KS101B/KS103/KS103S Ultra Sonic Range Finder

Technical Specification

Rev 3.58

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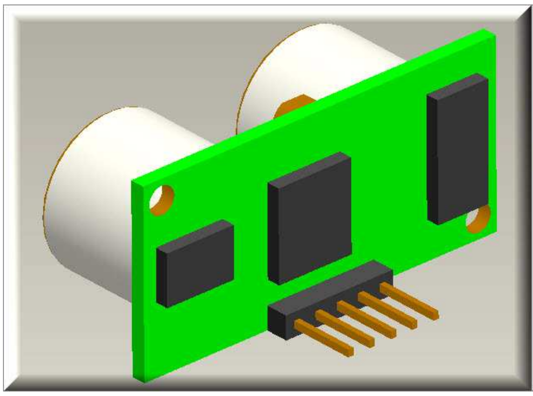
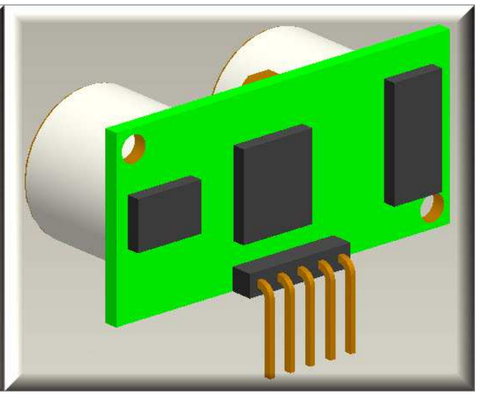


KS103 VERTICAL



KS103 BENDING

Function Abstract

- Ranging with temperature revised, high precision in distance
- Range in 1cm to 800cm, using patent technologies
- Detecting frequency up to 500Hz, which can detect 500 times per second
- Use slave I^{2}C bus/TTL serial bus, detect master's command automatically
- 20 I^{2}C address and can be changed, the address is 0xd0-0xfe (except 0xf0,0xf2,0xf4,0xf6)
- Broadcast address 0x00 allowed(except KS103/KS103S)
- Short and high precision temperature detect of 83ms each time
- Sleep automatically after 5s without commands, wake up by master at any time
- Short range in 10cm, 20cm to 470cm, 47 steps total
- 1ms in light intensity detect. Special command for light intensity detect
- Industrial and Extended Temperature range(-30℃~+85℃)(KS103/KS103S work in 0~70℃)
- Wide operating voltage range (3.0V~5.5V)
- The communication rate of the I2C mode 50~100kbit/s
- Unique filtering noise reduction technology, can still work under noisy power supply
- Pb free

Electrical Specification:

Operating Voltage: ***3.0V~5.5V***

Operating Current: ***1.6-2.7 mA@5.0V, typical   10.6mA@5.0V, max***

Standy Cueernt: ***500uA@5.0V, max.***

Use nano Watt Technology, power saving in sleep mode. Went into sleep mode automatically after 5s without I^{2}C command.

Connection pins marked on the KS101B/KS103/KS103S: VCC, SDA/TX (SDA), SCL/RX (SCL), GND and MODE. Setting the MODE pin for I^2C mode or TTL serial mode, if the MODE pin is left unconnected, KS101B/KS103/KS103S operates in I2C mode; if the MODE pin is connected to 0V before power on, KS101B/KS103/KS103S will work in TTL serial mode. The TTL serial port is not 232 serial port, TTL level can be directly connected with the MCU's TXD/RXD, but not with 232 serial ports directly connected (directly connected will burn out the module), you should need a MAX232 to connect to 232 serial port..

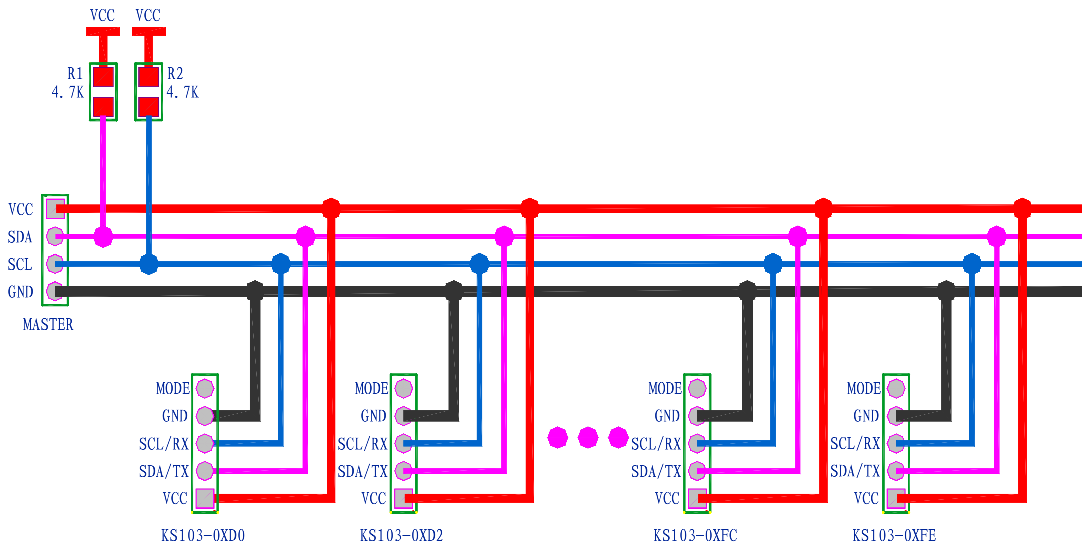
I^2C mode

KS101B/KS103/KS103S's connection:

As shown, there's five pins "VCC, SDA/TX, SCL/RX, GND, MODE" on KS101B/KS103/KS103S's board. The VCC pin should connect to master's VCC, the VCC must be in range of 3.0-5.5V(1). The GND connect to master's ground. The MODE pin should be left unconnected. It's only be used for program when producing. The SCL is I^2C bus's clock line, and SDA is I^2C bus's data line. The SCL and SDA lines should each have a pull-up resistor to VCC somewhere on the I^2C bus. We suggest one pair of resistors about 1.8k-4.7k on master board. Some master modules already have pull-up resistors to act as I^2C bus and you can connect KS101B/KS103/KS103S to I^2C bus directly.

Note 1: To achieve KS101B/KS103/KS103S'S best working conditions recommended +5 V power supply. Moreover, VCC and GND is strictly prohibited reverse, it may damage the circuit.

Here's the circuit diagram(20PCS KS101B/KS103/KS103S on I^2C bus):



KS101B/KS103/KS103S's default address is 0xe8 and can be change to the one of 0xd0, 0xd2 , 0xd4, 0xd6, 0xd8, 0xda, 0xdc, 0xde, 0xe0, 0xe2, 0xe4, 0xe6, 0xe8, 0xea, 0xec, 0xee, 0xf8, 0xfa, 0xfc, 0xfe. (2)

Note 2: 0xd0~0xfe except address "0xf0, 0xf2, 0xf4,0xf6"， this 4 address are reserved for 10 bit slave I^{2}C address.

Sequence of change I^{2}C address

Address	2	0x9a	Delay 1ms	Address	2	0x92	Delay 1ms	Address	2	0x9e	Delay 1ms	Address	2	New Address	Delay 100ms

Change I^{2}C address must follow the sequence and the delay time showed on table is the least delay time. It's won't be trouble because there's the right function(seen in attached files No.3) *change_i2c_address(addr old,addr_new)* to refer to. It's used for 51 MCU as an example.

You can't cut off the power when changing I^{2}C address or the EEPROM may be corrupted .After changing repower KS101B/KS103/KS103S and the LED on the back board will flash the new address in binary system. The change I^{2}C address function should not put in loop for ever such as while(1) loop. We suggest put it in initialization function, to make sure change I^{2}C address function run just one time when power up.

For KS101B,If you don't want to watch the old address, you can use general call address 0x00 instead.

GENERAL CALL ADDRESS SUPPORT (KS101B ONLY)

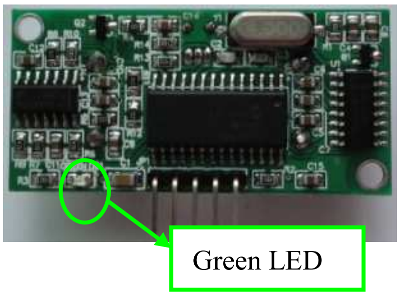
The addressing procedure for the I^{2}C bus is such that,the first byte after the Start condition usually determines which device will be the slave addressed by the master. The exception is the general call address,which can address all devices. When this address is used, all devices should, in theory, respond with an acknowledge.The general call address is one of eight addresses reserved for specific purposes by the I^{2}C protocol. It consists of all 0's with R/W = 0. You also can use address 0x00 to control KS101B, but you cannot get the range result by address "0x00+1", you should use the right address from 0xd0 to 0xfe to get KS101B's range result.

