RCWL-9600 超声波测距芯片

■ 产品概述

RCWL-9600 是一款由无锡日晨物联科技有限公司(WWW.WX-RCWL.COM)设计，专门针对开放式超声波测距应用的芯片。单芯片即可完成超声波发射，接收，解调，处理，计算，输出。

RCWL-9600 内置高性能处理单元，能够实现包括 GPIO,UART,IIC 等多种输出模式；其中 GPIO 模式兼容我司 HC-SR04。

驱动部分采用独特的扫频模式，使其对探头的适应能力更强。针对探头的温度特性，抛弃无温度特性晶体振模式，驱动部分做了温度同比补偿，使探头温飘影响降到最低。

采用 $\sqrt{\ }$用比较拟合曲线，使其对近距离不规则物体测量效果明显优于 HC-SR04。针对 16、12、10MM 探头的不同特性，芯片内置 3 种比较拟合曲线；芯片无需额外附加外围，即可实现自由匹配。

芯片外围只需 8 个阻容器件，最远测距可以通过电阻设置；内置高精度振荡器，无需外部晶振，具有极高的性价比。

配合我司 16,12,10MM 超声波探头,16MM 全彩，炫彩超声波探头；可轻松完成不同测距方案设计。我司亦提供芯片参数与 LOGO，探头，模块等定制化服务。

■ 主要特性

- 工作电压：2.8-3.6V
- 工作电流：2.2mA
- 支持 GPIO,UART 和 IIC 多种输出模式
  默认输出模式兼容 HC-SR04
- 2CM 盲区，可定制
- 7M 最远测距,可外围调节
- 内置高精度振荡器，无需晶振
- 50MS 测量周期,可定制其它时间
- 提供完整设计参考方案
- IO 口可耐受 5.5V
- 工作温度：-40℃-90℃
- 提供 3 种比较拟合曲线芯片
  16mm 探头：RCWL-9600
  12mm 探头：RCWL-9601
  10mm 探头：RCWL-9602

■ 典型应用

- 玩具，机器人避障
- 液位，水位测量
- 其它测距应用

RCWL-9600 Ultrasonic Distance Measurement IC

■ Product overview

The RCWL-9600 is a chip designed by Wuxi Morning IoT Technology Co., Ltd. (WWW.WX-RCWL.cOM) for open ultrasonic ranging applications. A single chip can complete ultrasonic transmission, reception, demodulation, processing, calculation and output.

The RCWL-9600 has a built-in high-performance processing unit, which can implement multiple output modes, such as GPI0, UART and 1IC. The GPI0 mode is compatible with Huawei HC-SR04.

The driving part adopts special frequency sweep mode, which makes it more adaptable to the probe. According to the temperature characteristic of probe, the non-temperature characteristic crystal vibration mode is abandoned, and the temperature compensation is made in the driving part to minimize the temperature drift of probe.

By using the √ comparison fitting curve, the measurement effect of the method is obviously better than that of HC-SRO4. Based on the different characteristics of the 16, 12, and 10 mm probes, the chip has three kinds of comparison curves. The chip can be freely matched without additional peripherals.

Only eight resistors and capacitors are required on the periphery of the chip. The furthest distance measurement can be set using resistors. Built-in high-precision oscillator, no need for external crystal oscillator, high cost performance.

With the Division I 16, 12, 10MM ultrasonic probe, 16MM full color, dazzling color ultrasonic probe; can easily complete different ranging scheme design. Division I also provide chip parameters and LOGO, probes, modules and other customized services.

■ Main features

- Operating voltage 2.8 - 3.6 V
- Operating current 2.2 mA
- Support GPIO, UART and IIC modes
  Default output mode compatible with HC-SR04
- 2 cm blind zone, customizable
- 7 m remotest distance measurement, peripheral adjustment
- Built-in high-precision oscillator, no crystal oscillator required ● 50 MS measurement period, other time can be customized ● Complete design reference solution ● 10 ports can withstand 5.5 V
- Working temperature -40 ... 90 °C
- Provide 3 types of comparision and fitting curve chips:
  - 16 mm probe: RCWL-9600
  - 12 mm probe: RCWL-9601
  - 10 mm probe: RCWL-9602

■ Typical applications

- Toys, robot obstacle avoidance
- Water level measurement
- Other ranging applications

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■ 管脚定义





■ 管脚定义

序号	符号	功能描述
1	IM-out	探头阻抗匹配输出
2	Vcc_a	模拟电源
3	IM-in	探头阻抗匹配输入
4	Vcc_d	数字电源
5	Echo/Tx/SDA	GPIO 模式： Echo ； 串口模式： Tx ； IIC 模式： SDA
6	40K+/IIC	接探头+极（测距应用可不分正负极）；接 10K 到地，选择 IIC 模式
7	Trig/Rx/SCL	GPIO 模式： Trig ； 串口模式： Rx ； IIC 模式： SCL
8	Gnd_d	数字地
9	40K-/Uart	接探头-极（测距应用可不分正负极）；接 10K 到地，选择串口模式
10	GN-out	放大输出，可调节最远测距
11	GN-in	放大输入，可调节最远测距
12	Vcap	内置偏置电压，外接 1uF
13	Gnd_d	数字地
14	BP-in	带通输入
15	BP-out	带通输出
16	Gnd_a	模拟地

