M8 Series

Laser Distance Module User Manual

Version: R0

Revision History

Version	Date	by	Description
R0	Sep./11/2018	ly	Initial

Contents

1. Introduction

For decades, JRT has been an expert in the field of laser technology, optics, electronics, and mechanical systems that make up a laser rangefinder. We are one of the leading manufacturers in this sector. Our products are put to successful use around the world.

M8xx series laser rangefinder module was developed for fast and precise distance measuring, even in difficult measurement conditions, like with poor reflect laser signal level. M8xx extremely small and lightweight make it suitable for size and weight limited applications, such as portable devices, drones etc.

1.1 Features

Features of the M8xx module include:

1. Small size:
   - 25mm width
   - 49mm long
   - 13mm height
2. Light Weight:
   - < 9g
3. Precise Distance Measuring
   - 1mm resolution
4. Long Measuring Distance
   - 40 meters

1.2 Quick Start

For quick testing shipped module please jump to section 6 Demonstration, after that reading the rest sections for more details.

2. Key parameters

Table 2-1 key parameters

Accuracy	± 1mm
Measuring Unit	millimeter
Measuring Range	0.03-40m
Measuring Time	0.4~4 seconds
Laser Class	Class II
Laser Type	635nm, <1mW
Size	25*49*13mm
Weight	About 9g
Voltage	DC 2.5~3.3V
Operating Temperature	0-40 ℃ （32-104 ℉ ）
Storage Temperature	-25~60 ℃ (-13~140 ℉)

*Accuracy is ± 1 mm + 40PPM

3. Mechanical Data

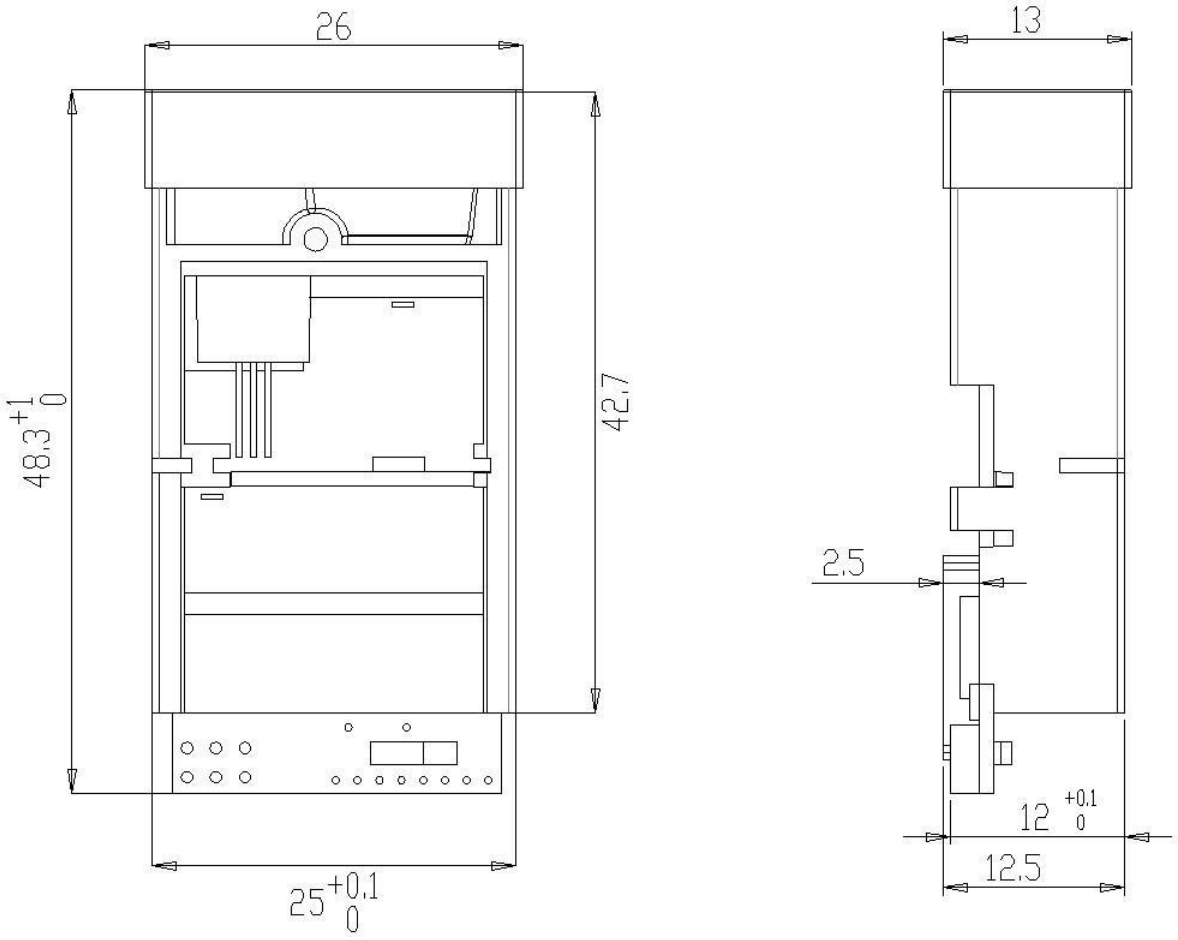
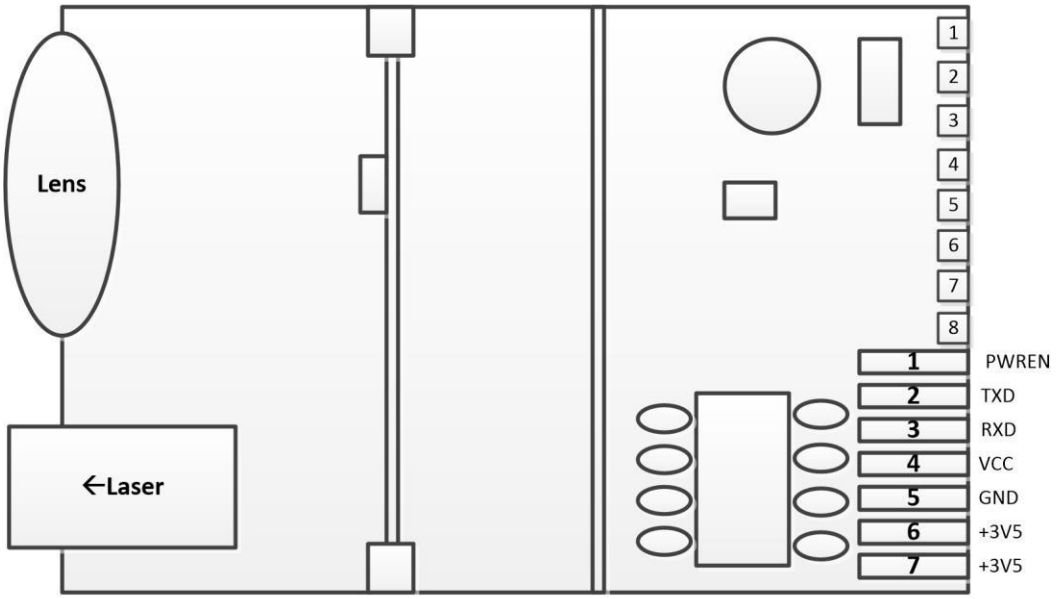