KS101B/KS103/KS103S's Work Sequence

After power on KS101B/KS103/KS103S, back green LED will flash the 8-bit address in binary system. Short flash twice will be "1", slow flash once will be "0". Such as address 0xea, it's

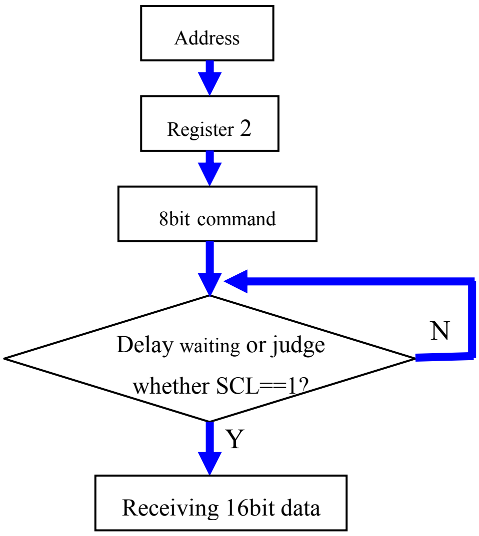
*0B*11101010 in binary system, the green LED will be *slow light→off→short flash twice→off→short flash twice→off→short flash twice→off→slow flash once→off→short flash twice→off→slow flash once→off→short flash twice→off→slow flash once.* (3)

Note 3: LED flashing green light may stimulate the eyes, try not to look at flashing LED directly, you can use the corner of the eye to observe the flashing.



After power up, when KS101B/KS103/KS103S receive valid command, it will stop flashing and begin to detecting at once.

KS101B/KS103/KS103S use the I^2C interface to communicate with master, automatic response to master I^2C control command s for the 8-bit data, there's command s send process:



Multi-range mode(KS103S doesn't support command 0xb4 and 0xbc and temperature command)

Detecting command from 0x01 to 0x2f, the greater the value, the greater the signal gain. Command 0x01 corresponding with range about 100mm, command 0x02 corresponding with range about 200mm, ..., and so on, command 0x2f corresponding with range about 4700mm. The smaller the range, the faster it detecting. Detection time based on the ultrasonic transmission time plus about 1ms. Note that the 16-bit value returned is a unit of time in μs, and the time spend is from ultrasonic transmit to receive.

And most useful range will be range of 0-5m of command 0xb0/0xb2/0xb4, and range of command 0-11m of 0xb8/0xba/0xbc. By using "address + register 2 + ranging command" to begin a new ranging, and then delay or wait for corresponding time that the table 1 specified, and then using the read function to read the value of register 2 and register 3, then you can get the 16-bit distance data. Command 0xb0 and 0xb8 will return distance in millimeter ,it's calculate by 25

℃(about 340m/s) according to the actual detecting time; command 0xb2 and 0xba detecting returns a unit μs of time spend, and the time spend is from ultrasonic transmit to receive.
To get accurate distance measurement value, use 0xb4 or 0xbc command, these two commands automatically using high-precision temperature revised technology, more stable and more accurate detection of the value. You can also use 0xb2/0xba (transmission time) + 0xc9/0xca/0xcb/0xcc (ambient temperature) combination, to detect the ultrasonic transmission time in the air and the corresponding temperature, and then translated by the speed of sound to get the exact distance values. Using a temperature revised 0xb4 command, the most accurate cac reach up to 1mm, the error is 0.152mm/17cm. With the change of environment and development of technology, KS101B/KS103/KS103S internal formula may not be in future. For millimeter-level accuracy of the distance, please use the latest possible formula to get the precise distance value when you get ultrasonic transit time and temperature.
Meanwhile, in the long-range detection, if the power supply is noisy, KS101B/KS103/KS103S will be likely not reach 1cm ~ 650cm maximum range, so if you use noisy power supply (for example, take power from the computer USB port), please use the detection range of 0-5m detection commands to get the right value.

Intelligent recognition of detecting end

After KS101B/KS103/KS103S finish detect command sending, it take some time to get the right side 16-bit I^2C data. The user only know the maximum detecting time, but we do not really know the actual time of each detecting. KS101B/KS103/KS103S use an intelligent recognition technology. Simply say, SCL will remain low when KS101B/KS103/KS103S's detecting, when it finish detecting SCL will become high level at once. User can check whether the SCL line goes high by using while (! SCL) statements to wait, SCL line goes high indicates that the detecting is completed, you can start receiving 16-bit data through the I^2C bus. Note that when finish sending the detect command, you need to delay at least 40us and then begin to judge whether the SCL line goes high, for the most fast command 0xa0 will take about 1ms, so we suggest to delay about 1ms, it won't interrupt the ongoing detecting, also won't reduce the detection efficiency. You can also delay a period of time and then starte to receive the 16-bit I^2C data. (4)

Note 4: The bus clamp detection methods can provide customers greater speed and efficiency of detection, rather than waiting at least every 65ms. In other words, most of the time users only need to quickly know whether there are obstacles within 1m range. Specific delay time should be greater than the maximum detecting time show in Table 1.

Intelligent recognition of detecting end will be a default configuration, if you do not want to judge the SCL line's level, you can sending a command 0xc3 to close this function, then power off and restart KS101B/KS103/KS103S SCL line won't go low when detecting. If you want to restore SCL clamp down function, you can send 0xc2 command to KS101B/KS103/KS103S.
Intelligent recognition of detecting end is automatically saved after configured, and immediately working under the new configuration.
Follow the attached files 3, the configuration code should be as follows:
write_byte (0xe8, 2,0 xc2); //SCL clamp
delayms (2000);
KS101B/KS103/KS103S will be run according to the new configuration when restart.

Detect command

When finish sending detect command , KS101B/KS103/KS103S will be based on to detect command to enter the appropriate detection mode, the host at this time should wait for some time before the beginning of the query results by to from I2C bus, I2C bus early inquiry will be “0xff “values. Note that each frame to detect command format is:

I^2C address	Register 2	8 bit data

Command and register list

Register	Command	Return value range(Decimal)	Return value range(Hex)	Note
0		0-255	0-0xff	Produce year
1		1-52	0x01-0x35	Produce week
2	0x01	80-577μs	0x50-0x241μs	Range of about 100mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x02	66-1154μs	0x42-0x482μs	Range of about 200mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x03	66-1731μs	0x42-0x6c3μs	Range of about 300mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x04	80-2308μs	0x50-0x904μs	Range of about 400mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x05	82-2885μs	0x52-0xb45μs	Range of about 500mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x06	80-3462μs	0x50-0xd86μs	Range of about 600mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x07	68-4039μs	0x44-0xfc7μs	Range of about 700mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x08	80-4616μs	0x50-0x1208μs	Range of about 800mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x09	80-5193μs	0x50-0x1449μs	Range of about 900mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x0a	66-5770μs	0x42-0x168aμs	Range of about 1000mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x0b	93-6347μs	0x5d-0x18cbμs	Range of about 1100mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x0c	79-6924μs	0x4f-0x1b0cμs	Range of about 1200mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x0d	93-7501μs	0x5d-0x1d4dμs	Range of about 1300mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x0e	79-8078μs	0x4f-0x1f8eμs	Range of about 1400mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x0f	79-8655μs	0x4f-0x21cfμs	Range of about 1500mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x10	79-9232μs	0x4f-0x2410μs	Range of about 1600mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x11	77-9809μs	0x4d-0x2651μs	Range of about 1700mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x12	77-10386μs	0x4d-0x2892μs	Range of about 1800mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x13	77-10963μs	0x4d-0x2ad3μs	Range of about 1900mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x14	79-11540μs	0x4f-0x2d14μs	Range of about 2000mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x15	63-12117μs	0x3f-0x2f55μs	Range of about 2100mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x16	79-12694μs	0x4f-0x3196μs	Range of about 2200mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x17	79-13271μs	0x4f-0x33d7μs	Range of about 2300mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x18	79-13848μs	0x4f-0x3618μs	Range of about 2400mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x19	77-14425μs	0x4d-0x3859μs	Range of about 2500mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x1a	93-15002μs	0x5d-0x3a9aμs	Range of about 2600mm, return μs. Maximum time consume = Maximum return value + 1000μs