■ Pin definition



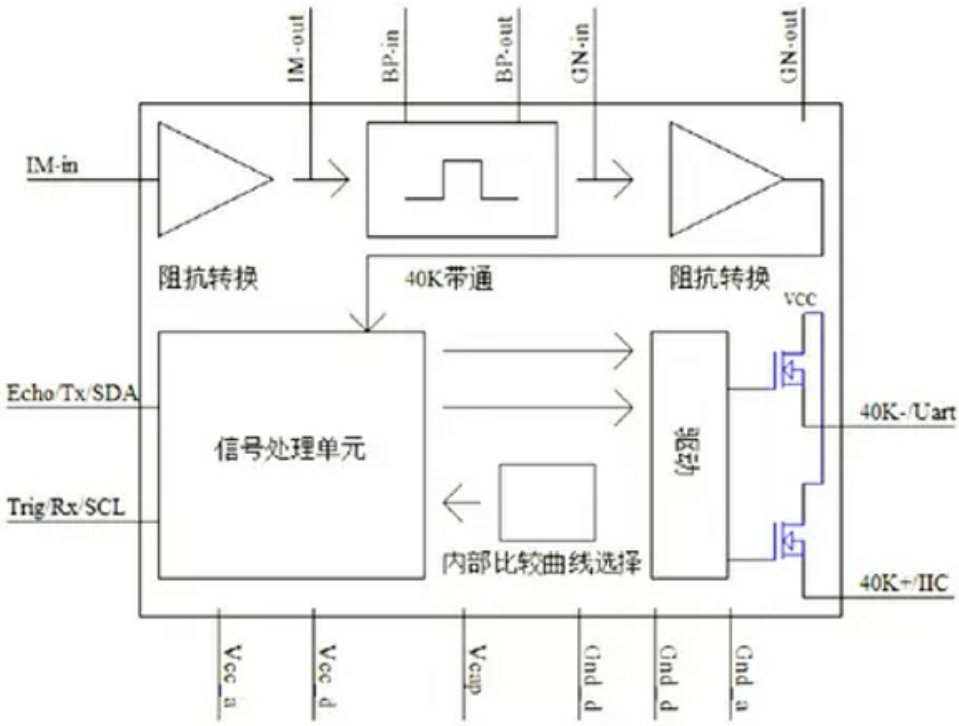


■ Pin definition

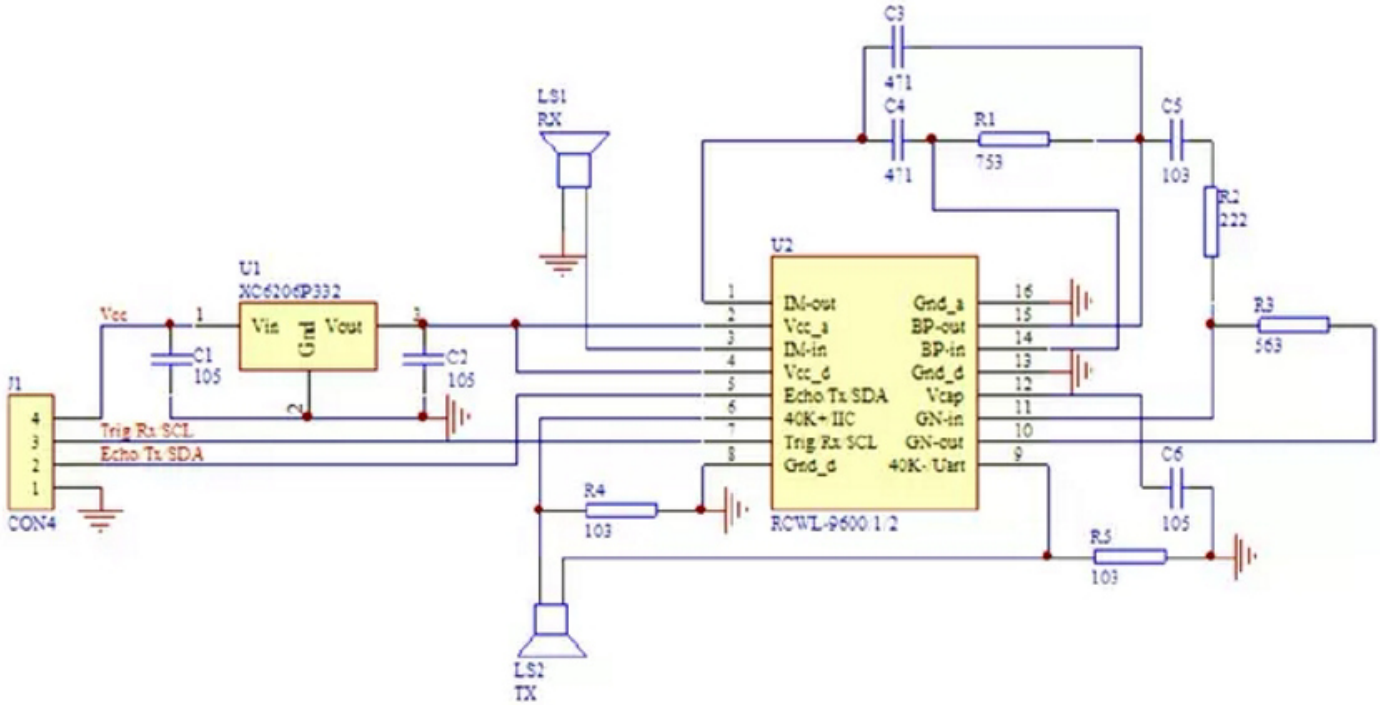
No	Symbol	Function description
1	IM-out	Probe impedance match output
2	Vcc_a	Analog power supply
3	IM-in	Probe impedance match input
4	Vcc_d	Digital power supply
5	Echo/Tx/SDA	GPIO mode: Echo; UART: Tx; IIC: SDA
6	40K+/IIC	Connect with probe + pole (the positive and negative poles can not be divided into the distance measurement application); Connect 10k to ground selects IIC mode.
7	Trig/Rx/SCL	GPIO mode: Trig; UART: Rx; IIC: SCL
8	Gnd_d	Digital ground
9	40K-/UART	Connect to probe "-" pole (the positive and negative poles can not be divided into the range measurement application); Connect 10k to ground selects serial mode.
10	GN-out	Amplified output, adjustable furthest range
11	GN-in	Amplified input, adjustable furthest range
12	Vcap	Internal bias voltage, 1uF
13	Gnd_d	Digital ground
14	BP-in	Band pass input
15	BP-out	Band pass output
16	Gnd_a	Simulation ground

