L76X GPS HAT User Manual

OVERVIEW

This is a Raspberry Pi GNSS HAT which supports Multi-GNSS systems: GPS, BDS, and QZSS, with advantages such as fast positioning, high accuracy, low power consumption, and so on.

It is an easy way to enable global positioning function for your Raspberry Pi.

FEATURES

- Supports Multi-GNSS systems: GPS, BDS, and QZSS
- EASY™, self track prediction technology, help quick positioning
- AlwaysLocate™, intelligent controller of periodic mode for power saving
- Supports DGPS, SBAS (WAAS/EGNOS/MSAS/GAGAN)
- UART communication baudrate: 4800~115200bps (9600bps by default)
- Onboard battery holder, supports ML1220 rechargeable battery, for preserving ephemeris information and hot starts
- 4x LEDs for indicating the module working status
- Comes with development resources and manual (examples for Raspberry Pi/Arduino/STM32)

SPCIFICATIONS

GPS SPECIFICATIONS

- Band: GPS L1(1575.42Mhz), BD2 B1 (1561.098MHz)
    - Channels: 33 tracking ch, 99 acquisition ch, 210 PRN ch
    - C/A code
    - SBA: WAAS, EGNOS, MSAS, GAGAN
- Horizontal position accuracy:
    - Autonomous: <2.5mCEP
- Time-To-First-Fix @-130dBm (EASY™ enabled):
    - Cold starts: <15s
    - Warm starts: <5s
    - Hot starts: <1s
- Sensitivity:
    - Acquisition: -148dBm
    - Tracking: -163dBm
    - Re-acquisition: -160dBm

- Dynamic performance:
  - Altitude (max): 18000m
  - Velocity (max): 515m/s
  - Acceleration (max): 4G

GENERAL SPECIFICATIONS

- Communication interface: UART
- Baudrate: 4800~115200bps (9600bps by default)
- Update rate: 1Hz (default), 10Hz (max)
- Protocols: NMEA 0183, PMTK
- Power supply voltage: 5V / 3.3V
- Operating current: 13mA
- Operating temperature: -40℃ ~ 85℃
- Dimensions: 65mm x 30.5mm