2	0x1b	63-15579µs	0x3f-0x3cdbµs	Range of about 2700mm, return µs. Maximum time consume = Maximum return value + 1000µs
2	0x1c	79-16156µs	0x4f-0x3f1cµs	Range of about 2800mm, return µs. Maximum time consume = Maximum return value + 1000µs
2	0x1d	79-16733µs	0x4f-0x415dµs	Range of about 2900mm, return µs. Maximum time consume = Maximum return value + 1000µs
2	0x1e	79-17310µs	0x4f-0x439eµs	Range of about 3000mm, return µs. Maximum time consume = Maximum return value + 1000µs
2	0x1f	77-17887µs	0x4d-0x45dfµs	Range of about 3100mm, return µs. Maximum time consume = Maximum return value + 1000µs
2	0x20	91-18464µs	0x5b-0x4820µs	Range of about 3200mm, return µs. Maximum time consume = Maximum return value + 1000µs
2	0x21	79-19041µs	0x4f-0x4a61µs	Range of about 3300mm, return µs. Maximum time consume = Maximum return value + 1000µs
2	0x22	79-19618µs	0x4f-0x4ca2µs	Range of about 3400mm, return µs. Maximum time consume = Maximum return value + 1000µs
2	0x23	79-20195µs	0x4f-0x4ee3µs	Range of about 3500mm, return µs. Maximum time consume = Maximum return value + 1000µs
2	0x24	79-20772µs	0x4f-0x5124µs	Range of about 3600mm, return µs. Maximum time consume = Maximum return value + 1000µs
2	0x25	77-21349µs	0x4d-0x5365µs	Range of about 3700mm, return µs. Maximum time consume = Maximum return value + 1000µs
2	0x26	79-21926µs	0x4f-0x55a6µs	Range of about 3800mm, return µs. Maximum time consume = Maximum return value + 1000µs
2	0x27	63-22503µs	0x3f-0x57e7µs	Range of about 3900mm, return µs. Maximum time consume = Maximum return value + 1000µs
2	0x28	79-23080µs	0x4f-0x5a28µs	Range of about 4000mm, return µs. Maximum time consume = Maximum return value + 1000µs
2	0x29	63-23657µs	0x3f-0x5c69µs	Range of about 4100mm, return µs. Maximum time consume = Maximum return value + 1000µs
2	0x2a	79-24234µs	0x4f-0x5eaaµs	Range of about 4200mm, return µs. Maximum time consume = Maximum return value + 1000µs
2	0x2b	79-24811µs	0x4f-0x60ebµs	Range of about 4300mm, return µs. Maximum time consume = Maximum return value + 1000µs
2	0x2c	79-25388µs	0x4f-0x632cµs	Range of about 4400mm, return µs. Maximum time consume = Maximum return value + 1000µs
2	0x2d	77-25965µs	0x4d-0x656dµs	Range of about 4500mm, return µs. Maximum time consume = Maximum return value + 1000µs
2	0x2e	79-26542µs	0x4f-0x67aeµs	Range of about 4600mm, return µs. Maximum time consume = Maximum return value + 1000µs
2	0x2f	63-27119µs	0x3f-0x69efµs	Range of about 4700mm, return µs. Maximum time consume = Maximum return value + 1000µs
2	0x70	void	void	First level noise reduction, factory default settings, for battery-powered
2	0x71	void	void	Second level noise reduction, for USB-powered
2	0x72	void	void	Third level noise reduction, for long distance USB-powered
2	0x73	void	void	Fourth level noise reduction, for switching power supply
2	0x74	void	void	Fifth level noise reduction, for noisy switching power supply
2	0x75	void	void	Sixth level noise reduction, for high noise power supply
2	0x8a	void	void	I2C communications test command, after sending LED will flash display the binary value of the command
2	0x8b	void	void	
2	0x8c	void	void	
2	0x92	void	void	The second sequence change address
2	0x9a	void	void	The first sequence change address
2	0x9e	void	void	The third sequence change address
2	0xa0	0-1023	0-0x3ff	Light intensity detect, the light is stronger, the greater the value, the detect takes about 1ms
2	0xb0	10-5200mm	0x0a-0x1450mm	0-5m range, normal range (without temperature revised), return mm, detection took about 33ms maximum

2	0xb2	79-30000μs	0x4f-0x7530μs	0-5m range, normal range (without temperature revised), return μs, detection took about 32ms maximum
2	0xb4	10-5200mm	0x0a-0x1450mm	0-5m range, normal range (with temperature revised), return mm, detection took about 87ms maximum(KS103S doesn't support this command)
2	0xb8	20-11280mm	0x14-0x2c10mm	0-11m range, normal range (without temperature revised), return mm, detection took about 68ms maximum
2	0xba	159-65278μs	0x9f-0xfefeμs	0-11m range, normal range (without temperature revised), return μs, detection took about 66ms maximum
2	0xbc	20-11280mm	0x14-0x2c10mm	0-11m range, normal range (with temperature revised), return mm, detection took about 87ms maximum(KS103S doesn't support this command)
2	0xc0	void	void	Open LED flash when detecting，default
2	0xc1	void	void	Close LED flash when detecting
2	0xc2	void	void	SCL line force to low when detecting, the default
2	0xc3	void	void	SCL line keep high level when detecting
2	0xc4	void	void	5 seconds for sleep waiting
2	0xc5	void	void	1 seconds for sleep waiting
2	0xc9	0-255	0-0xff	Return 9-bit precision temperature data, according to DS18B20 format, range of -40 ℃ - +125 ℃, detection takes about 83ms(KS103S doesn't support this command)
2	0xca	0-255	0-0xff	Return 10-bit precision temperature data, according to DS18B20 format, range of -40 ℃ - +125 ℃, detection takes about 168ms(KS103S doesn't support this command)
2	0xcb	0-255	0-0xff	Return 11-bit precision temperature data, according to DS18B20 format, range of -40 ℃ - +125 ℃, detection takes about 315ms(KS103S doesn't support this command)
2	0xcc	0-255	0-0xff	Return 12-bit precision temperature data, according to DS18B20 format, range of -40 ℃ - +125 ℃, detection takes about 610ms(KS103S doesn't support this command)
3		0-255	0-0xff	Register 3 and register 2 use together, register 2 returns high 8-bit of 16-bit data, and register 3, returns the lower 8-bits of data 16-bit data.
4		0-255	0-0xff	High 8-bit data of power on times
5		0-255	0-0xff	Low 8-bit data of power on times
6		0-255	0-0xff	Program version
7-15		0	0	Reserved

Table 1

Noise reduction of power supply command

KS101B/KS103/KS103S recommend using the default battery power. If you use noisy power supply, distance values may be volatile instability. Users can send command 0x70, 0x71, 0x72, 0x73, 0x74, 0x75 to configure KS101B/KS103/KS103S ranging module clutter suppression. Command 0x70 will configure the module on first level noise reduction, suitable for battery-powered occasions, but also the factory default settings. Command 0x71 will enable the module to be second level noise reduction, for USB-powered. Command 0x72 will configure the module to be third level noise reduction, for long distance USB-powered. Command 0x73 will configure the module to be fourth level noise reduction, for switching power supply. Command 0x74 will configure the module to be fifth level noise reduction, for noisy switching power supply.

Command 0x75 will configure the module to be sixth level noise reduction, for high noise power supply.

Should choose smaller values such as 0x70 to ensure accuracy. The higher the noise reduction level, the greater the probability that the waveform is eliminated.

Configuration is very simple, send commands to the module as follows: "I^2C address + register 2 +0x70/0x71/0x72/0x73/0x74/0x75 " , and at least 2 seconds delay after sending to allow the system to automatically configure . And begin work under the new configuration.

Follow the attached files 3, the configuration code should be as follows:

write_byte (0xe8, 2,0 x71); //config. to the second level

delayms (2000);

KS101B/KS103/KS103S will be run according to the new configuration when restart.

Temperature detecting (KS101B and KS103 only)

Temperature detecting included 0xc9, 0xca, 0xcb, 0xcc total of four commands, through the "I^2C address + register 2 + 0xc9/0xca/0xcb/0xcc" sequence, delay or wait for corresponding time that table 1 specified, and then use register read function to get the 16-bit data by reading the value of register 2 and register 3, the 16-bit data obtained to comply with the rules DS18B20 chip temperature readings, the specific information please refer to the chip DS18B20. To 0xcc command , for example, it will get a total of 16-bit data. The high five bit of 16-bit data is the sign bit, if the measured temperature is greater than 0℃, the high five bit will 00000, and then the 16-bit data divide by 16 and we can get the temperature.

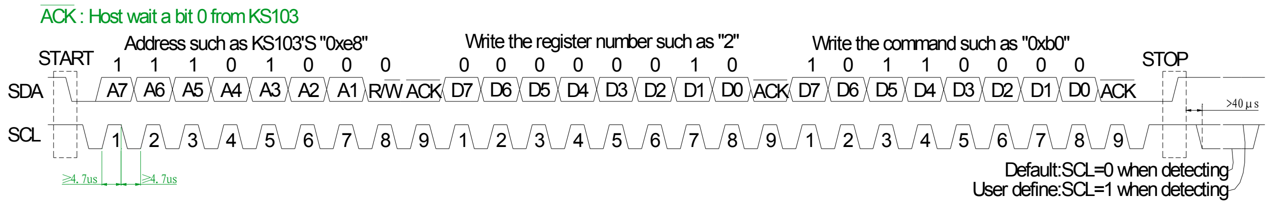
Light intensity detecting

Use 0xa0 command, through the "I^2C address + register 2 + 0xa0 " sequence, delay or wait for 1ms and then use register read function to read the value of register 2 and register 3, you can quickly get the ambient light intensity. The stronger the light, the greater the return value, and the return value is between 0 to 1023.