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■ 功能框图

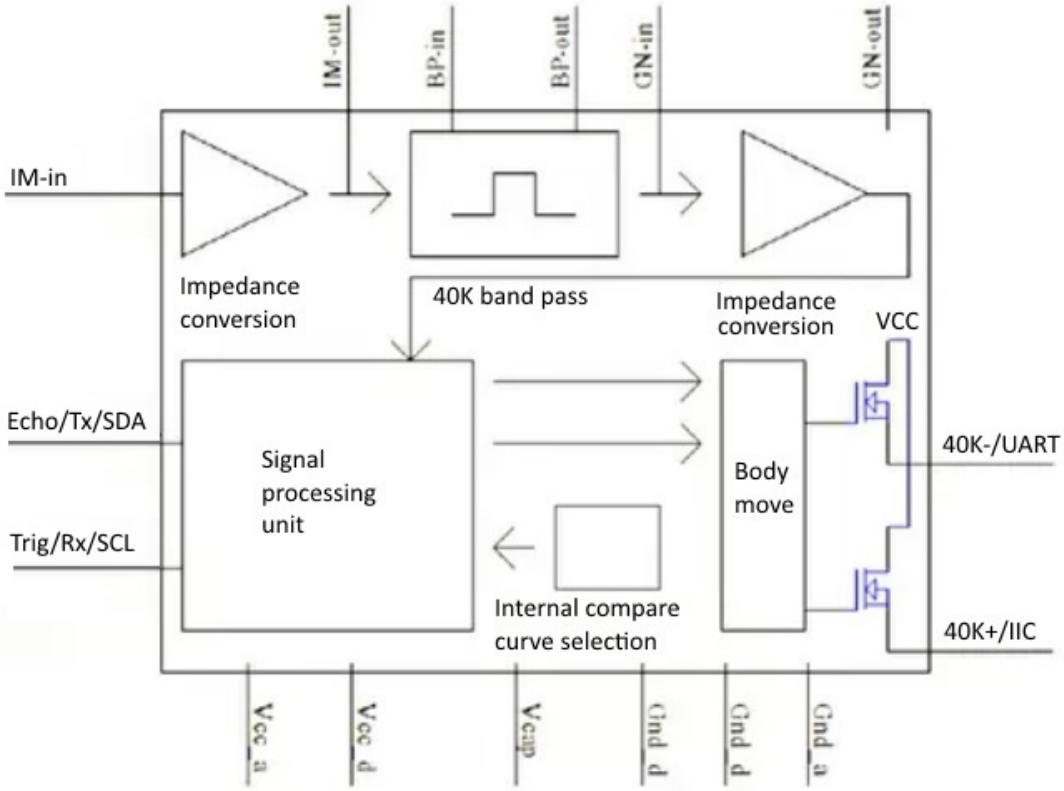


■ 应用线路图

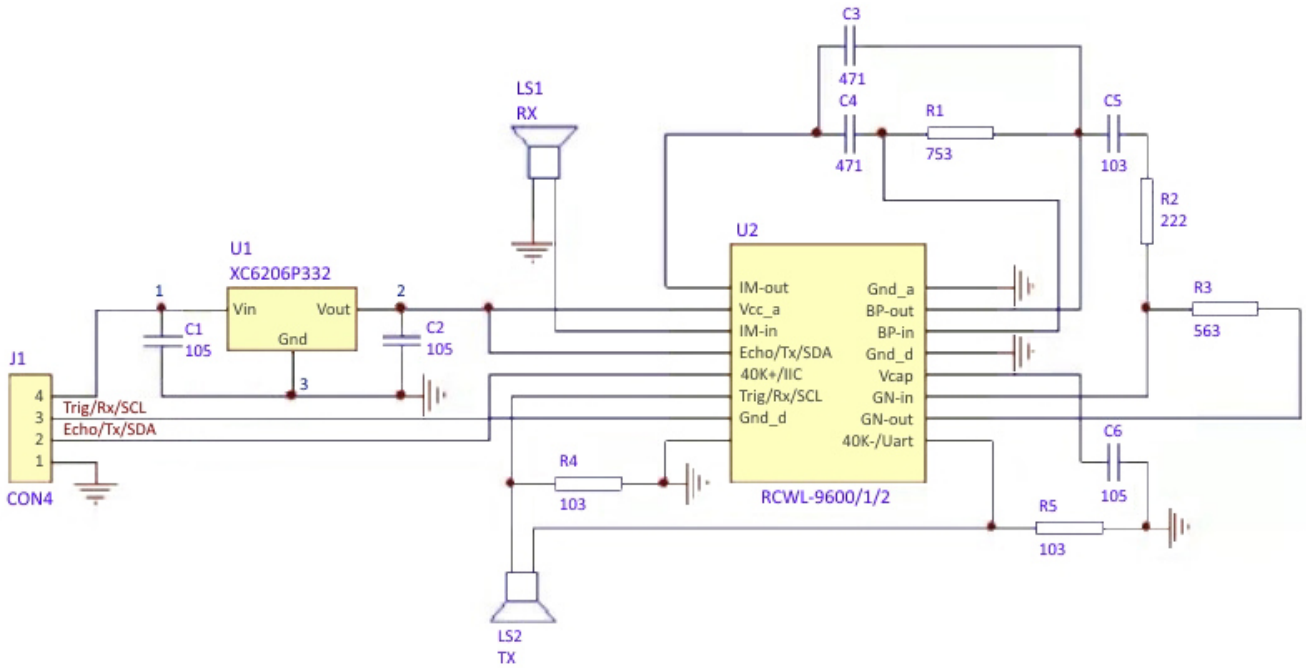


注：3-5V 应用线路图，LDO 选 3.3V 或 3V 的都可以，XC 系列 LDO 输入输出压差很小；如 3.3V 应用，LDO 可省略；如单独 5V 工作，串接一个 1K 电阻到 5V，芯片分压到 3.3V 即可。

Functional block diagram



Application circuit diagram



Note: circuit diagram 3...5 V is used.
LDO can be 3,3 or 3,0 V.
The input and output voltage difference of XC series LD0 is small.
If 3,3 V is applied, LD0 can be omitted.
For example if 5 V is operated independently, connect 1K resistor in series to 5 V and divide to 3,3 V.

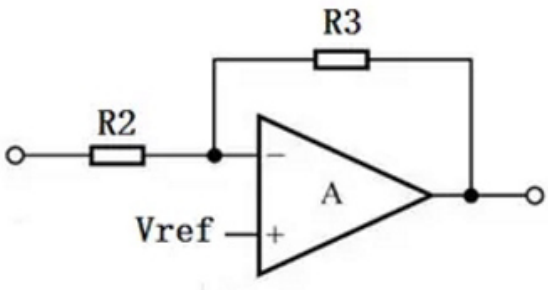
■ 性能参数

参数名称	备注	最小值	典型值	最大值	单位
工作电压		2.8		4.2	V
工作电流			2.2	3	mA
最大探测距离	平整墙面		450	600	CM
工作频率			40		KHz
盲区	盲区内随机值		2	3	CM
探测精度	同一温度		±2		%
分辨率	理论		1		mm
探测角度	最大方向角度		±15	±20	度
测量周期时间			50		mS
输出接口模式		GPIO/UART/IIC			
存储温度		-50		100	℃
工作温度		-40		90	℃
封装材料		环保料			
封装尺寸		SOP16			

■ GPIO,Uart,IIC 选择

序号	模式	R4/R5 电阻设置
1	GPIO	R4（40K+/IIC）=NC R5（40K-Uart/IIC）=NC 默认
2	IIC	R4（40K+/IIC）=10K R5（40K-Uart/IIC）=NC
3	UART	R4（40K+/IIC）=NC R5（40K-Uart/IIC）=10K

■ 最远测距调节