CONTENT

Overview 1

Features 1

Spcifications 1

GPS Specificiations 1

General Specifications 2

Hardware 4

Testing in PC 6

Hardware connection 6

Demo codes 8

Download Demo code 8

Arduino examples 8

Hardware connection 8

Expected result 9

Raspberry Pi examples 9

Hardware connection 9

Copy examples 10

Install libraries 10

Enable serial port 11

Install MINICOM 11

Running codes 12

Expected result 12

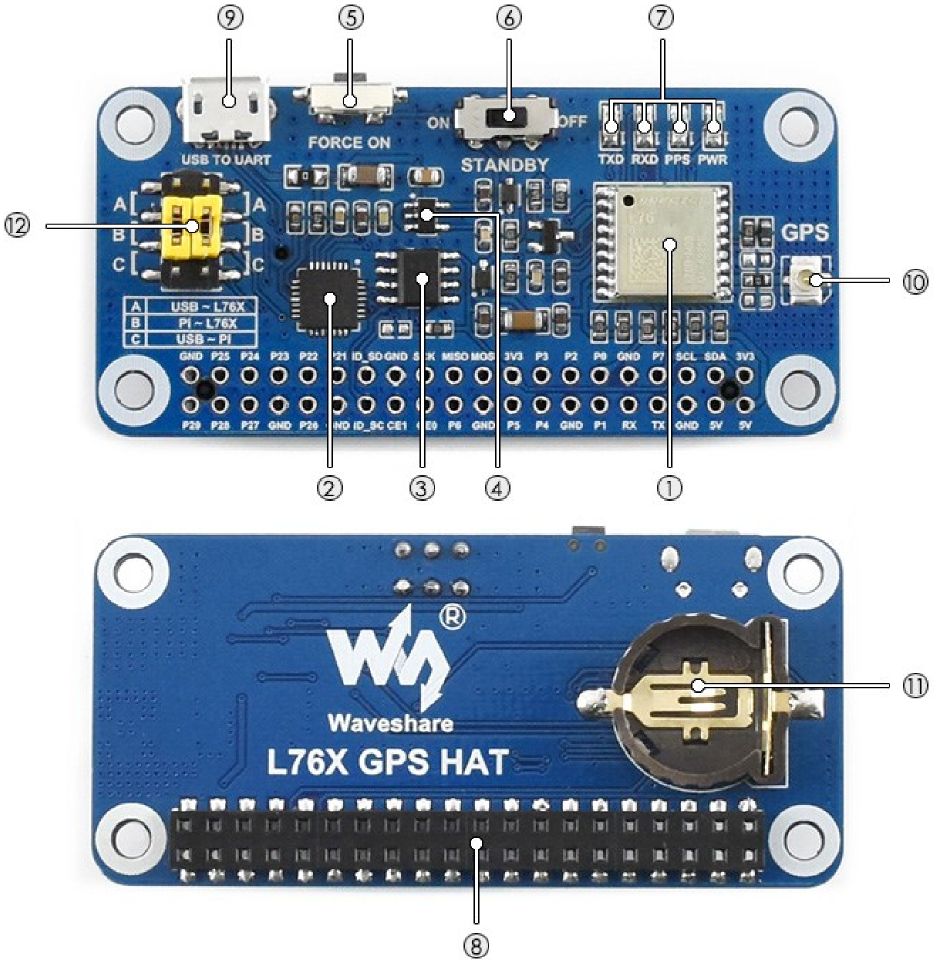
STM32 example 13

Hardware connection 13

Expected result 14

FAQ 15

HARDWARE



1. **L76B module**
2. **CP2102**: USB TO UART converter
3. **CAT24C32**: EEPROM
4. **RT9193-33**: power manager
5. **Backup mode wakeup button**
6. **Standby switch**
7. **Indicators**:
    a) RXD/TXD: UART RX/TX indicator
    b) PPS: GPS status indicator
    c) PWR: power indicator
8. **Raspberry Pi GPIO connector**: for connecting with Raspberry Pi
9. **USB TO UART port**
10. **GNSS antenna connector**
11. **Battery holder:** supports ML1220 rechargeable battery, for preserving ephemeris information and hot starts
12. **UART selection jumpers**
    a) A: control the L76B through USB TO UART
    b) B: control the L76B through Raspberry Pi
    c) C: access Raspberry Pi through USB TO UART

Standby mode: Standby switch is used to switch Standby mode and Working mode. When module is in Standby mode, the power consumption is ultra-low. It stop satellite searching and navigating, no NMEA message outputted. Module is accessible for PMTK command or other data.

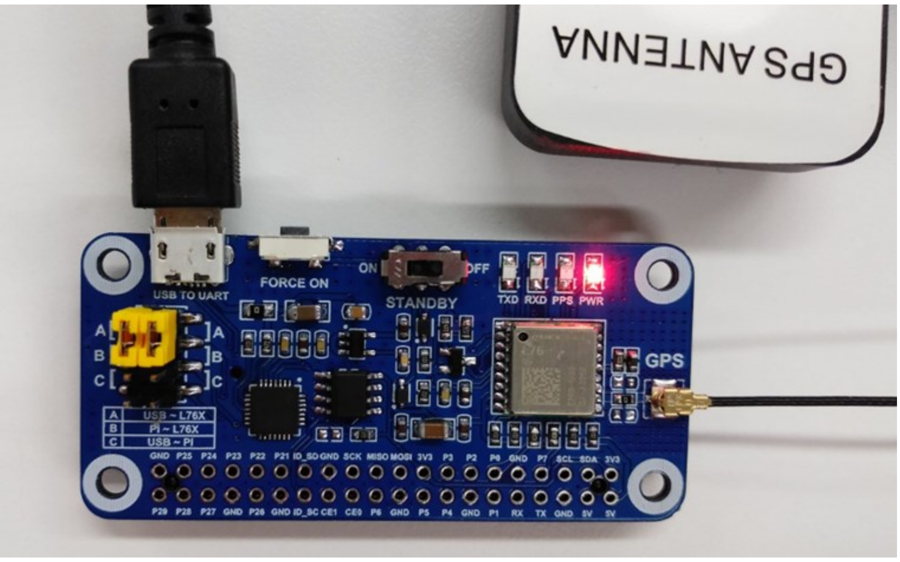
Backup mode: FORCE ON button is used to exit Backup mode. Relate to Standby mode, the consumption of Backup mode is lower. In this mode, module stop searching satellite. UART1 is inaccessible, only the backup memory (GPS messages and several user variables used for quick start) in RTC area works. The working current of Backup mode is about 7uA. The only way to wakeup from Backup mode is pull high of FORCE_ON pin.