Sequence

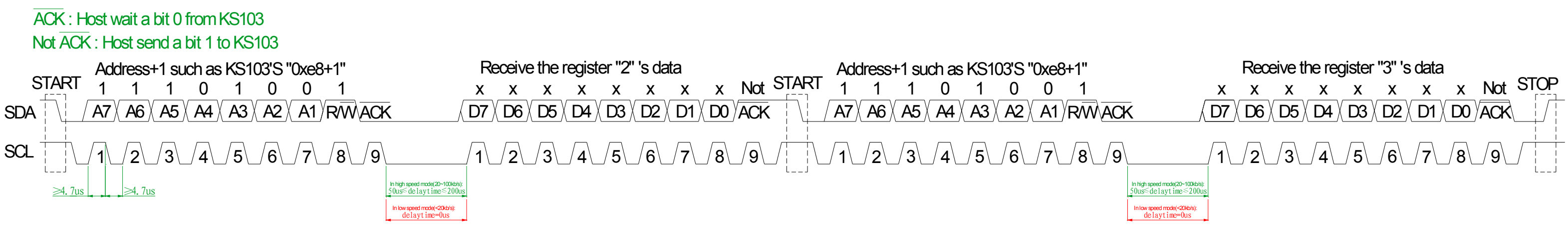
Sequence 1: Send detect command to KS101B/KS103/KS103S(Such as register 2):

Address	Register 2	8-bit command



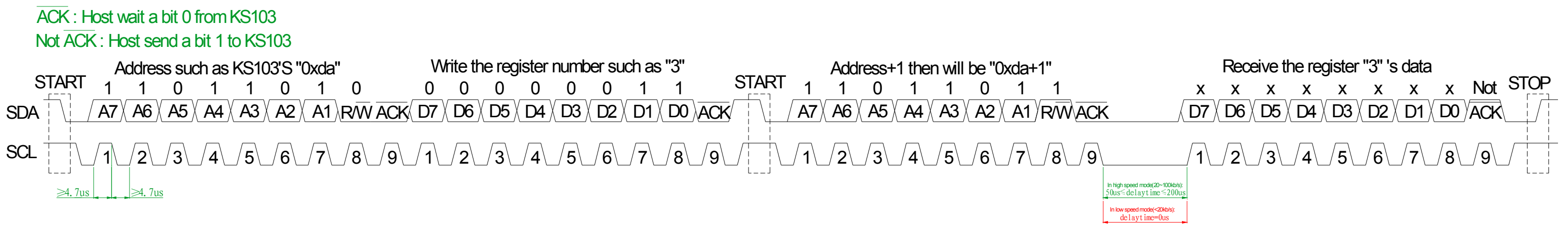
Sequence 2: After sequence 1, wait for SCL goes high or delay 100ms, then begin to receive 16 bit data, high byte first low byte behind:

Address+1	Read Register 2	Address+1	Read Register 3



Read any register(Such as register 3): (5)

Address	Register 3	Address+1	Read Register 3



Note 5: To read any register will be OK except register 2 and register 3. If you want to read register 2 and register 3, you must send detecting command to register 2 first. Note that all detecting command are stored in the register 2.

Further power saving measures

If you want to save power, you can send command 0xc1 to turn off LED flash to reduce current consumption. Send command 0xc0 will turn on LED flash when detecting.

LED flash when decting will be a default configuration.

The configuration of LED flash mode is automatically saved after configured, and immediately working under the new configuration. KS101B/KS103/KS103S will be run according to the new configuration when restart.

Follow the attached files 3, the configuration code should be as follows:

write_byte (0xe8, 2,0 xc1); //close LED flash

delayms (2000);

KS101B/KS103/KS103S will be run according to the new configuration when restart.

Sleep waiting time settings

The default setting of sleep mode is to wait five seconds, KS101B/KS103/KS103S will enter sleep mode automatically if there's no detecting command in five seconds. Another sleep mode is to wait one seconds. Send command 0xc5 through the I^2C bus will change KS101B/KS103/KS103S to one seconds waiting sleep mode; and send command 0xc4 the five seconds waiting sleep mode can be restored.

The configuration of sleep mode is automatically saved after configured, and immediately working under the new configuration. KS101B/KS103/KS103S will be run according to the new configuration when restart.

Follow the attached files 3, the configuration code should be as follows:

write_byte (0xe8, 2,0 xc5); //one seconds waiting

delayms (2000);

KS101B/KS103/KS103S will be run according to the new configuration when restart.

TTL serial mode

To use the KS101B/KS103/KS103S in Serial mode, make sure the MODE pin is connected to 0v

Ground before power on.

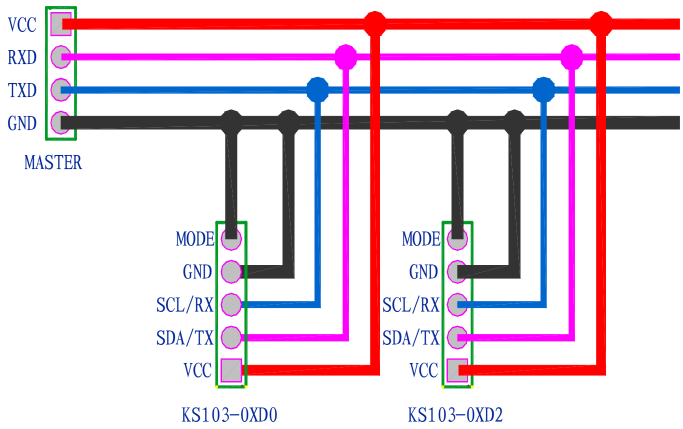
Serial data is fixed at 9600 baud 1 start, 1 stop and no parity bits. Serial data is a TTL level signal, It is not RS232 level. Do not connect the KS101B/KS103/KS103S to a RS232 port - it will destroy the module. If you would like to connect the KS101B/KS103/KS103S to your PC's RS232 port, you must use a MAX232 or similar device. Or use the KS10R(seen in www.dauxi.com) to connect your PC with KS101B/KS103/KS103S. The KS10R is a USB-to-TTL serial converter.

KS101B/KS103/KS103S's connection:

As shown, there's five pins "VCC, SDA/TX, SCL/RX, GND, MODE" on KS101B/KS103/KS103S's board. The VCC pin should connect to master's VCC, the VCC must be in range of 3.0-5.5V [(6)]. The GND connect to master's ground. The MODE pin should be connected to 0v Ground before power on. The SDA/TX should connect to MCU's RXD pin, the SCL/RX should connect to MCU's TXD pin.

Note 6: To achieve KS101B/KS103/KS103S'S best working conditions recommended +5 V power supply. Moreover, VCC and GND is strictly prohibited reverse, it may damage the circuit.

Here's the circuit diagram(no more than 2 PCS KS101B/KS103/KS103S on TTL serial bus):



KS101B/KS103/KS103S's default address is 0xe8 and can be change to the one of 0xd0, 0xd2 , 0xd4, 0xd6, 0xd8, 0xda, 0xdc, 0xde, 0xe0, 0xe2, 0xe4, 0xe6, 0xe8, 0xea, 0xec, 0xee, 0xf8, 0xfa, 0xfc, 0xfe. [(7)]

Note 7: 0xd0~0xfe except address "0xf0, 0xf2, 0xf4,0xf6", the same to I^2C address. **Only no more than 2 modules can be connect together in TTL serial bus.**

Sequence of change TTL serial address

Address	2	0x9a	Delay 1ms	Address	2	0x92	Delay 1ms	Address	2	0x9e	Delay 1ms	Address	2	New Address	Delay 100ms

Change TTL serial address must follow the sequence and the delay time showed on table is the least delay time. After changing LED will light for 5 seconds. You can't cut off the power when changing TTL serial address or the EEPROM may be corrupted .After changing, repower KS101B/KS103/KS103S and the LED on the back board will flash the new address in binary system. The change I^2C address function should not put in loop for ever such as while(1) loop. We suggest put it in initialization function, to make sure change TTL serial address function run just one time when power up.

KS101B/KS103/KS103S's Work Sequence

After power on KS101B/KS103/KS103S, back green LED will flash the 8-bit address in binary system. Short flash twice will be "1", slow flash once will be "0". Such as address 0xea, it's *0B*11101010 in binary system, the green LED will be *slow light → off → short flash twice → off*

→ short flash twice → off → short flash twice → off → slow flash once → off → short flash twice → off → slow flash once → off → short flash twice → off → slow flash once. (8)

Note 8: LED flashing green light may stimulate the eyes, try not to look at flashing LED directly, you can use the corner of the eye to observe the flashing.

After power up, when KS101B/KS103/KS103S receive valid command, it will stop flashing and begin to detecting at once. The LED will flash once when detecting once.

