection range of biological signals based on the set distance. In short-distance mode, the range is -20 to +20 mm at the set distance. In long range mode, the range is -200 to +200 mm from the set gully. Setting it to 0 sets it to the entire range. When setting the value, dislimit is automatically changed to 0.
Human detection level setting	sensitivity sensitivity 2	3 / 1~5	Adjust the speed at which a person is detected and responded to. Lower values allow for quicker detection of people, but may result in false positives due to surrounding noise. To reduce false positives, set the value higher.
Response time for human detection	response	1 / 0, 1	Sets the response speed for human detection. 0: Fast response, within 0.5 seconds 1: Normal response, within 4.5 seconds Fast response increases the likelihood of false detections. If it is determined that it is not a human after a false detection, the biometric signal output will stop.
Start data output	start		Start data output default start state
Stop data output	stop		Stop data output
Check detection target mode	object		The current detection target is displayed, which is set to one of people, small dogs, large dogs, and cats. The default setting is human.
Set person detection mode	human		Shows what is currently being detected The detection target is set to one of people, small dogs, large dogs, and cats. Default is set to human
Set small dog detection mode	sdog		Set to small dog detection mode Equivalent to a weight of 13.5 kg (30 lb) or less
Set large dog detection mode	ldog		Set to large dog detection mode Applies to a weight of 13.5 kg (30 lb) or mor
Set cat detection mode	cat		Set to cat detection mode
Enable vital-sign graph data output	onwave		Set to heart rate and respiration waveform output mode Output 20 times per second Default mode is onwave state
Disable vital-sign graph data output	offwave		Simple data output mode. Set to output only heart rate, respiratory rate, and HRV without including waveform data. Output once per second.
Set comma separator mode	oncomma		Set data to be separated by commas (,) default mode
Set blank separator mode	onblacnk		Set data to be separated by spaces
Set no separator character mode	offspace		Set to print with spaces between data
Reset	reset		System reset. System returns to initial state
Enable detected object distance data output	len		Set to output the distance of the detected object to the temporary data field
Enable detected object energy data output	pwr		Set to output the energy of detected objects to a temporary data field
Disable additional data output	off		Set temporary data fields to contain nothing, default mode
Help	help		Setting command output Changes to stop state when running Requires system start with start additional command

9   Bluetooth Information

AS_611Bn supports Bluetooth 4.0 and later. To check the transmission and reception data of Bluetooth,

install the [nRF toolbox] app on Android or iOS and select the Universal Asynchronous Receiver/Transmitter (UART) item in the Utils services item. If you have power connected to AS_611Bn, you can find AS_611Bn with the scanner..

Note: If you change the device's settings, the device will reboot again. Therefore, Bluetooth needs to be reconnected as well.

9.1 Bluetooth settings for app/web development
The AS_611B is compliant with the BLE standard GATT and uses the Nordic UART Service.

Service	Value
Service	Nordic UART Service
Vendor-specific UUID	6E400001-B5A3-F393-E0A9-E50E24DCCA9E
TX UUID	6E400003-B5A3-F393-E0A9-E50E24DCCA9E
RX UUID	6E400002-B5A3-F393-E0A9-E50E24DCCA9E

10   Order Information
Order model   :   AS_611(Bn)_D/V_P/C/U
                        AS_611(Bn) _ Function model _ Interface select

- AS_611   : Based model
- AS_611Bn   : BLE support model
- D/V : D : Distance detection function model
                        : V : Vital sign detection function model
- P/C/U   : P : Installing 2.54mm pin header
                        : C : Installing connector
                        : U : Installing USB-C connector

Ex) AS_611_D   : Based model of distance sensing model without connectors or pin header
      AS_611Bn_V_U: Vital sign detection BLE support model with USB-C connector
      AS_611_V_CU   : Based model of vital sign detection with USB-C connector and connector

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