反馈信号最后一级放大可调，调节该级增益可以改变最远测距值。实际应用，一般调节 R3 电阻，R3 电阻值越大，增益越大，最远测距越大。推荐线路中 R3=563，最远测距一般 4M 左右。R3=753，最远一般 4.5M-5M。客户可根据自己需求调节该电阻值。

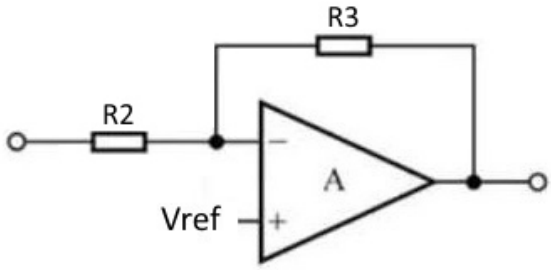
■ Performance parameters

Param name	Note	Min	Typ	Max	Unit
Working voltage		2.8		4.2	V
Working current			2.2	3	mA
Max detection range	Boundary		450	600	cm
Working frequency			40		kHz
Blind area	Random value in blind zone		2	3	cm
Detection accuracy	The same temperature		±2		%
Resolution	Theoretic		1		mm
Detection angle	Maximum detection range		±15	±20	degree
Masurement cycle			50		mS
Output interface mode		GPIO / UART / IIC			
Storage temperature		-50		+100	°C
Operating temperature		-40		+90	°C
Packaging materials		Environmental protection material			
Package type		SOP16			

■ GPIO, Uart and IIC

Pin	Mode	R4/R5 resistor settings
1	GPIO	R4 (40K+/IIC) = NC; R5 (40K-UART/IIC)=NC; Default
2	IIC	R4 (40K+/IIC) = 10K; R5 (40K-UART/IIC) = NC
3	UART	R4 (40K+/IIC) = NC; R5 (40K-UART/IIC) = 10K

■ Maximum distance measurement adjustment



The last stage of amplification of feedback signal is adjustable, and the maximum range value can be changed by adjusting the gain of this stage.