KS101B/KS103/KS103S use the TTL serail interface to communicate with master, automatic response to master control command s for the 8-bit data, there's command send process:

TTL serial address(0xe8)—>delay 20~100us—>register(0x02)—> delay 20~100us—> detecting command s(0xbc)—>receive high 8 bit data on serial bus—>receive low 8 bit data on serial bus

KS101B/KS103/KS103S work in serial mode, only write register 0x02 will be valid, write other register values will not respond. When the KS101B/KS103/KS103S finish detecting, it will send the 16 bit data to master automatically. The master can use MCU's serial **interrupt** to receive the 16 bit data, when finish receiving the 16 bit data, you can begin another detecting. Otherwise the port will return an incorrect value. Each detecting command should be:

TTL serial address	Register 2	8 bit data command

Command and register list of TTL serial Mode:

Register	**Command**	**Return value range(Decimal)**	**Return value range(Hex)**	**Note**
2	0x01	80-577μs	0x50-0x241μs	Range of about 100mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x02	66-1154μs	0x42-0x482μs	Range of about 200mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x03	66-1731μs	0x42-0x6c3μs	Range of about 300mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x04	80-2308μs	0x50-0x904μs	Range of about 400mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x05	82-2885μs	0x52-0xb45μs	Range of about 500mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x06	80-3462μs	0x50-0xd86μs	Range of about 600mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x07	68-4039μs	0x44-0xfc7μs	Range of about 700mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x08	80-4616μs	0x50-0x1208μs	Range of about 800mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x09	80-5193μs	0x50-0x1449μs	Range of about 900mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x0a	66-5770μs	0x42-0x168aμs	Range of about 1000mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x0b	93-6347μs	0x5d-0x18cbμs	Range of about 1100mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x0c	79-6924μs	0x4f-0x1b0cμs	Range of about 1200mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x0d	93-7501μs	0x5d-0x1d4dμs	Range of about 1300mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x0e	79-8078μs	0x4f-0x1f8eμs	Range of about 1400mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x0f	79-8655μs	0x4f-0x21cfμs	Range of about 1500mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x10	79-9232μs	0x4f-0x2410μs	Range of about 1600mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x11	77-9809μs	0x4d-0x2651μs	Range of about 1700mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x12	77-10386μs	0x4d-0x2892μs	Range of about 1800mm, return μs. Maximum time

				consume = Maximum return value + 1000μs
2	0x13	77-10963μs	0x4d-0x2ad3μs	Range of about 1900mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x14	79-11540μs	0x4f-0x2d14μs	Range of about 2000mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x15	63-12117μs	0x3f-0x2f55μs	Range of about 2100mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x16	79-12694μs	0x4f-0x3196μs	Range of about 2200mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x17	79-13271μs	0x4f-0x33d7μs	Range of about 2300mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x18	79-13848μs	0x4f-0x3618μs	Range of about 2400mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x19	77-14425μs	0x4d-0x3859μs	Range of about 2500mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x1a	93-15002μs	0x5d-0x3a9aμs	Range of about 2600mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x1b	63-15579μs	0x3f-0x3cdbμs	Range of about 2700mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x1c	79-16156μs	0x4f-0x3f1cμs	Range of about 2800mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x1d	79-16733μs	0x4f-0x415dμs	Range of about 2900mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x1e	79-17310μs	0x4f-0x439eμs	Range of about 3000mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x1f	77-17887μs	0x4d-0x45dfμs	Range of about 3100mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x20	91-18464μs	0x5b-0x4820μs	Range of about 3200mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x21	79-19041μs	0x4f-0x4a61μs	Range of about 3300mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x22	79-19618μs	0x4f-0x4ca2μs	Range of about 3400mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x23	79-20195μs	0x4f-0x4ee3μs	Range of about 3500mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x24	79-20772μs	0x4f-0x5124μs	Range of about 3600mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x25	77-21349μs	0x4d-0x5365μs	Range of about 3700mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x26	79-21926μs	0x4f-0x55a6μs	Range of about 3800mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x27	63-22503μs	0x3f-0x57e7μs	Range of about 3900mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x28	79-23080μs	0x4f-0x5a28μs	Range of about 4000mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x29	63-23657μs	0x3f-0x5c69μs	Range of about 4100mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x2a	79-24234μs	0x4f-0x5eaaμs	Range of about 4200mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x2b	79-24811μs	0x4f-0x60ebμs	Range of about 4300mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x2c	79-25388μs	0x4f-0x632cμs	Range of about 4400mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x2d	77-25965μs	0x4d-0x656dμs	Range of about 4500mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x2e	79-26542μs	0x4f-0x67aeμs	Range of about 4600mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x2f	63-27119μs	0x3f-0x69efμs	Range of about 4700mm, return μs. Maximum time consume = Maximum return value + 1000μs
2	0x70	void	void	First level noise reduction, factory default settings, for battery-powered
2	0x71	void	void	Second level noise reduction, for USB-powered
2	0x72	void	void	Third level noise reduction, for long distance USB-powered
2	0x73	void	void	Fourth level noise reduction, for switching power supply

2	0x74	void	void	Fifth level noise reduction, for noisy switching power supply
2	0x75	void	void	Sixth level noise reduction, for high noise power supply
2	0x8a	void	void	I2C communications test command, after sending LED will flash display the binary value of the command
2	0x8b	void	void	
2	0x8c	void	void	
2	0x92	void	void	The second sequence change address
2	0x9a	void	void	The first sequence change address
2	0x9e	void	void	The third sequence change address
2	0xa0	0-1023	0-0x3ff	Light intensity detect, the light is stronger, the greater the value, the detect takes about 1ms
2	0xb0	10-5200mm	0x0a-0x1450mm	0-5m range, normal range (without temperature revised), return mm, detection took about 33ms maximum
2	0xb2	79-30000μs	0x4f-0x7530μs	0-5m range, normal range (without temperature revised), return μs, detection took about 32ms maximum
2	0xb4	10-5200mm	0x0a-0x1450mm	0-5m range, normal range (with temperature revised), return mm, detection took about 87ms maximum(KS103S doesn't support this command)
2	0xb8	20-11280mm	0x14-0x2c10mm	0-11m range, normal range (without temperature revised), return mm, detection took about 68ms maximum
2	0xba	159-65278μs	0x9f-0xfefeμs	0-11m range, normal range (without temperature revised), return μs, detection took about 66ms maximum
2	0xbc	20-11280mm	0x14-0x2c10mm	0-11m range, normal range (with temperature revised), return mm, detection took about 87ms maximum(KS103S doesn't support this command)
2	0xc0	void	void	Open LED flash when detecting，default
2	0xc1	void	void	Close LED flash when detecting
2	0xc2	void	void	SCL line force to low when detecting, the default
2	0xc3	void	void	SCL line keep high level when detecting
2	0xc4	void	void	5 seconds for sleep waiting
2	0xc5	void	void	1 seconds for sleep waiting
2	0xc9	0-255	0-0xff	Return 9-bit precision temperature data, according to DS18B20 format, range of -40 ℃ - +125 ℃, detection takes about 83ms(KS103S doesn't support this command)
2	0xca	0-255	0-0xff	Return 10-bit precision temperature data, according to DS18B20 format, range of -40 ℃ - +125 ℃, detection takes about 168ms(KS103S doesn't support this command)
2	0xcb	0-255	0-0xff	Return 11-bit precision temperature data, according to DS18B20 format, range of -40 ℃ - +125 ℃, detection takes about 315ms(KS103S doesn't support this command)
2	0xcc	0-255	0-0xff	Return 12-bit precision temperature data, according to DS18B20 format, range of -40 ℃ - +125 ℃, detection takes about 610ms(KS103S doesn't support this command)

Table 2

All of the commands in register 2 have the same function with the I2C command.

Sequence

Send detect command to KS101B/KS103/KS103S(Only register 2):

TTL serial address	Delay 20～100us	Register 2	Delay 20～100us	8 bit command

Receive 16 bit data suggest the use of the serial port interrupt, so the microcontroller can spare time to do other things:

High 8 bit	Low 8 bit

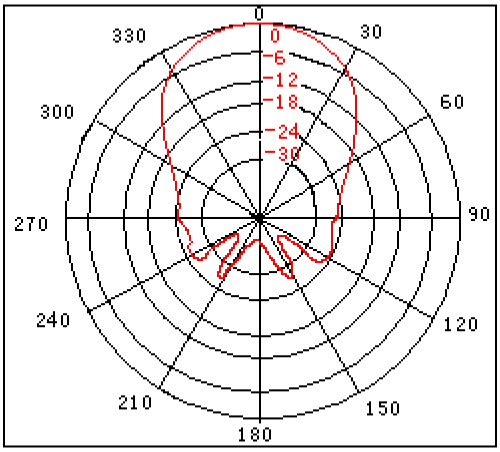
When finish receive 16 bit data, you can begin to send the next detect command (such as "0xe8+0x02+0xbc").

Sleep mode

In TTL serial mode, the module will not get into sleep.