CAT24C32: This chip is used to provide ID EEPROM for Raspberry Pi (Include supplier information, GPIO mapping and device tree information). This chip is added for better compatibility with other Raspberry Pi HATs according to the micro-HAT(uHAT) standard (https://github.com/raspberrypi/hats) of Raspberry Pi.

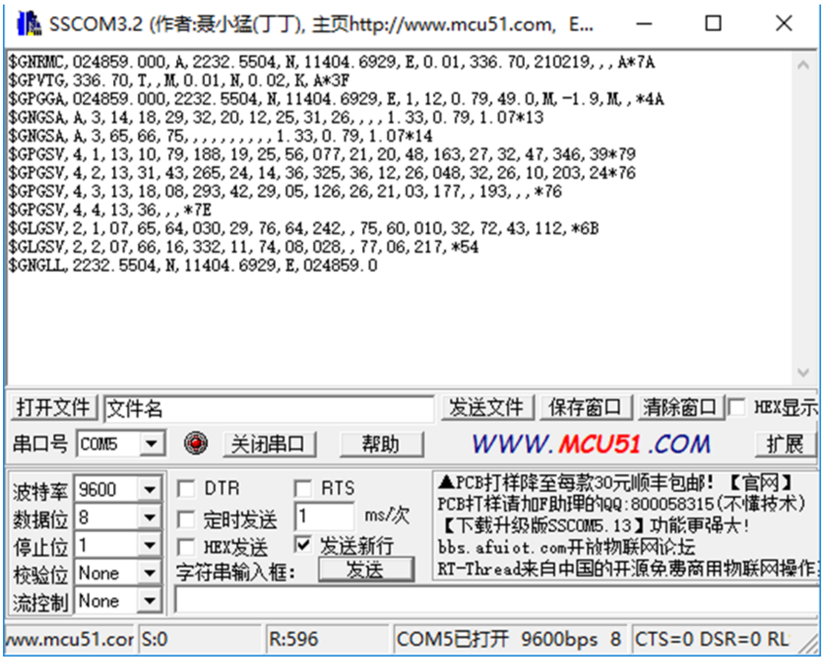
TESTING IN PC

HARDWARE CONNECTION

1. Mounting ML1220 battery (No included) to the battery holder in backside.
2. Connect GPS antenna. Wire A by yellow jumpers. Turn the STANDBY switch to OFF.
3. Connect L76X GPS HAT to PC by USB cable, then the PWR indicator lights on



4. Waiting for about 1s. TXD LED become to flash, which mean that data is transmitting
5. Open serial assistant software in PC. Select the correct COM port (according to the Device Manager), set baud rate: 9600, data bit: 1, stop bit: 1



```
$GNRMC,024859.000,A,2232.5504,N,11404.6929,E,0.01,336.70,210219,,,A*7A
$GPVTG,336.70,T,,M,0.01,N,0.02,K,A*3F
$GPGGA,024859.000,2232.5504,N,11404.6929,E,1,12,0.79,49.0,M,-1.9,M,,*4A
$GNGSA,A,3,14,18,29,32,20,12,25,31,26,,,,1.33,0.79,1.07*13
$GNGSA,A,3,65,66,75,,,,,,,,,,1.33,0.79,1.07*14
$GPGSV,4,1,13,10,79,188,19,25,56,077,21,20,48,163,27,32,47,346,39*79
$GPGSV,4,2,13,31,43,265,24,14,36,325,36,12,26,048,32,26,10,203,24*76
$GPGSV,4,3,13,18,08,293,42,29,05,126,26,21,03,177,,193,,,*76
$GPGSV,4,4,13,36,,,*7E
$GLGSV,2,1,07,65,64,030,29,76,64,242,,75,60,010,32,72,43,112,*6B
$GLGSV,2,2,07,66,16,332,11,74,08,028,,77,06,217,*54
$GNGLL,2232.5504,N,11404.6929,E,024859.0
```

串口号 COM5

波特率 9600
数据位 8
停止位 1
校验位 None
流控制 None

□ DTR □ RTS
□ 定时发送 1 ms/次
□ HEX发送 ☑ 发送新行

▲PCB打样降至每款30元顺丰包邮! 【官网】
PCB打样请加F助理的QQ:800058315(不懂技术)
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bbs.afuiot.com开放物联网论坛
RT-Thread来自中国的开源免费商用物联网操作