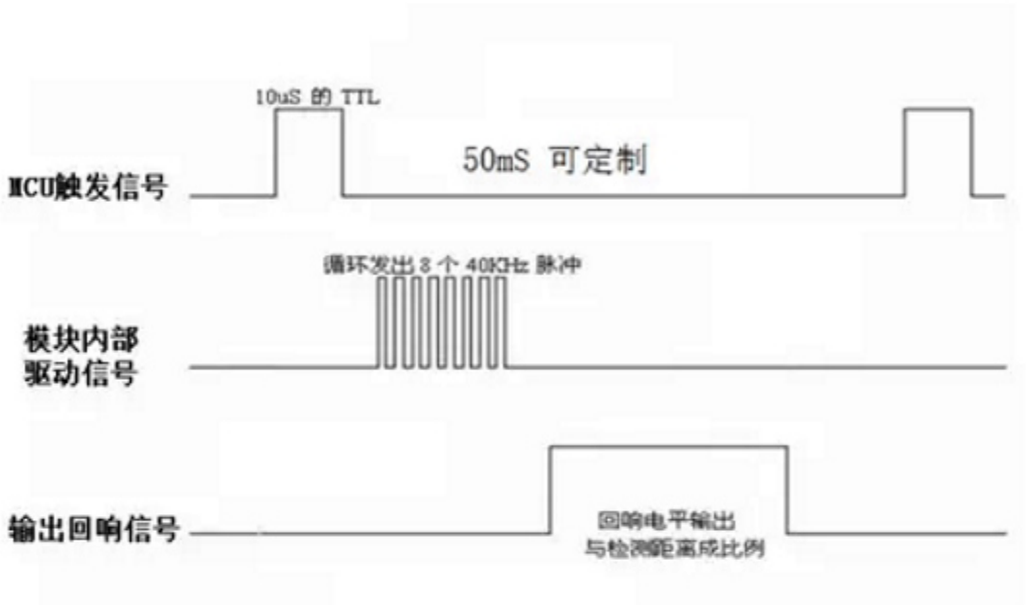
In practice, the R3 resistance is generally adjusted. The larger R3, the larger the gain and larger the distance.

The recommended line for R3 = 563, and the furthest distance is generally about 4 m.
R3 = 753, the furthest distance is about 4.5 - 5 m.
The customer can adjust the resistance according to their needs.

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■ 测量操作

一：GPIO 模式



超声波时序图

工作模式同 HC-SR04。外部 MCU 给模块 Trig 脚一个大于 10uS 的高电平脉冲；模块会给出一个与距离等比的高电平脉冲信号，可根据脉宽时间“T”算出：

距离=T*C/2 （C 为声速）

声速温度公式：c=(331.45+0.61t/℃)m•s-1（其中 330.45 是在 0℃）

0℃声速： 330.45M/S

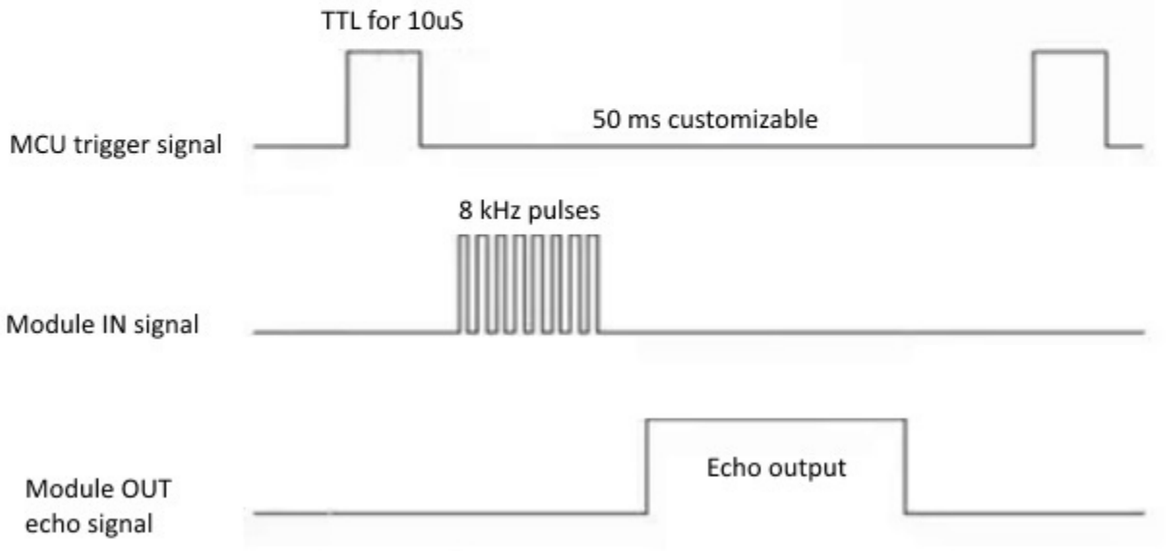
20℃声速： 342.62M/S

40℃声速： 354.85M/S

0℃-40℃声速误差 7%左右。实际应用，如果需要精确距离值，必需要考虑温度影响，做温度补偿。如有需要，可关注我司带温补单芯片 RCWL-9700。

■ Measurement operation

1: GPIO mode



Ultrasonic timing diagram

The working mode is the same as HC-SR04. An external MCU sends a high level pulse greater than 10 uS to the Trig pin of the module. The module gives a high level pulse proportional to distance, which is calculated from the pulse width time "T":

Distance = T * C / 2 (C is the speed of sound)

Sound velocity temperature formula:

c = (331.45 + 0.61t /°C) m/s (where 330.45 is at 0 °C)

Sound velocity: 0 °C = 330.45M/S
20 °C = 342.62M/S
40 °C = 354.85M/S

The error of sound velocity at 0 - 40 C is about 7%.

