MoreSense-AT10LP Radar Module HCI Communication Protocol And Debugging Guide_V2.0

This document mainly introduces and explains MoreSense serial port HCI protocol and instruction set of the AT10LP radar module.

Revision History

Release Date	Revision	Description	Charged
2022-11-28	V1.0	HCI Initial version	Job Huang
2022-12-2	V2.0	1. The instruction to set parameters no longer automatically saves parameters,effectively reducing the erasing and writing of EEPROM and improving the service life 2. Added instructions for saving parameters and restoring factory configuration	Job Huang

Catalog

1 HCI Protocol Introduction

The AT10LP supports radar parameter configuration by using a standard serial port.

The serial port parameters are configured as follows:

Baud Rate	9600bps
Data Bit	8bit
Parity Bit	None
Stop Bit	1bit

2 Radar Module Commands

The host computer uses the serial port protocol to communicate with MoreSense radar module.

The format of the command issued by the master device is as follows:

0x55+LEN+CMD+DATA+CHECK_CODE

0x55: Frame header.

LEN: Data length,1 Byte.The length is CMD+DATA bytes.

CMD: Command code,1 Byte.

DATA: Data, n Byte.

CHECK_CODE: Check Code,1 Byte.Use and check.

CHECK_CODE=0x55+LEN+CMD+DATA,the result is 8 bits lower.

The format of responding to instructions from the device is described in the instruction set.

The HCI commands set is as follows:

Function	Command Code	Command Data	Returning Data	Note
Set up the working power consumption,gain,threshold,inductive output time	0x11	8 bytes. POWER+GAIN+DELTA+LOT POWER:1 byte. Configure power consumption. 0x00:26mA 0x08:153uA 0x0D:51uA GAIN:1 byte. Configure the gain level. Values can only be taken in the following sets: [0x03, 0x13, 0x23, 0x33, 0x43, 0x53, 0x63, 0x73, 0x83, 0x93, 0xA3, 0xB3, 0xC3, 0xD3].The larger the value,the smaller the gain,and this value is used for coarse tuning of distance. DELTA:2 bytes. Configure thresholds. Range:0~1023.The high byte comes first and the low byte comes last.The larger the value and the shorter the distance,and	Returned in Hex format: 0x4F 0x4B: Success (ASCII code is OK) 0x45 0x52: Failed (ASCII code is ER)	E.s. 55 09 11 00 33 00 64 00 00 01 FF 06 represents the set working power consumption is 26mA, gain 0x33,threshold 100,inductive output time is 511ms.

		this value is used for fine-tuning of the distance. LOT: 4 bytes. Configure the induction output time(unit:ms). The high byte comes first and the low byte comes last.		
Inquiry the working power consumption,gain, threshold,inductive output time	0x12	1 byte. Fixed to 0x00	Returned in Hex format: POWER+GAIN+DELTA+LOT POWER: 1 Byte GAIN: 1 byte DELTA: 2 bytes LOT: 4 bytes	Fixed Command: 55 02 12 00 69 Returning code e.s.: 00 33 00 64 00 00 01 FF Working Power consumption: 26mA Gain:0x33 Threshold:100 Inductive output time:511ms.
Save parameters/ restore factory reset configuration	0x13	1 byte. 0x00: restore factory configuration. 0x01: save parameters.	Returned in Hex format: 0x4F 0x4B: Success (ASCII code is OK)	Factory reset command: 55 02 13 00 6A Save parameter command: 55 02 13 01 6B

3 Radar Parameter Debugging Instructions

This section provides further explanation of some parameters' configuration or API interfaces in Section 2 and provides some projects debugging process experience for your reference.

3.1 Working Power Consumption

This version supports 3 power consumption settings of 26mA,153uA, and 51uA.

Without considering power consumption,it is recommended to use the working current of 26mA gear,especially in AC-to-DC application which can improve stability.In pure DC scenarios such as battery power,153uA and 51uA can be selected.