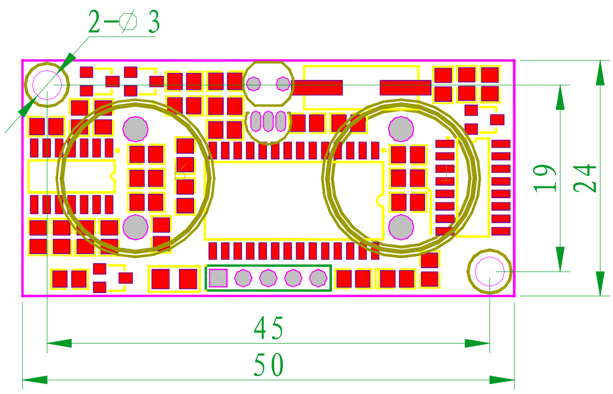
Beam Angle:

Tested at 40.0Khz frequency

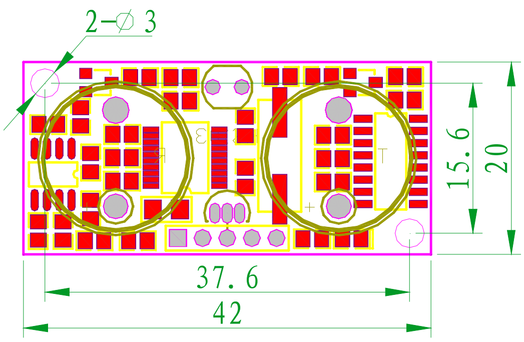


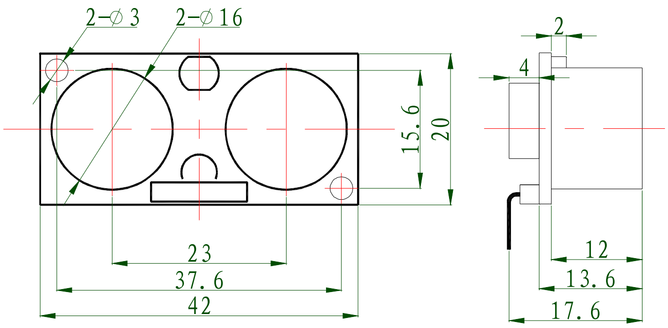
Fixing Size(Unit:mm)

KS101B:



KS103/KS103S:





Suggest using M3 screw and M3 or Φ3 boss.

Package details:

1) Size of KS101B: 50mm×24mm×17mm
2) Size of KS103/KS103S: 42mm×20mm×17mm;
2) Weight：KS101B:11g; KS103/KS103S:9g.
3) Package size：KS101B/ KS103/KS103S:85mm×80mm×32mm(1PCS/each box)
4) Package weight：KS101B/ KS103/KS103S:75g 。

Attached files:

1) Use PIC16F877A to control KS101B/KS103/KS103S(Hardware I^2C)
2) Use PIC16F877A to control KS101B/KS103/KS103S(simulate I^2C)
3) Use 51 MCU to control KS101B/KS103/KS103S(simulate I^2C)
4) Use STM32 CORTEX-3 ARM MCU to control KS101B/KS103/KS103S(simulate I^2C)
5) KS101B/KS103/KS103S vedio show:
http://v.youku.com/v_show/id_XMjYwMjUwNTg4.html
Twenty KS101B/KS103/KS103S working on I2C bus:
http://v.youku.com/v_show/id_XMjYxMzMxNDE2.html

1) Use PIC16F877A to control KS101B/KS103/KS103S(Hardware I^2C)

/*connection：PIC16F877A's IO PORT SCL、SDA conect to KS101B/KS103/KS103S's SCL、SDApin. PIC16F877A's SCL、SDA need a 4.7K resistance pull-up*/

```
#include <pic.h>                           //4MHz
__CONFIG(0x3d76);                          //WDT open
#define DELAY() delay(10)
#difine SCL RC3                  // a 4.7K resistance pull-up
#difine SDA RC4                  // a 4.7K resistance pull-up
void setup(void);
unsigned int detect_KS101B/KS103/KS103S(unsigned char ADDRESS, unsigned char command);
void delay(unsigned int ms);
void change_address(unsigned addr_old,unsigned char addr_new);
void send_command(unsigned char cmd);
void display(unsigned int distance,unsigned int delay);     //display function,you should apply it to the master
unsigned int distance;
void main(void)
{
        setup();
        //change_address(0xe8,0xe0);    //change default address 0xe8 to 0xe0
        while(1)
        {
                CLRWDT();
                distance = detect_KS101B/KS103/KS103S(0xe8,0xb4);   //Address:0xe8; command:0xb4.
                                                        //Get detect result from KS101B/KS103, 16 bit data.
                display(distance,100);                  //display function,you should apply it to the master
                delayms(200);
        }
}
void display(unsigned int distance,unsigned int delay);     //display function,you should apply it to the master
{
        CLRWDT();
}
void change_address(unsigned addr_old,unsigned char addr_new)
{
        SEN = 1;                                                // send start bit to KS101B/KS103/KS103S
        while(SEN);                                             // wait for it to clear
        while(!SSPIF);                                          // wait for interrupt
        SSPIF = 0;                                              // then clear it.

        SSPBUF = addr_old;                              // KS101B/KS103/KS103S's I2C address
        while(!SSPIF);                                  // wait for interrupt
        SSPIF = 0;                                      // then clear it.

        SSPBUF = 2;                                     // write the register number
        while(!SSPIF);                                  // wait for interrupt
        SSPIF = 0;                                      // then clear it.

        SSPBUF = 0x9a;                          //command=0x9a, change I2C address, first sequence
        while(!SSPIF);
        SSPIF = 0;

        PEN = 1;                                                // send stop bit
        while(PEN);
DELAY();                                        // let KS101B/KS103/KS103S to break to do something

        SEN = 1;                                                // send start bit
        while(SEN);                                             // and wait for it to clear
        while(!SSPIF);
        SSPIF = 0;

        SSPBUF = addr_old;                              // KS101B/KS103/KS103S's I2C address
        while(!SSPIF);                                  // wait for interrupt
```

```
        SSPIF = 0;                              // then clear it.

        SSPBUF = 2;                                 // address of register to write to
        while(!SSPIF);                          //
        SSPIF = 0;

        SSPBUF = 0x92;                  //command=0x92, change I2C address, second sequence
        while(!SSPIF);                          //
        SSPIF = 0;

        PEN = 1;                                    // send stop bit
        while(PEN);                                 //
DELAY();                                            // let KS101B/KS103/KS103S to break to do
something
        SEN = 1;                                    // send start bit
        while(SEN);                                 // and wait for it to clear
        while(!SSPIF);
        SSPIF = 0;

        SSPBUF = addr_old;                  // KS101B/KS103/KS103S's I2C address
        while(!SSPIF);                          // wait for interrupt
        SSPIF = 0;                              // then clear it.

        SSPBUF = 2;                                 // address of register to write to
        while(!SSPIF);                          //
        SSPIF = 0;

        SSPBUF = 0x9e;                  //command=0x9e,, change I2C address,third sequence
        while(!SSPIF);                          // wait for interrupt
        SSPIF = 0;                              // then clear it.

        PEN = 1;                                    // send stop bit
        while(PEN);                                 //
DELAY();                                            // let KS101B/KS103/KS103S to break to do
something
        SEN = 1;                                    // send start bit
        while(SEN);                                 // and wait for it to clear
        while(!SSPIF);
        SSPIF = 0;

        SSPBUF = addr_old;                  // KS101B/KS103/KS103S's I2C address
        while(!SSPIF);                          // wait for interrupt
        SSPIF = 0;                              // then clear it.

        SSPBUF = 2;                                 // address of register to write to
        while(!SSPIF);                          //
        SSPIF = 0;

        SSPBUF = addr_new;          //new address, it will be 0xd0~0xfe(without 0xf0,0xf2,0xf4,0xf6)
        while(!SSPIF);                          //
        SSPIF = 0;

        PEN = 1;                                    // send stop bit
        while(PEN);                                 //
DELAY();                                            // let KS101B/KS103/KS103S to break to do
something
}

unsigned int detect_KS101B/KS103/KS103S(unsigned char ADDRESS, unsigned char command)
{       // ADDRESS will be KS101B/KS103/KS103S's address such as 0xb0, command will be the detect command
such as 0xb4
unsigned int range=0;
        SEN = 1;                                    // send start bit
```

```
	while(SEN);						// and wait for it to clear
	while(!SSPIF);
	SSPIF = 0;

	SSPBUF = ADDRESS;					// KS101B/KS103/KS103S's I2C address
	while(!SSPIF);						// wait for interrupt
	SSPIF = 0;						// then clear it.

	SSPBUF = 2;						// address of register to write to
	while(!SSPIF);						//
	SSPIF = 0;
	SSPBUF = command;

	while(!SSPIF);						//
	SSPIF = 0;
						//

	PEN = 1;						// send stop bit
	while(PEN);						//

	TMR1H = 0;						// delay while the KS101B/KS103/KS103S is
ranging
	TMR1L = 0;
	T1CON = 0x31;						//configuration of TIME1
	TMR1IF = 0;						//clean TIME1 interrupt flag
	while((!SCL) || (!TMR1IF))display(distance,100);	//you can delete the display function
	TMR1ON = 0;						// stop timer
	// finally get the range result from KS101B/KS103/KS103S
	SEN = 1;						// send start bit
	while(SEN);						// and wait for it to clear
	ACKDT = 0;						// acknowledge bit
	SSPIF = 0;

	SSPBUF = ADDRESS;					// KS101B/KS103/KS103S I2C address
	while(!SSPIF);						// wait for interrupt
	SSPIF = 0;						// then clear it.

	SSPBUF = 2;					// address of register to read from - high byte of result
	while(!SSPIF);						//
	SSPIF = 0;						//

	RSEN = 1;						// send repeated start bit
	while(RSEN);						// and wait for it to clear
	SSPIF = 0;						//
	SSPBUF = ADDRESS+1;			// KS101B/KS103/KS103S I2C address - the read bit is set this time
	while(!SSPIF);						// wait for interrupt
	SSPIF = 0;						// then clear it.
	RCEN = 1;						// start receiving
	while(!BF);					// wait for high byte of range
	range = SSPBUF<<8;					// and get it
	ACKEN = 1;						// start acknowledge sequence
	while(ACKEN);						// wait for ack. sequence to end
	RCEN = 1;						// start receiving
	while(!BF);					// wait for low byte of range
	range += SSPBUF;					// and get it
	ACKDT = 1;						// not acknowledge for last byte
	ACKEN = 1;						// start acknowledge sequence
	while(ACKEN);						// wait for ack. sequence to end
	PEN = 1;						// send stop bit
	while(PEN);						//
	return range;
}
```

```
void send_command(unsigned char command)      //send a 8-bit command to KS101B/KS103/KS103S
{
        SEN = 1;                                                  // send start bit
        while(SEN);                                               // and wait for it to clear
        while(!SSPIF);
        SSPIF = 0;
        SSPBUF = ADDRESS;                                 // KS101B/KS103/KS103S I2C address
        while(!SSPIF);                                    // wait for interrupt
        SSPIF = 0;                                        // then clear it.
        SSPBUF = 2;                                               // address of register to write to
        while(!SSPIF);                                    //
        SSPIF = 0;
        SSPBUF = command;
        while(!SSPIF);                                    //
        SSPIF = 0;
        PEN = 1;                                                  // send stop bit
        while(PEN);                                               //
}

void setup(void)                                  //PIC16F877A's hardware init
{
        SSPSTAT = 0x80;
        SSPCON = 0x38;
        SSPCON2 = 0x00;
        SSPADD = 50;
        OPTION=0B10001111;              //PSA = 1;    1:128    to WDT, WDT must clear in 32.64ms
        TRISC=0B00011000;
        PORTC=0x01;
        RBIE=0;
}

void delay(unsigned int ms)
{
  unsigned char i;
  unsigned int j;
  for(i=0;i<70;i++)
        for(j=0;j<ms;j++)CLRWDT();
}
```