In practical applications, if accurate distance values are required, temperature effects must be considered and temperature compensation must be done.

If necessary, please pay attention to the RCWL-9700 with temperature compensation.

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二：UART 模式

UART 模式波特率设置： 9600 N 1

命令	返回值	说明
0XA0	BYTE_H BYTE_M BYTE_L	输出距离为： （（BYTE_H<<16）+（BYTE_M<<8）+ BYTE_L)/1000 单位 mm
0XF1		公司及版本信息

连接串口。外部 MCU 或 PC 发命令 0XA0，模块完成测距后发 3 个返回距离数据：

BYTE_H，BYTE_M 与 BYTE_L。

距离计算方式如下（单位 mm）：

距离=（（BYTE_H<<16）+（BYTE_M<<8）+ BYTE_L)/1000

2: UART mode

UART mode baud rate settings: 9600 N 1

Command	Return value	Description
0xA0	BYTE_H BYTE_M BYTE_L	The output distance is (mm): ((BYTE_H<<16) + (BYTE_M<<8) + BYTE_L) / 1000
0xF1		Company and version information

Connect to the serial port.
The MCU or PC sends the 0xA0 command.
After distance measured, the module return three bytes of data: BYTE_H, BYTE_M and BYTE_L.

The distance is calculated in mm as follows:

Distance = ((BYTE_H<<16) + (BYTE_M<<8) + BYTE_L) / 1000

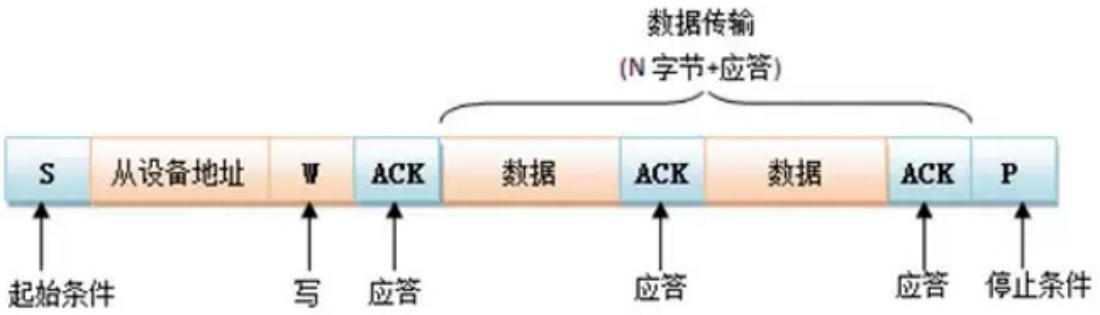
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三：IIC 模式

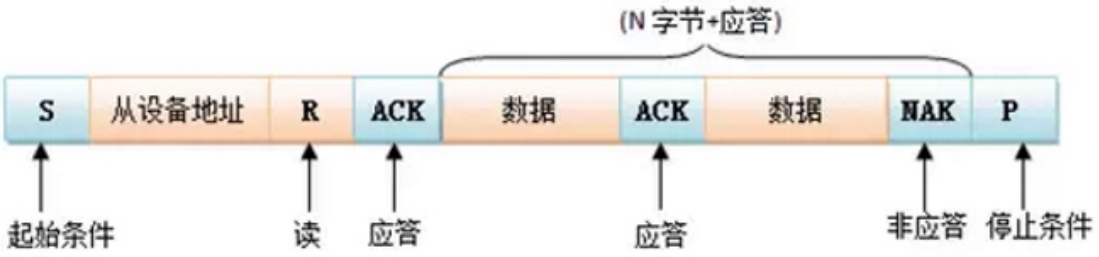
IIC 地址： 0X57

IIC 传输格式：

写数据：



读数据：



命令格式：

地址	命令	返回值	说明
写 地 址 0XAE	0X01		开始测距命令
读 地 址 0XAF		BYTE_H BYTE_M BYTE_L	输出距离为： （（BYTE_H<<16）+（BYTE_M<<8）+ BYTE_L)/1000 单位 mm

向模块写入 0X01，模块开始测距；等待 100mS(模块最大测距时间)以上。直接读出 3 个距离数据。BYTE_H，BYTE_M 与 BYTE_L。

距离计算方式如下（单位 mm）：

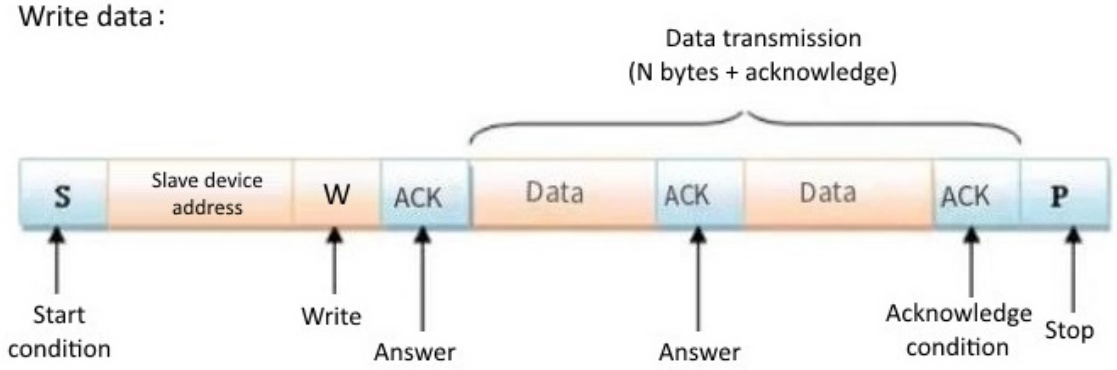
距离=（（BYTE_H<<16）+（BYTE_M<<8）+ BYTE_L)/1000