Under the premise that other parameters are exactly the same,the higher the operating power consumption,the farther the limit distance that the module can sense and the better the sensing accuracy at the farthest point,but the difference in the sensing accuracy at close range is small.For example,the sensing distance of smart door locks is generally about 0.8-1.5m,so it is recommended to use 51uA working current.

3.2 Induction Time

Induction time refers to the duration for which the OUT pin outputs a high level after the radar module detects a moving object.If the induction time is set to 2s,the module will output a high level of 2s after sensing,but if the radar continues to detect moving objects during the output of 2s high level,the output time of 2s will be continuously refreshed,that is the "delayed".

It is worth noting that the total length of the sensing time = the chip internal substrate output time + the induction output time.The base output time is set to 500ms by default.The inductive output time can be modified by command,but cannot be set to 0ms.In other words,when the sensing output time is set by command to 1ms,the module will still output a high level signal of about 500ms after sensing.

3.3 Protection Time

When the radar OUT pin changes from high level to low level, that is,after the induction output ends,it stops detecting moving objects for the next period of time, and this time to stop detecting moving objects is called the "protection time".

Generally speaking, when the OUT of the radar module changes from high level to low level,the whole machine/product does some corresponding processing or actions,such as disconnecting or closing the relay,motor starting or stopping,LED flashing,buzzer reminder.These actions are usually triggered when the radar finishes output,and these actions introduce some interference and cause the radar to be re-triggered,eventually causing the module to be triggered all the time and continuously output high level.Therefore,in order to avoid the above situation,after the end of the output,the radar will stop detecting for a period of time for protection.

The protection time is set to 1s by default,and generally does not need to be modified.If some applications need to control the peripheral action time after the radar end output and then the radar is triggered again,you need to modify the length of the protection time appropriately and ensure that there is enough margin,it is recommended to leave a margin of more than 500ms.If you meet some issue during changing this value,you could ask MoreSense for technical support.

3.4 Gain

Gain and sensing threshold are the most important parameters that determine the radar sensing range of radar,and the two parameters need to be reasonably coordinated to achieve the ideal sensing effect.

The radar module provides a total of 14 gear gains to be set in the following ranges: [0x03, 0x13, 0x23, 0x33, 0x43, 0x53, 0x63, 0x73, 0x83, 0x93, 0xA3, 0xB3, 0xC3, 0xD3].The lower the gear,the greater the gain.In theory,the greater the gain,the farther the limit distance that can be inducted.But in practical applications,it is also necessary to consider the influence of the whole machine/product structure and components and the influence of mold material.Generally speaking,metal shell products need to set a relatively large gain,plastic shell gain can be lower.

When actually debugging the sensing distance,the gain parameter is a coarse adjustment effect on the distance sensing.The generally recommended gain range is[0x33, 0x43, 0x53, 0x63, 0x73, 0x83, 0x93].

In the application scenario of radial/straight sensing,generally the sensitivity of radar to the front and sides of the antenna will be higher than that of the parameter with small gain.

3.5 Sensing Threshold

The sensing threshold and gain are the most important parameters that determine the sensing range of the radar.The gain enables coarse adjustment of distance,and the sensing threshold enables fine adjustment of distance.

The sensing threshold can be adjusted from 0~1023.Since the granularity that can be adjusted is small,it is possible to fine-tune the distance.The larger the sensing threshold, the closer the sensing distance.

In general,the sensing threshold of 0~8 is prohibited,because it will cause the module to self-defence basically.The sensing threshold of 9~15 is not recommended,because even if the module is not self-excited,it may not be possible to mass production in the later stage due to insufficient margin.Setting the sensing threshold to 1023 causes the module to fail to sense.

When the project requires a long sensing distance,such as a straight-line distance of more than 5m or a hanging height sensing radius of more than 3m,it is necessary to probe the bottom of the whole machine.Bottom exploration can allow us to understand the limit performance of the whole machine/product,and find some improvement areas,and it is also a key step to determine whether the project can be mass-produced.

Regarding self-stimulation,bottoming and margin,you can view the following sections.