Figure 3-1 Mechanical Size

4. Pin Information

At most 5 Pins need to power and control the laser rangefinder module.



Module Bottom View

All these pins list below:

Table 4-1 Pin List

Pin	Name	Function	Default	Description
1	PWREN	Digital Input	Low	Module power up enable pin, active **HIGH**
2	TXD	Digital Output	High	Module USART Transmit pin, **Open-Drain**
3	RXD	Digital Input	High	Module USART Receive pin, **Open-Drain**
4	VCC/VBAT	Power	Power	Power supply， DC 2.5V~3.3V 300mA+
5	GND	Power	Ground	Module power ground

Application may need more than one laser range finder module to read out each distance. **In multi-slave applications, beware to set address for each laser module before it be connected to the network to avoid the addressing conflict. After factory stage all modules address was set to 0x00 as default.**

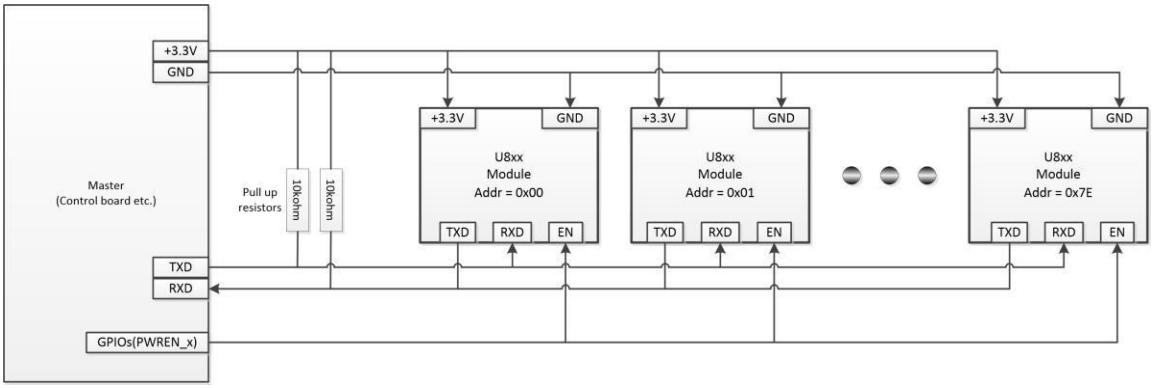


Figure 4-1 Multi-Module Wiring

4.1.1 Self-soldering with module on board pads

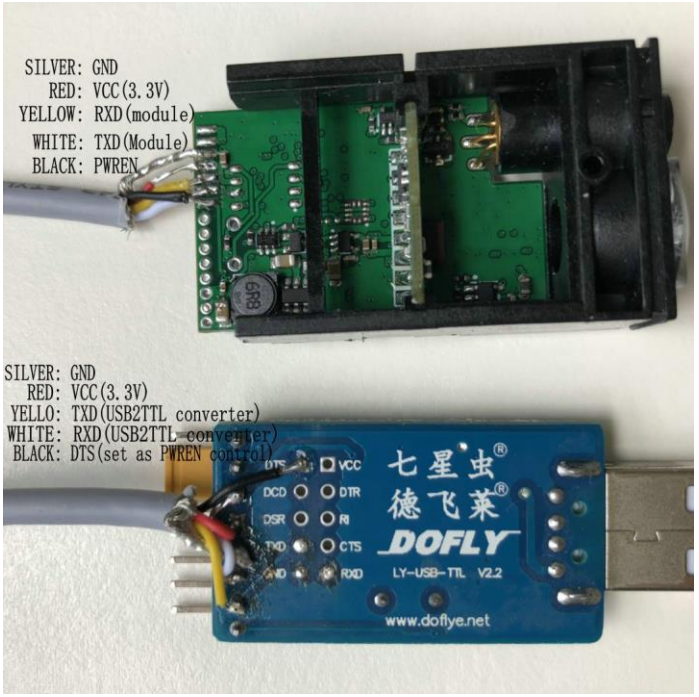


Figure 4-2 Solder Connector

!!! Figure 4-2 Solder Connector shows NO pull-up resistor for module TXD/RXD, because the USB2TTL converter has internal pull-up resistors for TXD/RXD pins. But please keep in mind module TXD/RXD pins are OPEN-DRAIN which without internal pull-up resistors.

5. Absolute maximum ratings

!!!Note: Exceeding one or more of the limiting values may cause module permanent damage!

Table 5-1 Absolute Max. Ratings

Operating conditions	Min	Normal	Max	Units
Voltages				
VCC	-0.3	3.0	5.5	V
GND		0	0	V
TXD	-0.3		VCC+0.3	V
RXD	-0.3		VCC+0.3	V
PWREN	-0.3	VCC	4.0	V
Temperature				
Operating	0		+40	℃
Storage	-25		+60	℃

Warning:Please note that normal operating voltage is DC2.5~3.3V.Voltage between DC3.3V~5.0V would not damage the module immediately,but it still will burn the module!Don't use any power above DC3.3V.