3: IIC mode

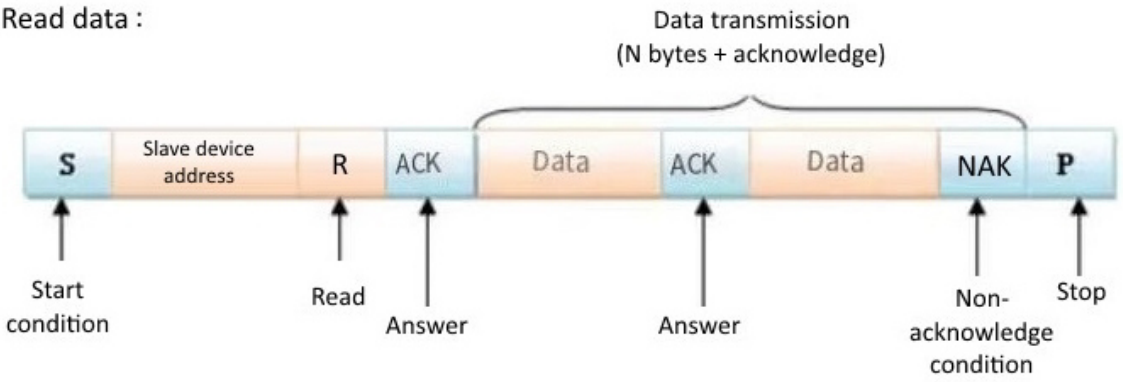
I2C address 0x57

I2C transmission format

Write data :



Read data :



Command format:

Address	Command	Return value	Description
Write 0xAE	0x01		Start ranging command
Read 0xAF		BYTE_H BYTE_M BYTE_L	Distance calculated as (in mm): ((BYTE_H<<16) + (BYTE_M<<8) + BYTE_L) / 1000

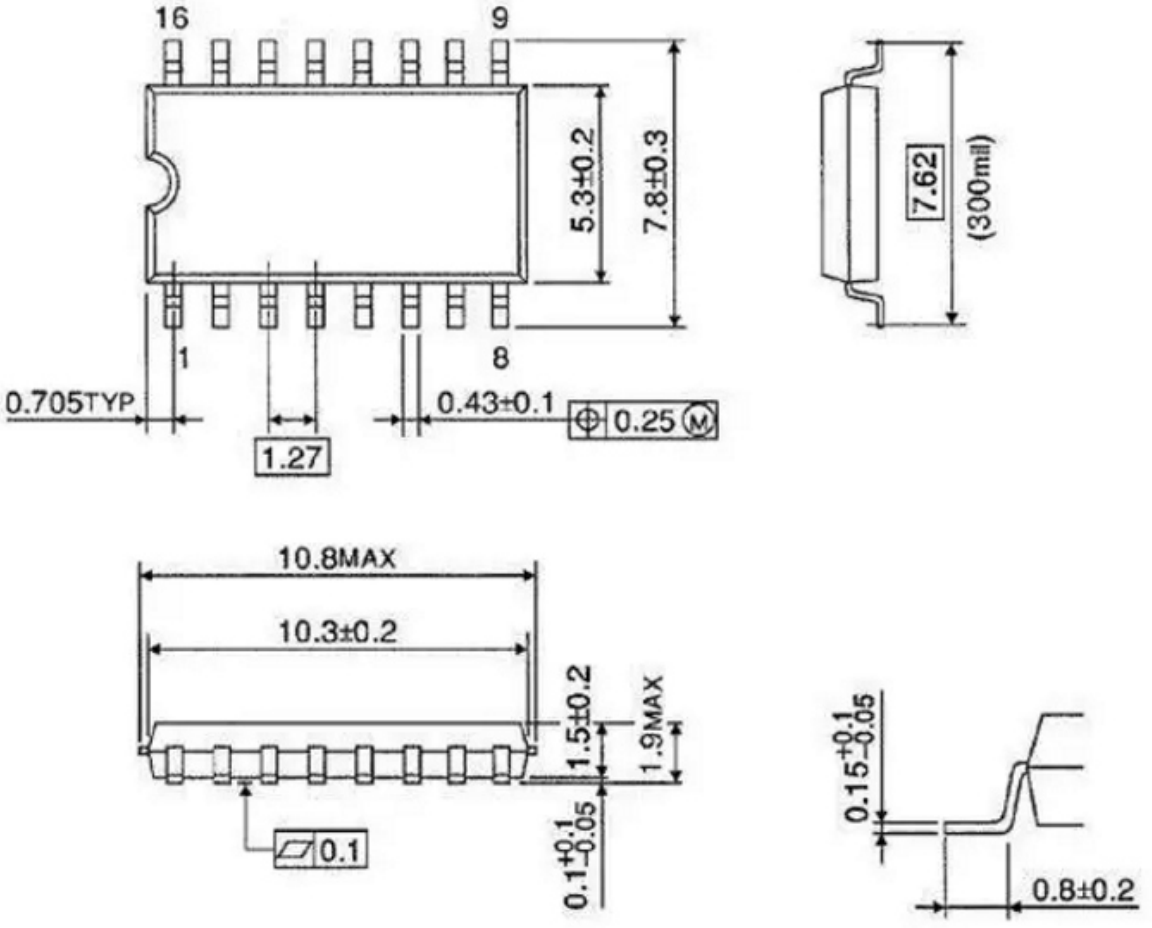
Write 0x01 to the module to start distance measurement.
Wait for more than 100 ms (maximum measurement time of the module).
Directly read out three bytes of distance data: BYTE_H, BYTE_M, BYTE_L.