3.6 Light Sensor

The sensor module does not solder the light sensor by default and there is no hardware interface for reserved light sensor on some models.If you need to use the light sensor function,please confirm whether the module used has a light sensor hardware interface and the light sensor has been soldered firstly.The light sensor hardware interface is on the antenna side and it consists of 3 components.

After using the light sensor function,the radar is only turned on when the ambient light is low to a certain extent.

Due to MCU resource limitation,light sensor parameters can only be set by MoreSense firmware directly and cannot be modified by commands.

3.7 Self-Excitation

Self-excitation refers to the phenomenon in which the radar module outputs an sensing signal by itself in the absence of obvious interference from moving objects.

There are many phenomena of self-excited output,such as irregular and occasional output,periodic output,continuous output.

There are many causes of self-motivation,but here are some common causes of self-motivation:

1. The sensing threshold is set too low.

2. The power supply is unstable and the ripple is too large.

3. Buzzer,relay and other work produce mechanical interference and power fluctuations.

4. Diode,transistor periodic switch,LED flashing,etc.

5. Working influence of motor,fan, air conditioning fan blade,etc.

Specific analysis is required when dealing with self-excitation problems,some can be circumvented by software processing,while others need to be handled by modifying hardware or structure.

3.8 Bottoming

The radar module is ultimately to be installed in the whole machine/product to work.We need to understand the limit parameters for the whole machine to work normally after installation.

The process of obtaining the limit parameters of the radar module in the whole machine is called "bottoming".The goal of bottoming out is to obtain the sensing threshold at which the whole machine begins to self-excite at a fixed gain.

The steps to probe the bottoming are as follows:

1. Fixed gain parameters.

2. Set the induction threshold to a relatively large initial value, it is recommended to be 100.

3. Place the whole machine in the actual environment and let it stand.Make sure there are no people or other moving objects in the environment, and observe the whole machine whether the radar in the product will self-excite (the general observation time is 5-10min).

4. If the whole machine does not self-excited,change the sensing threshold to smaller and re-proceed to step 3;If the whole machine produces self-excitation,it means that the sensing threshold set is too small,change the threshold value to larger,and then proceed to step 3 again.

5. Repeat the above steps until you find an sensing threshold that just puts the whole device at the critical point of self-excitation,which is the bottoming value under the current gain.

The bottoming value can be used to assess whether the final mass production's parameter values are reasonable.Specific evaluation methods refer to the introduction of margins.

3.9 Margin

The margin referred to in this section is the process of commissioning the radar,and the parameters selected should leave sufficient tolerances for subsequent mass production.

Debugging is generally carried out on the prototype machine,and the parameters obtained can only represent the function of the radar on the debugging prototype machine,but it does not mean that when mass production is carried out,the consistency of all products is exactly the same as the prototype machine.

In the actual mass production process,due to the impact of PCB plates,electronic component errors,batches and assembly processes, it is difficult to ensure that the performance of each PCBA and the whole machine is exactly the same.Therefore,if the radar parameters are selected with more extreme values,it may lead to the same batch of products that can function normally and some of them have abnormal functions,and the consistency is not good.

Generally speaking,most of the performance of products in production will be basically the same as the prototype machine debugged in the laboratory,but there are a few products whose performance will be worse than the prototype machine,and there are also products with better performance than the prototype machine.

Therefore,we need a way to tell us whether the currently selected radar parameter can be used in mass production,so that this parameter can also be used on the part of the product with poor performance.

Generally speaking,we believe that when the parameter value is selected at least 1.5~2 times of the bottom value,it can basically ensure that the parameter can be used for mass production,that is, there is a margin of 0.5~1 times to ensure the consistency of the final product.

For example,if a whole machine bottoming value is 40,then when we select the final sensing threshold,we must at least ensure that the value is greater than 40*1.5=60,ideally greater than 40*2=80.If the project is debugged to find that an sensing threshold of 50 is required to meet the sensing distance requirements,it is clear that 50 is below the minimum margin requirement,and it is necessary to carefully analyze whether there is still an opportunity to reduce the bottom value of the whole machine.