6. Operation Protocol

6.1 USART Interface

- **Baudrate: Auto Detect (9600bps ~115200bps recommend) OR Default 19200bp)**
- **Start bits: 1 bit**
- **Data bits: 8 bits**

- **Stop bits：1 bit**
- **Parity：none**
- **Flow control：none**

6.2 Control flow char

All communication commands are issued by master board, laser rangefinder module play slave role to answer master's request. The Ask & Answer flow though USART is shown as Figure 6-1.

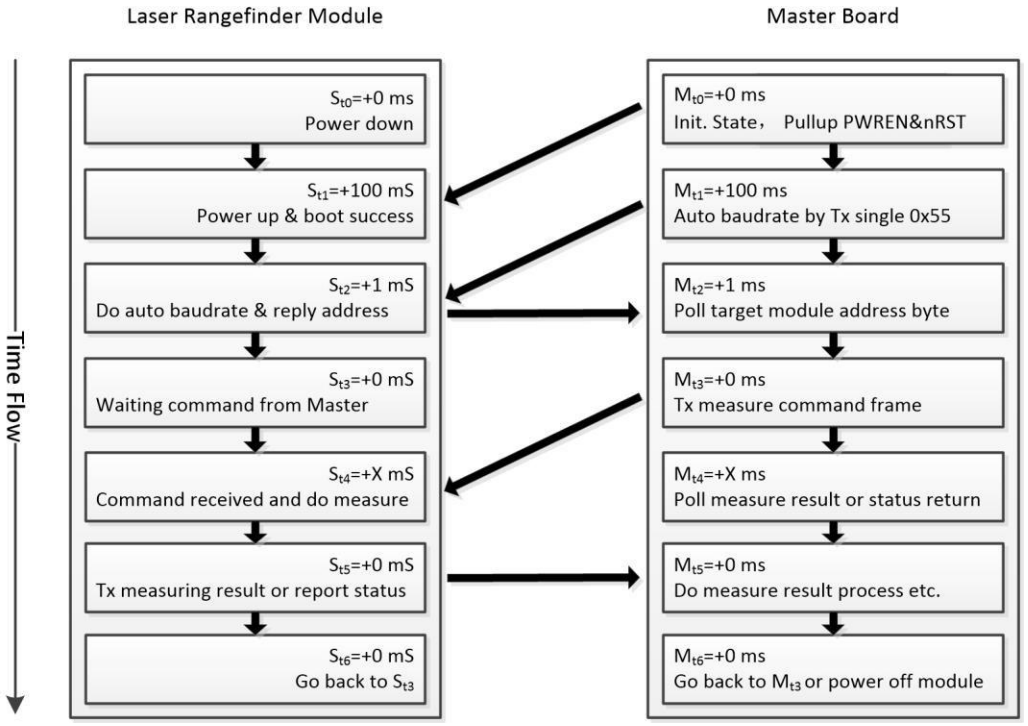


Figure 6-1 Control Flow

In initial state, Slave module (laser rangefinder) is in power down mode before Master pull up the PWREN pin. After PWREN goes high, and if nRST pin. Used please also remember to de-assert the nRST ping by pull it up, Slave will take about 100 milliseconds to do self-boot, and then entering auto baud rate detect stage.

Master transfer 1byte fixed data 0x55 to slave for auto baud rate, if success, slave will reply 1-byte data to master, which present the slave itself address. In one master and multi-slave communication situation, the self-address reply from the slaves may cause USART bus conflict, keep in mind this byte should be ignored.

Communication between master and slave has been established after the successful auto baud rate. Now master can send command frame to slave.

6.3 Command Frame

Command frame may consist 6 parts as Table 6-1 shows.

Table 6-1 command structure

Bytes	0	1		2	3	4	5	6	7	8
Bits	[7:0]	[7]	[6:0]	[7:0]	[7:0]	[7:0]	[7:0]	[7:0]	[7:0]	[7:0]
Name	**Head**	**R/W.**	**Address**	**Register**		Payload count		Payload		Checksum
Data	0xAA	0	0x51	0x00	0x20	0x00	0x01	0x00	0x00	0x72

Table 6-1 shows the 1-shot measure request command from master to slave. In this command frame:

- Request frame always start with fixed head byte 0xAA, this byte can also be 0xEE during error reply frame from slave to master, please refer to section 6.4.16 error reply frame;
- R/W indicate bit, 0: Master write to Slave, 1: Master read from Slave
- Slave address is 0x51, address has only 7-bits, so the address is from 0x00 to 0x7F, 0x00 is the default address before master issue module address change command, 0x7F is the broadcast address reserved for one-master to multi-slave network;
- Slave register is 0x0020 (REG_MEA_MODE, see register list 6.3.1 for more details);
- Payload data count write to register 0x0020 is 0x0001, this section may not present when R/W = 1, Master read from slave;
- The single data write to register 0x0020 is 0x0000, this section may not present when R/W = 1, Master read from slave;
- The frame checksum is 0x72, checksum = address byte + register bytes + payload count bytes + all payload bytes, byte overflow ignored;

6.3.1 Control Registers

Table 6-2 Registers

No.	Register	Name	Function
1	0x0000	REG_ERR_CODE	System status code
2	0x0006	REG_BAT_VLTG	Input voltage
3	0x0010	REG_ADDRESS	Module address
4	0x0012	REG_OFFSET	Module measure result offset
5	0x0020	REG_MEA_START	Initiate measure
6	0x0022	REG_MEA_RESULT	Measure result
7	0x01BE	REG_CTRL_LD	Laser diode control

6.4 Commands

6.4.1 Read Module Latest Status

Table 6-3 cmd. Read Module Status

Bytes	0	1	2	3	4
Name	**Head**	RW/Address	Register		Checksum
Data	0xAA	0x80	0x00	0x00	0x80

- Type: Read command
- Slave address: 0x00
- Register address: 0x0000
- Function: master read out the module's status after previous command executed;
- Reply from slave:

Table 6-4 cmd. Reply Read Module Status

Bytes	0	1	2	3	4	5	6	7	8
Name	**Head**	**RW/Address**	**Register**		Payload count		Payload		Checksum
Data	0xAA	0x80	0x00	0x00	0x00	0x01	0xYY	0xZZ	Checksum

Byte 0xZZ is the status code replied from slave, see status codes Table 6-24 for details.