2) Use PIC16F877A to control KS101B/KS103/KS103S(simulate I^{2}C)

```
#include <pic.h>                  //4MHz
__CONFIG(XT&WDTEN); //WDT open
#define   SDA   RD6         // a 4.7K resistance pull-up
#define   SCL   RD5         // a 4.7K resistance pull-up
#define   SDAPORT   TRISD6 //
#define   SCLPORT   TRISD5    // RD6, RD5 can change to any other I/O port
void delay(void)                        //short delay
{
        unsigned char k;
        for(k=0;k<180;k++)
                asm("CLRWDT");
}
void delayms(unsigned char ms) //delay some ms
  {
        unsigned int i,j;
        for (i=0;i<ms;i++)
                for(j=0;j<110;j++)
                asm("CLRWDT");
}
void i2cstart(void)    // start the i2c bus
{
        SCLPORT=0;
        SDAPORT=0;
```

```
        SCL=1;
        asm("NOP");     asm("NOP");     asm("NOP");     asm("NOP");     asm("NOP");
        SDA=1;
        delay();
        SDA=0;
        delay();
        SCL=0;
        delay();
}
void i2cstop(void)    // stop the i2c bus
{
        SDA=0;
        SCLPORT=0;
        SDAPORT=0;
        SDA=0;
        asm("NOP");     asm("NOP");     asm("NOP");     asm("NOP");     asm("NOP");
        SCL=1;
        delay();
        SDA=1;
        delay();
}
void bitin(void)      //read a bit from i2c bus
{
        eepromdi=1;
        SCLPORT=0;
        SDAPORT=1;
        SCL=1;
        asm("NOP");     asm("NOP");     asm("NOP");     asm("NOP");     asm("NOP");
        eepromdi=SDA;
        asm("NOP");     asm("NOP");     asm("NOP");     asm("NOP");     asm("NOP");
        SCL=0;
        asm("NOP");     asm("NOP");     asm("NOP");     asm("NOP");     asm("NOP");
}
void bitout(void)    //write a bit to i2c bus
{
        SCLPORT=0;
        SDAPORT=0;
        SDA=eepromdo;
        asm("NOP");     asm("NOP");     asm("NOP");     asm("NOP");     asm("NOP");
        SCL=1;
        asm("NOP");     asm("NOP");     asm("NOP");     asm("NOP");     asm("NOP");
        SCL=0;
        asm("NOP");     asm("NOP");     asm("NOP");     asm("NOP");     asm("NOP");
}
void i2cwrite(unsigned char sedata)    //write a byte to i2c bus
{
        unsigned char k;
        for(k=0;k<8;k++)
        {
        if(sedata&0x80)
        {
                eepromdo=1;
        }
        else
        {
                eepromdo=0;
        }
        sedata=sedata<<1;
        bitout();
        }
        bitin();
}
unsigned char i2cread(void)          //read a byte from i2c bus
```

```
{
	unsigned char redata;
	unsigned char m;
	for(m=0;m<8;m++)
	{
	redata=redata<<1;
	bitin();
	if(eepromdi==1)
	{
		redata|=0x01;
	}
	else
	{
		redata&=0xfe;
	}
	asm("NOP");
	}
	eepromdo=1;
	bitout();
	return redata;
}

unsigned char KS101B/KS103/KS103S_read(unsigned char address,unsigned char buffer)
/////////////read register: address + register ,there will be 0xe8 + 0x02/0x03
{
	unsigned char eebuf3;
//	unsigned int range;
	i2cstart();
	i2cwrite(address);
	i2cwrite(buffer);
	i2cstart();
	i2cwrite(address+1);
	i2cstart();
	eebuf3=i2cread();
	i2cstop();
	return eebuf3;
}

void KS101B/KS103/KS103S_write(unsigned char address,unsigned char buffer,unsigned char command)
  ////////////////write a command: address + register + command,there will be 0xe8 + 0x02 + 0xb0
{
	i2cstart();
	i2cwrite(address);
	i2cwrite(buffer);
	i2cwrite(command);
	i2cstop();
}
void change_i2c_address(addr_old,addr_new) // addr_old is the address now, addr_new will be the new address
{                                            //that you want change to
    delayms(200);                           //Protect the eeprom,you can delete this
    KS101B/KS103/KS103S_write( (addr_old,2,0x9a);
    delayms(1);
    KS101B/KS103/KS103S_write(addr_old,2,0x92);
    delayms(1);
    KS101B/KS103/KS103S_write(addr_old,2,0x9e);
    delayms(1);
    KS101B/KS103/KS103S_write(addr_old,2, addr_new);
    delayms(100);                           //Protect the eeprom,you can delete this
}

unsigned int detect_KS101B/KS103/KS103S(unsigned char address, unsigned char command)
{
unsigned int range1;
```

```
        KS101B/KS103/KS103S_write(address,2,command);
        delayms(1);
        delayms(80);      //this delat should be longer if detecting the temperature，and can be delete
        //SCLPORT=1;while(!SCL);
        // delayms(80) can change to " SCLPORT=1;while(!SCL);" to improve the detection efficiency
        range1 = KS101B/KS103/KS103S_read(address,2);
        range1 =(range1<<8) + KS101B/KS103/KS103S_read(address,3);
        delayms(5);
        return range1;
}

void main(void)
{
    unsigned int range;
//change_i2c_address(0xe8,0xfe);    //change default address 0xe8 to 0xfe
        delayms(200);
        while(1)
        {
                asm("CLRWDT");
                range = detect_KS101B/KS103/KS103S(0xe8,0xb4);   //you just need the only one sentence to get the
range.
                delayms(200);
        }
}
```