The distance is calculated in mm as follows:

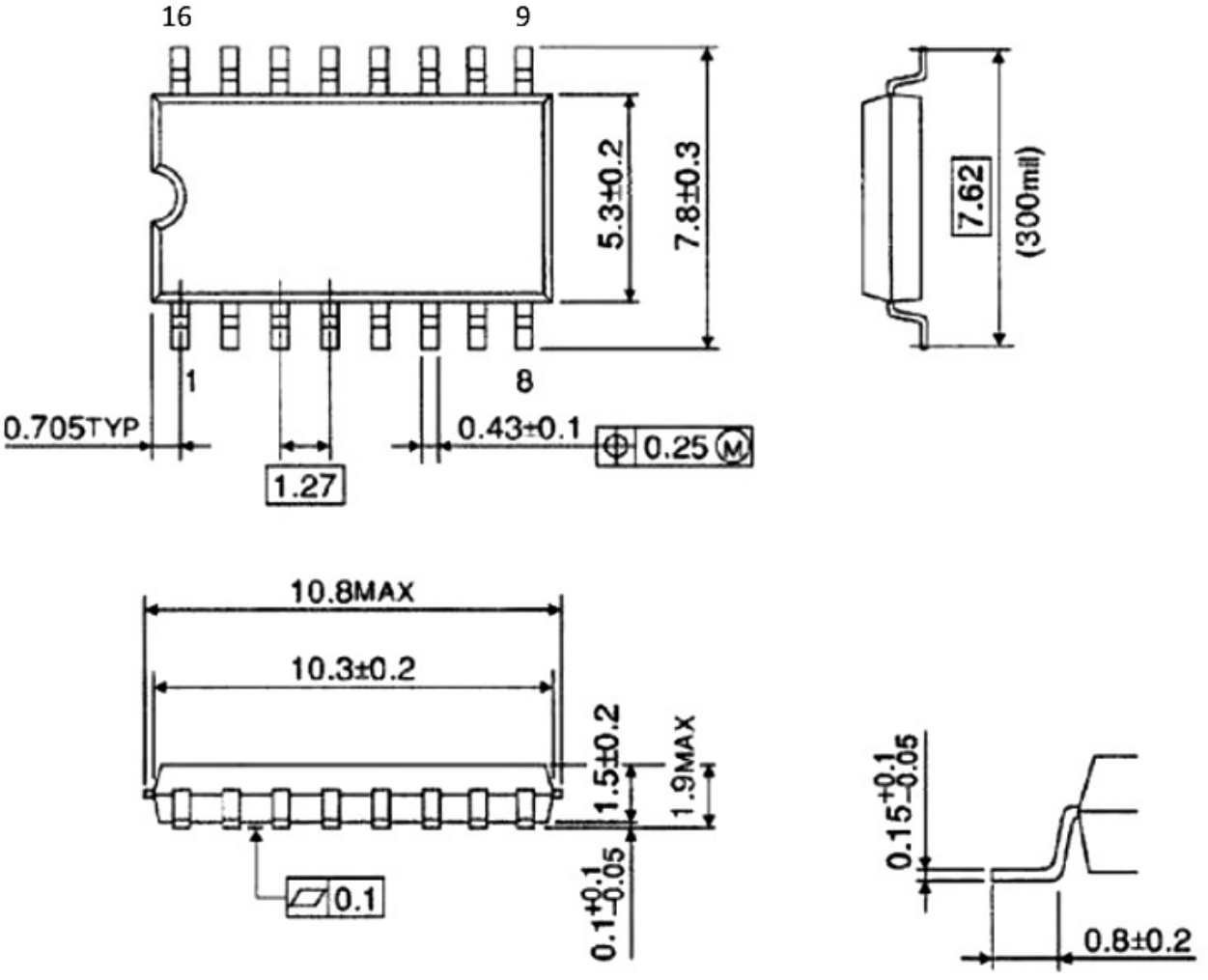
Distance = ((BYTE_H<<16) + (BYTE_M<<8) + BYTE_L) / 1000

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■ 封装外型图


16
9
1
8
5.3±0.2
7.8±0.3
7.62
(300mil)
0.705TYP
1.27
0.43±0.1
0.25 M
10.8MAX
10.3±0.2
1.5±0.2
1.9MAX
0.1
0.1+0.1 -0.05
0.15+0.1 -0.05
0.8±0.2

Package outline



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It is not reccomended to use in areas where malfunction or disfunction may cause harm people.

It is used as a key component in life-saving, life-support devices or systems. Wuxi Morning IoT Technology Co., Ltd. has the right to modify products without prior notice.

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