6.4.2 Read Hardware Version Number

Table 6-5 cmd. Read HW version

Bytes	0	1	2	3	4
Name	Head	RW/Address	Register		Checksum
Data	0xAA	0x80	0x00	0x0A	0x8A

- Type: Read command
- Slave address: 0x00
- Register address: 0x000A
- Function: master read out the module's HW version number;
- Reply from slave:

Table 6-6 cmd. Reply Read HW version

Bytes	0	1	2	3	4	5	6	7	8
Name	Head	RW/Address	Register		Payload count		Payload		Checksum
Data	0xAA	0x80	0x00	0x0A	0x00	0x01	0xVV	0xYY	sum

HW version number is 0xVVYY.

6.4.3 Read Software Version Number

Table 6-7 cmd. Read HW version

Bytes	0	1	2	3	4
Name	Head	RW/Address	Register		Checksum
Data	0xAA	0x80	0x00	0x0C	0x8C

- Type: Read command
- Slave address: 0x00
- Register address: 0x000C
- Function: master read out the module's SW version number;
- Reply from slave:

Table 6-8 cmd. Reply Read SW version

Bytes	0	1	2	3	4	5	6	7	8
Name	Head	RW/Address	Register		Payload count		Payload		Checksum
Data	0xAA	0x80	0x00	0x0C	0x00	0x01	0xVV	0xYY	sum

SW version number is 0xVVYY.

6.4.4 Read Module Serial Number

Table 6-9 cmd. Read Serial version

Bytes	0	1	2	3	4
Name	Head	RW/Address	Register		Checksum
Data	0xAA	0x80	0x00	0x0E	0x8E

- Type: Read command
- Slave address: 0x00
- Register address: 0x000E

- Function: master read out the module's serial number;
- Reply from slave:

Table 6-10 cmd. Reply Read Serial Number

Bytes	0	1	2	3	4	5	6	7	8
Name	**Head**	**RW/Address**	**Register**		Payload count		Payload		Checksum
Data	0xAA	0x80	0x00	0x0E	0x00	0x01	0xSS	0xNN	sum

HW version number is 0xSSNN.

6.4.5 Read Input Voltage

Table 6-11 cmd. Read HW version

Bytes	0	1	2	3	4
Name	**Head**	RW/Address	Register		Checksum
Data	0xAA	0x80	0x00	0x06	0x86

- Type: Read command
- Slave address: 0x00
- Register address: 0x0006
- Function: master read out the module's input voltage in mV with BCD encode;
- Reply from slave:

Table 6-12 cmd. Reply Read HW version

Bytes	0	1	2	3	4	5	6	7	8
Name	**Head**	**RW/Address**	**Register**		Payload count		Payload		Checksum
Data	0xAA	0x80	0x00	0x06	0x00	0x01	0x32	0x19	sum

Input voltage = 3219mV.

6.4.6 Read Measure Result

Table 6-13 cmd. Read Measure Result

Bytes	0	1	2	3	4
Name	**Head**	RW/Address	Register		Checksum
Data	0xAA	0x80	0x00	0x22	0xA2

- Type: Read command
- Slave address: 0x00
- Register address: 0x0022
- Function: master read out the distance measure result;
- Reply from slave:

Table 6-14 cmd. Reply Measure Result

Bytes	0	1	2	3	4	5	6:9	10:11	8
Name	**Head**	**RW/ Address**	**Register**		Payload count		Payload Distance	Payload SQ	Check sum
Data	0xAA	0x00	0x00	0x22	0x00	0x03	0xAABBCCDD	0x0101	Check

									sum

6.4.7 Set Module Address

Table 6-15 cmd. Set Module Address

Bytes	0	1	2	3	4	5	6	7	8
Name	**Head**	**RW/Address**	**Register**		Payload count		Payload		Checksum
Data	0xAA	0x00	0x00	0x10	0x00	0x01	0x00	0xYY	sum

- Type: Write command
- Slave address: 0x00
- Register address: 0x0010
- Function: master set slave's address, this address will not lost after module power off;
- Reply from slave:

Table 6-16 cmd. Reply Set Module Address

Bytes	0	1	2	3	4	5	6	7	8
Name	**Head**	**RW/Address**	**Register**		Payload count		Payload		Checksum
Data	0xAA	0x00	0x00	0x10	0x00	0x01	0x00	0xYY	sum

Slave address set to 0xYY (!!!Beware: address only take bit[6:0], other bits will be ignored).
！！！ **Note**: Do not set slave address to broadcast address 0x7F, this address is reserved for one master to multi-slave network which needs all slave to measure distance at the same time, and no slave reply measure result until master ask one of them to.

6.4.8 Set Module Measure Offset

Bytes	0	1	2	3	4	5	6	7	8
Name	**Head**	**RW/Address**	**Register**		Payload count		Payload		Checksum
Data	0xAA	0x00	0x00	0x12	0x00	0x01	0xZZ	0xYY	sum

- Type: Write command
- Slave address: 0x00
- Register address: 0x0012
- Function: master set slave's measure offset. For example, if the offset 0xZZYY = 0x7B(+123) , it means the final output of measure result will **PLUS** 123 millimeters , if the offset 0xZZYY = 0xFF85(-123), it means the final output of measure result will **MINUS** 123 millimeters.
- Reply from slave:

Table 6-17 cmd. Reply Set Module Address

Bytes	0	1	2	3	4	5	6	7	8
Name	**Head**	**RW/Address**	**Register**		Payload count		Payload		Checksum
Data	0xAA	0x00	0x00	0x12	0x00	0x01	0xZZ	0xYY	sum

6.4.9 Turn On or Turn Off Laser

Table 6-18 cmd. Turn on/off Laser

Bytes	0	1	2	3	4	5	6	7	8
Name	**Head**	**RW/Address**	**Register**		Payload count		Payload		Checksum
Data	0xAA	0x00	0x01	0xBE	0x00	0x01	0x00	0xZZ	Checksum

- Type: Write command
- Slave address: 0x00
- Register address: 0x01BE
- Function: turn on or turn off laser beam, if 0xZZ = 0x01 laser on, 0xZZ = 0x00 laser off.
- Reply from slave:

Table 6-19 cmd. Reply Turn On/Off Laser

Bytes	0	1	2	3	4	5	6	7	8
Name	**Head**	**RW/Address**	**Register**		Payload count		Payload		Checksum
Data	0xAA	0x00	0x01	0xBE	0x00	0x01	0x00	0xZZ	Checksum