3) Use 51 MCU to control KS101B/KS103/KS103S(simulate I^2C)

```
#include <reg51.h>                      //12.0MHz
#include <intrins.h>
sbit SDA=P3^6;                          // a resistance 4.7k pull-up
sbit SCL=P3^7;                          // a resistance 4.7k pull-up
unsigned int range;
void display(unsigned int range)
{
        //input your display function,please.
}
void delay(void)                        //short delay
  {
        _nop_(); _nop_(); _nop_(); _nop_();
        _nop_(); _nop_(); _nop_(); _nop_();
        _nop_(); _nop_(); _nop_(); _nop_();
        _nop_(); _nop_(); _nop_(); _nop_();
  }

  void start(void)                      //I2C start
  {
         SDA = 1;
        delay();
        SCL = 1;
        delay();
        SDA = 0;
        delay();
  }

  void stop(void)                       //I2C stop
  {
        SDA = 0;
        delay();
        SCL = 1;
        delay();
        SDA = 1;
        delay();
  }
```

```
void ack(void)                          //ack
{
        unsigned char i;
        SCL = 1;
        delay();
        while(SDA == 1 && i < 200)
        {
                i++;
        }
        SCL = 0;
        delay();
}

void no_ack()                           //not ack
{
        SDA = 1;
        delay();
        SCL = 1;
        delay();
        SCL = 0;
        delay();
}

void i2c_write_byte(unsigned char dat)          //write a byte
{
        unsigned char i;
        SCL = 0;
        for(i = 0; i < 8; i++)
        {
                if(dat & 0x80)
                {
                        SDA = 1;
                }
                else
                {
                        SDA = 0;
                }
                dat = dat << 1;
                delay();
                SCL = 1;
                delay();
                SCL = 0;
                delay();
        }
        SDA = 1;
        delay();
}

unsigned char i2c_read_byte(void)       //read a byte
{
        unsigned char i,dat;
        SCL = 0;
        delay();
        SDA = 1;
        delay();
        for(i = 0; i < 8; i++)
        {
                SCL = 1;
                delay();
                dat = dat << 1;
                if(SDA == 1)
                {
```

```
                dat++;
            }
            SCL = 0;
            delay();
        }
        return dat;
}

void init_i2c(void)                    //i2c init
{
        SDA = 1;
        SCL = 1;
}

void write_byte(unsigned char address,unsigned char reg,unsigned char command) //address+register+command
{
        init_i2c();
        start();
        i2c_write_byte(address);
        ack();
        i2c_write_byte(reg);
        ack();
        i2c_write_byte(command);
        ack();
        stop();
}

unsigned char read_byte(unsigned char address,unsigned char reg)    //address(with bit 0 set) + register
{
        unsigned char dat;
        init_i2c();
        start();
        i2c_write_byte(address);
        ack();
        i2c_write_byte(reg);
        ack();
        start();
        i2c_write_byte(address+1);
        ack();
        delay();
        delay();
        delay();
        delay();
        delay();                       //follow the sequence
        dat = i2c_read_byte();
        no_ack();
        stop();
        return dat;
}

void delayms(unsigned int ms)        //delay ms
{
        unsigned char i;
        unsigned int j;
        for(i=0;i<110;i++)
            for(j=0;j<ms;j++);
}

void change_i2c_address(unsigned char addr_old,unsigned char addr_new)
// addr_old is the address now, addr_new will be the new address
{                                                    //that you want change to
    delayms(2000);                                   // Protect the eeprom ,you can delete this sentence
    write_byte(addr_old,2,0x9a);
```

```
    delayms(1);
    write_byte(addr_old,2,0x92);
    delayms(1);
    write_byte(addr_old,2,0x9e);
    delayms(1);
    write_byte(addr_old,2, addr_new);
    delayms(500);                              //Protect the eeprom, you can delete this sentence
}

unsigned int detect(unsigned char address,unsigned char command)    //0xe8(address) + 0xb0(command)
{
        unsigned int distance,count;
        write_byte(address,2,command);                             //use command "0xb0" to detect the distance
        delayms(1);                                                //delay
        //delayms(80);                                     //the delay should follow the time show in table 1
        count=800;while(--count || !SCL)display(range);            //wait for detecting end
//      while(!SCL)display(range);      //you can delete "display(range)"
//      also can use while(!SCL)
        distance=read_byte(address,2);
        distance <<= 8;
        distance += read_byte(address,3);
        return distance;                        //return 16 bit distance in millimeter
}

void main(void)
{
        //change_i2c_address(0xe8,0xfe);    //change default address 0xe8 to 0xfe
        while(1)
        {
                range = detect(0xe8,0xb0);
                //0xe8 is the address; 0xb0 is the command.you just need the only one sentence to get the range.
                //display(range);
                delayms(200);
        }
}
```

4) Use STM32 CORTEX-3 ARM MCU to control KS101B/KS103/KS103S(simulate I^2C)

```
#include <stm32f10x_lib.h>
#include "sys.h"
#include "usart.h"
#include "delay.h"

u8 KS103_ReadOneByte(u8 address, u8 reg)
{
        u8 temp=0;

       IIC_Start();
       IIC_Send_Byte(address);                    //send address
        IIC_Wait_Ack();
        IIC_Send_Byte(reg);                       //send register
        IIC_Wait_Ack();
        IIC_Start();
        IIC_Send_Byte(address + 1);              //begin to receive
        IIC_Wait_Ack();

        delay_us(50);                             //follow the Sequence

       temp=IIC_Read_Byte(0);                     //read register
       IIC_Stop();                                //stop
        return temp;
}
```

```
void KS103_WriteOneByte(u8 address,u8 reg,u8 command)
{

      IIC_Start();
       IIC_Send_Byte(address);
       IIC_Wait_Ack();
       IIC_Send_Byte(reg);
       IIC_Wait_Ack();
      IIC_Send_Byte(command);
       IIC_Wait_Ack();
      IIC_Stop();
}



void IIC_Init(void)
{
        RCC->APB2ENR|=1<<4;             //enable IO clock of PORTC
        GPIOC->CRH&=0XFFF00FFF;      //PC11/12 output
        GPIOC->CRH|=0X00033000;
        GPIOC->ODR|=3<<11;              //PC11,12 output high level
}
                                          //IIC start
void IIC_Start(void)
{
        SDA_OUT();
        IIC_SDA=1;
        IIC_SCL=1;
        delay_us(10);
        IIC_SDA=0;                      //START:when CLK is high,DATA change form high to low
        delay_us(10);
        IIC_SCL=0;                      //clamp I2C bus, prepare to send or receive
}

void IIC_Stop(void)
{
        SDA_OUT();
        IIC_SCL=0;
        IIC_SDA=0;                      //STOP:when CLK is high DATA change form low to high
        delay_us(10);
        IIC_SCL=1;
        IIC_SDA=1;                      //stop IIC bus
        delay_us(10);
}
//wait for ack
//return: 1，fail
//        0，success
u8 IIC_Wait_Ack(void)
{
        u8 ucErrTime=0;
        SDA_IN();
        IIC_SDA=1;delay_us(6);
        IIC_SCL=1;delay_us(6);
        while(READ_SDA)
        {
                ucErrTime++;
                if(ucErrTime>250)
                {
                        IIC_Stop();
                        return 1;
                }
        }
```

```
        IIC_SCL=0;
        return 0;
}
//ACK
void IIC_Ack(void)
{
        IIC_SCL=0;
        SDA_OUT();
        IIC_SDA=0;
        delay_us(10);
        IIC_SCL=1;
        delay_us(10);
        IIC_SCL=0;
}
//no ACK
void IIC_NAck(void)
{
        IIC_SCL=0;
        SDA_OUT();
        IIC_SDA=1;
        delay_us(10);
        IIC_SCL=1;
        delay_us(10);
        IIC_SCL=0;
}
//send one byte
void IIC_Send_Byte(u8 txd)
{
       u8 t;
        SDA_OUT();
       IIC_SCL=0;                          //begin to send data
       for(t=0;t<8;t++)
       {
             IIC_SDA=(txd&0x80)>>7;
             txd<<=1;
               delay_us(10);
               IIC_SCL=1;
               delay_us(10);
               IIC_SCL=0;
               delay_us(10);
       }
}

//read one byte, if ack=1, send ACK; if ack=0, send nACK
u8 IIC_Read_Byte(unsigned char ack)
{
        unsigned char i,receive=0;
        SDA_IN();                                 //SDA input
       for(i=0;i<8;i++ )
        {
             IIC_SCL=0;
             delay_us(10);
               IIC_SCL=1;
             receive<<=1;
             if(READ_SDA)receive++;
               delay_us(5);
       }
       if (!ack)
             IIC_NAck();                          //send nACK
       else
             IIC_Ack();                           //sendACK
       return receive;
}
```

```
int main(void)
{
        u16 range;
        Stm32_Clock_Init(9);                    //config system clock
        delay_init(72);                         //delay time init
        uart_init(72,9600);                     //init serial port 1
        while(1)
        {
                KS103_WriteOneByte(0XE8,0X02,0XB0);
                delay_ms(80);
                range = KS103_ReadOneByte(0xe8, 0x02);
                range <<= 8;
                range += KS103_ReadOneByte(0xe8, 0x03);
        }
}
```