6.4.10 Start 1-shot Auto Distance Measure

Bytes	0	1	2	3	4	5	6	7	8
Name	**Head**	**RW/Address**	**Register**		Payload count		Payload		Checksum
Data	0xAA	0x00	0x00	0x20	0x00	0x01	0x00	0x00	0x21

- Type: Write command
- Slave address: 0x00
- Register address: 0x0020
- Function: Initiate slave to do 1-shot measure in auto mode, for measure modes please refer to section 6.5.
- Reply from slave:

Table 6-20 cmd. Reply 1-shot Auto Measure

Bytes	0	1	2	3	4	5	6:9	10:11	8
Name	**Head**	**RW/ Address**	**Register**		Payload count		Payload Distance	Payload SQ	Check sum
Data	0xAA	0x00	0x00	0x22	0x00	0x03	0xAABBCCDD	0x0101	Check sum

- Type: Reply from slave
- Slave address: 0x00
- Register address: 0x0022
- Function: Reply measure result to master, measure result = 0xAABBCCDD millimeters (frame byte6 = 0xAA, byte7 = 0xBB, byte8 = 0xCC, byte9 = 0xDD) and signal quality = 0x101， less signal quality number stands for stronger laser signal and more reliable distance result.

6.4.11 Start 1-shot Slow Distance Measure

Bytes	0	1	2	3	4	5	6	7	8
Name	Head	RW/Address	Register		Payload count		Payload		Checksum
Data	0xAA	0x00	0x00	0x20	0x00	0x01	0x00	0x01	0x22

- Type: Write command
- Slave address: 0x00
- Register address: 0x0020
- Function: Initiate slave to do 1-shot measure in slow mode.
- Reply from slave: same as 1-shot auto mode.

6.4.12 Start 1-shot Fast Distance Measure

Bytes	0	1	2	3	4	5	6	7	8
Name	Head	RW/Address	Register		Payload count		Payload		Checksum
Data	0xAA	0x00	0x00	0x20	0x00	0x01	0x00	0x02	0x23

- Type: Write command
- Slave address: 0x00
- Register address: 0x0020
- Function: Initiate slave to do 1-shot measure in fast mode.
- Reply from slave: same as 1-shot auto mode.

6.4.13 Start Continuous Auto Distance Measure

Bytes	0	1	2	3	4	5	6	7	8
Name	Head	RW/Address	Register		Payload count		Payload		Checksum
Data	0xAA	0x00	0x00	0x20	0x00	0x01	0x00	0x04	0x25

- Type: Write command
- Slave address: 0x00
- Register address: 0x0020
- Function: Initiate slave to do continuous measure in auto mode.
- Reply from slave: same as 1-shot auto mode.

6.4.14 Start Continuous Slow Distance Measure

Bytes	0	1	2	3	4	5	6	7	8
Name	Head	RW/Address	Register		Payload count		Payload		Checksum
Data	0xAA	0x00	0x00	0x20	0x00	0x01	0x00	0x05	0x26

- Type: Write command
- Slave address: 0x00
- Register address: 0x0020

- Function: Initiate slave to do continuous measure in slow mode.
- Reply from slave: same as 1-shot auto mode.

6.4.15 Start Continuous Fast Distance Measure

Bytes	0	1	2	3	4	5	6	7	8
Name	Head	RW/Address	Register		Payload count		Payload		Checksum
Data	0xAA	0x00	0x00	0x20	0x00	0x01	0x00	0x06	0x27

- Type: Write command
- Slave address: 0x00
- Register address: 0x0020
- Function: Initiate slave to do continuous measure in fast mode.
- Reply from slave: same as 1-shot auto mode.

6.4.16 Error Reply from Slave

If any error occurred during measuring stage, laser rangefinder module will reply error report frame:

Table 6-21 Error Reply

Bytes	0	1	2	3	4	5	6	7	8
Name	Head	RW/Address	Register		Payload count		Payload		Checksum
Data	0xEE	0x00	0x00	0x00	0x00	0x01	0x00	0x0F	0x10

- Type: Reply from slave
- Slave address: 0x00
- Register address: 0x0000
- Function: report error status code to master, the error code = 0x000F, please refer section 6.6 status codes for its meaning.

6.4.17 Exit from Continuous Measure

Master transfer one byte 0x58 (upper case character 'X') to stop continuous measure mode immediately.

6.4.18 Start Multi-slaves Measure

Master send out 1-shot measure commands to slave address 0x7F, that will make all online slaves to measure distance at the same time， but none of them will return its measure result to master until master ask each one to return the measure result. Before master send out the reading measure result command, master should read the slave's status code to make sure there was no error occurred during this slave measuring.

Table 6-22 Broadcast Measuring

Bytes	0	1	2	3	4	5	6	7	8
Name	Head	RW/Address	Register		Payload count		Payload		Checksum
Data	0xAA	0x7F	0x00	0x20	0x00	0x01	0x00	0x00	0xA0

- Type: Write command

- Slave address: 0x00
- Register address: 0x0020
- Function: Initiate all slave to do 1-shot measure in auto mode
- Reply from slave: NO REPLY

After sending this command out, master polling each slave address for their status, if slave replies its status code with 0x0000, means no error, then send Read-measure-Result command to read back the distance. Measure result for each slave will NOT overwrite until next successful measure command with a new distance result.

6.5 Measure Modes

There are 2 types of measure mode, 1-shot and continuous.

- 1-shot gives only 1 measure result for each distance measure request command;
- Continuous measuring continuous to reply distance result as more as 255 times if master not break the measuring cycles. To break the continuous measuring, master need to send 1 byte 0x58 (upper case character 'X' in ASCII) during measuring.

Each measure mode has 3 working attributes:

- Auto, module returns Measure Result & Signal Quality(SQ), Less SQ value stands for more reliable distance result, in this mode module adjust reading speed according to the laser reflect level;
- Slow, distance read for higher accuracy;
- Fast, distance read for lower accuracy, but higher speed.

Table 6-23 Measuring Modes

Attribute / Modes	Auto	Slow	Fast
1-shot	1-shot Auto	1-shot Slow	1-shot Fast
Continuous	Continuous Auto	Continuous Slow	Continuous Fast
Measure Speed	Auto	Slow	Fast
Measure Accuracy	Auto	High	Low

6.6 Status Codes

Table 6-24 status codes

Status Code	Description
0x0000	No error
0x0001	Power input too low, power voltage should >= 2.2V
0x0002	Internal error, don't care
0x0003	Module temperature is too low(< -20℃)
0x0004	Module temperature is too high(> +40℃)
0x0005	Target out of range
0x0006	Invalid measure result
0x0007	Background light too strong
0x0008	Laser signal too weak
0x0009	Laser signal too strong
0x000A	Hardware fault 1
0x000B	Hardware fault 2
0x000C	Hardware fault 3
0x000D	Hardware fault 4
0x000E	Hardware fault 5
0x000F	Laser signal not stable
0x0010	Hardware fault 6
0x0011	Hardware fault 7
0x0081	Invalid Frame

7. Demonstration

7.1 Wiring to USB2TTL converter

For test purpose, Pin.PWREN tied to RTS line. When RTS asserted, RTS line goes low, so de-assert RTS to power module, module then start to boot.

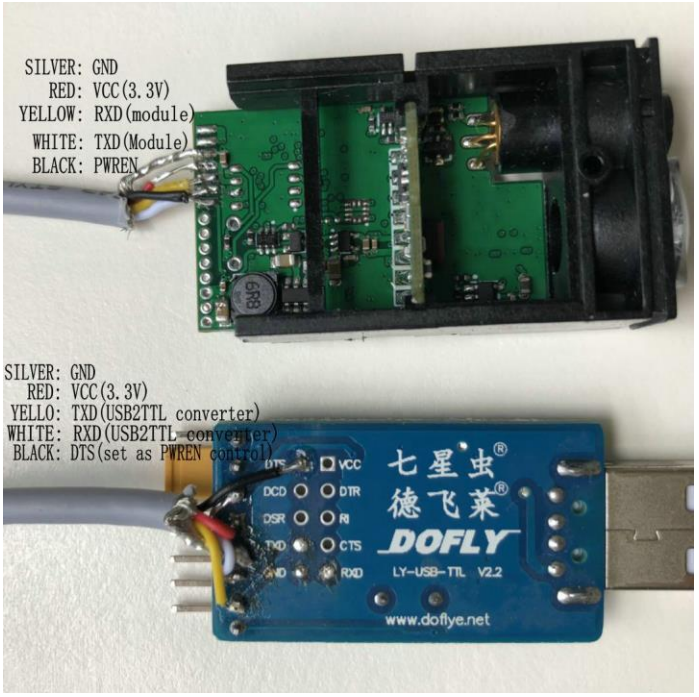


Figure 7-1 Wiring

7.2 Serial Port Test Software

Before start the command test, we need to:

1. Plug & Install CH341 USB2TTL converter driver on your computer;
2. Download & install the trial version serial port test software before start, software download page : http://www.geshe.com/en/support/download;
3. Start the software and follow the steps:

After starting the PC soft you have 2 options:

1. Create a new project;
2. load configuration file and do some modify according to your serial port number;

- Create New Project from scratch.

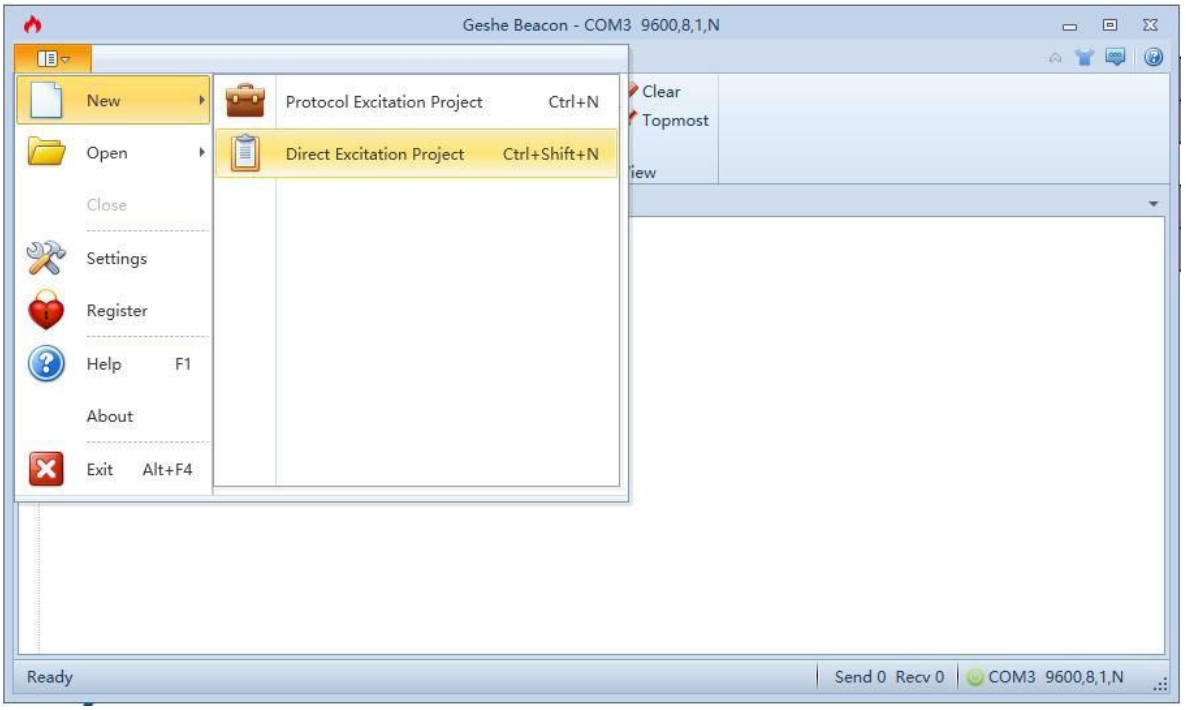


Figure 7-2 Create New Project

- Load Configuration file "GeseDemoConfig.bsp" from test file folder

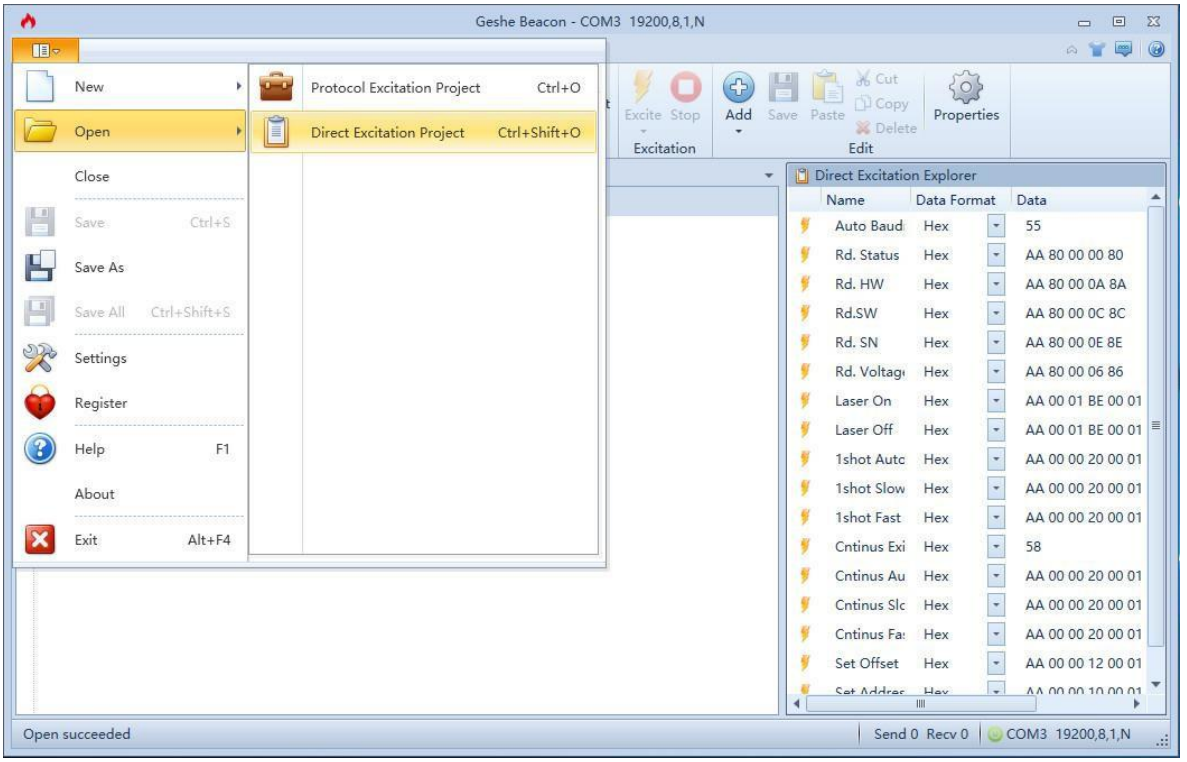
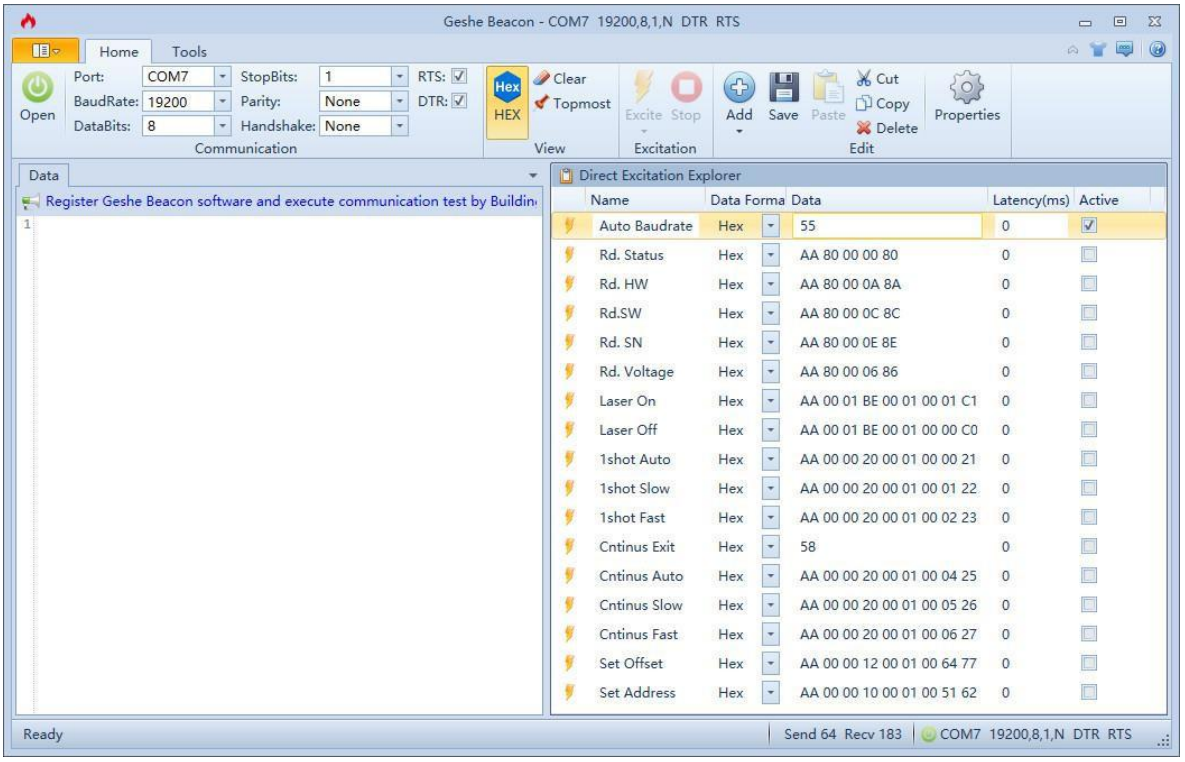


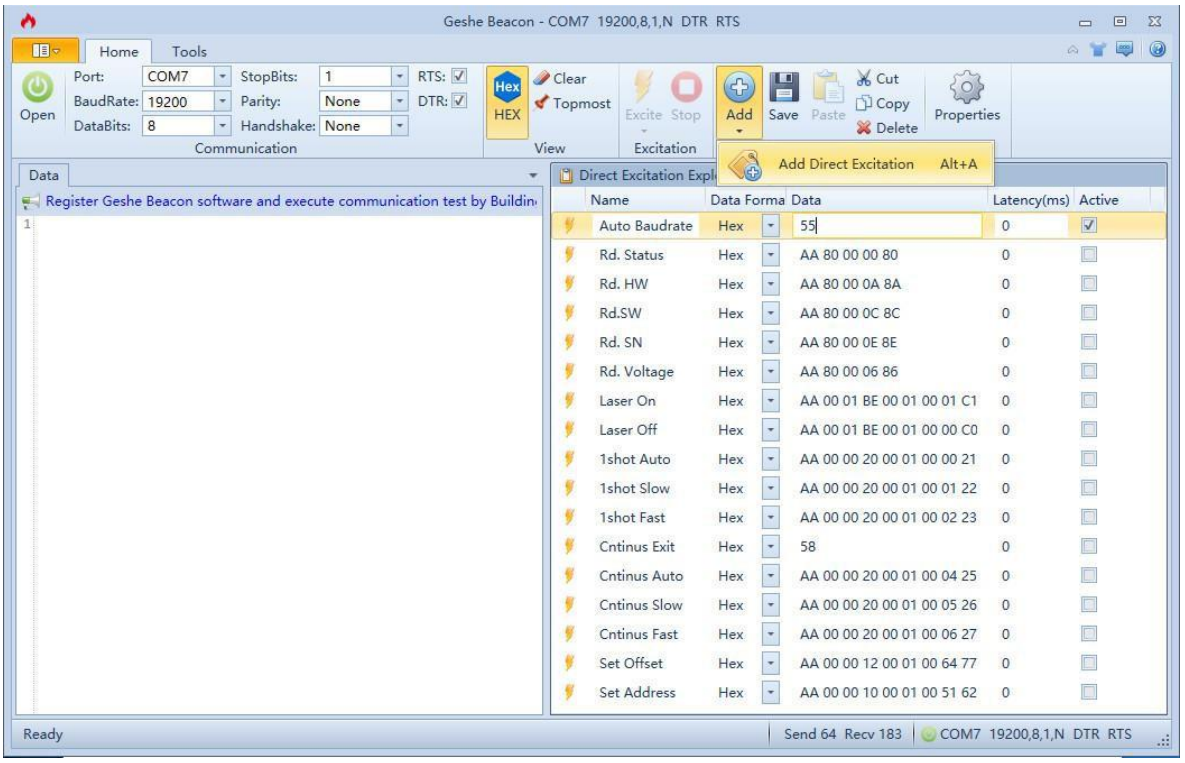
Figure 7-3 Load Config. File

Serial Port parameters Configuration, select the Port No. after plug the USB2TTL converter according to your computer, COM7 on my computer. Baud rate can be any of you want, 9600bps 19200bps, 115200bps etc.

Remember to assert RTS box to power off module before start test.

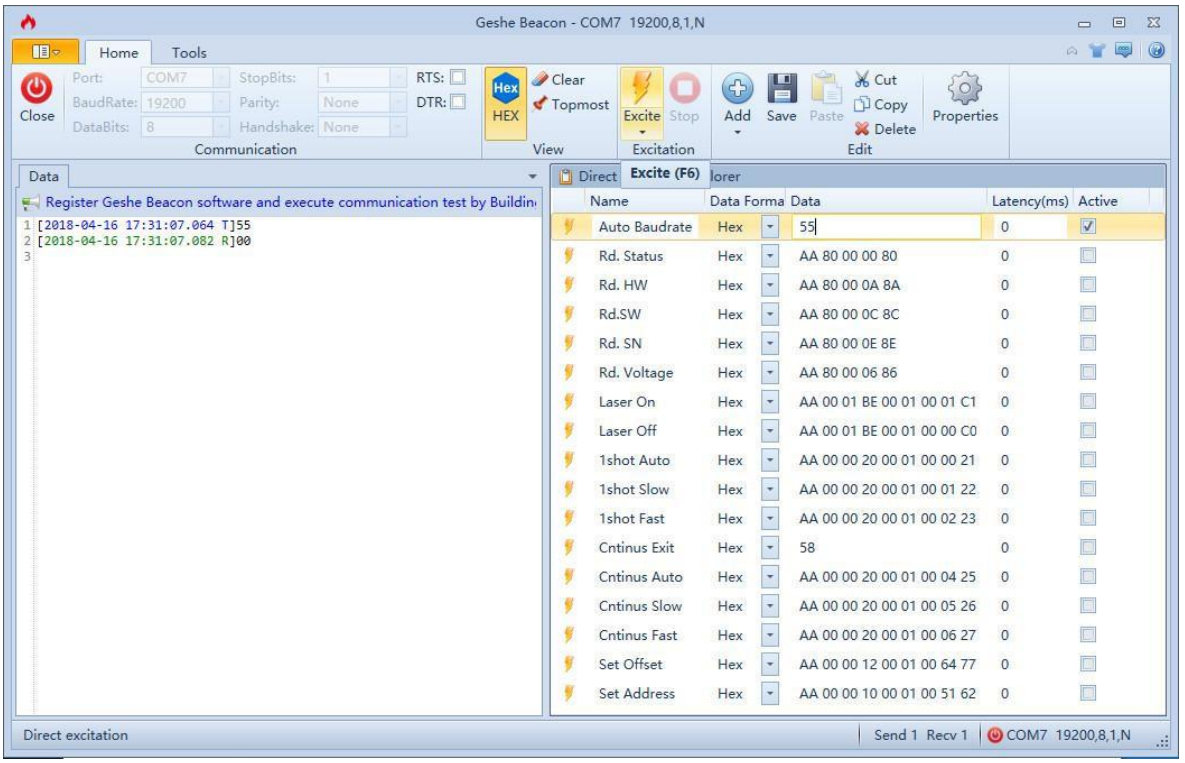


If you chose to create new project, you have to add your commands by clicking ICO ADD to add commands, after that, Click ICO OPEN to turn serial port on.



First release the PWREN by de-assert RTS box, and wait 100 milliseconds for module boot, then do the auto baud rate stage by assert the 1st command Active box, click ICO EXCITE to transmit command 0x55 to laser rangefinder module, Module reply its address right after the auto baud rate success. Now

it's ready to receive further commands from master.



More commands and reply transfer between the laser rangefinder module and the master.