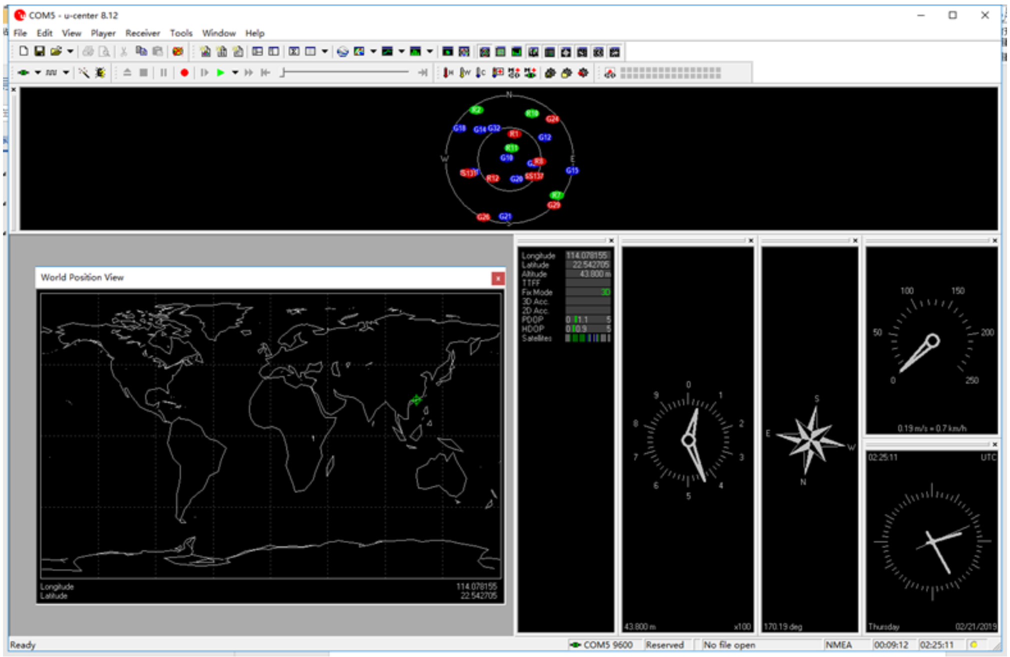
www.mcu51.cor S:0 R:596 COM5已打开 9600bps 8 CTS=0 DSR=0 RL

【Note】

a) Please set the module or receiver of antenna outdoor for stable GPS signal

b) Generally, first time module should use about 35s to locate (cold starting), the locating time (first) maybe longer even failed because of environment, please be patient.

6. Download U-center software from wiki. Unzip it and install. Open U-center software, click Receiver menu, choose Port, and select the correct com port (refer to Devices Manager). Set baud rate: 9600 then click button to connect L76X GPS HAT. U-center display information after connecting.



Longitude 114.078155
Latitude 22.542705
Altitude 43.800 m
TTFF
Fix Mode 3D
3D Acc.
2D Acc.
PDOP 0 1.1 5
HDOP 0 0.9 5
Satellites

Longitude 114.078155
Latitude 22.542705

43.800 m x100

170.19 deg

Thursday 02/21/2019

Ready | COM5 9600 | Reserved | No file open | NMEA | 00:09:12 | 02:25:11

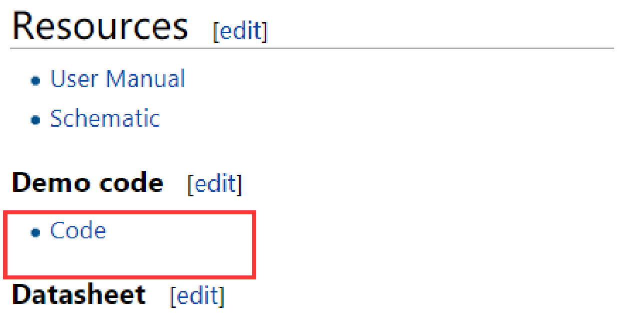
7. If you want to check the area better, you can install GoogleEarthPluginSetup.exe tool, which allow you to choose Google Earth under View menu

【Note】The result you get from Google Earth maybe different with actual area because of dynamic drift of GPS

DEMO CODES

DOWNLOAD DEMO CODE

Find the product in Waveshare website, open the wiki and download demo code from wiki.



Resources [edit]

- User Manual
- Schematic

Demo code [edit]

- Code

Datasheet [edit]

Unzip:

名称	修改日期	类型	大小
Arduino	2019/2/20 18:03	文件夹	
RaspberryPi	2019/2/20 15:34	文件夹	
STM32	2019/2/20 15:35	文件夹	

Arduino: Arduino examples based on Arduino UNO

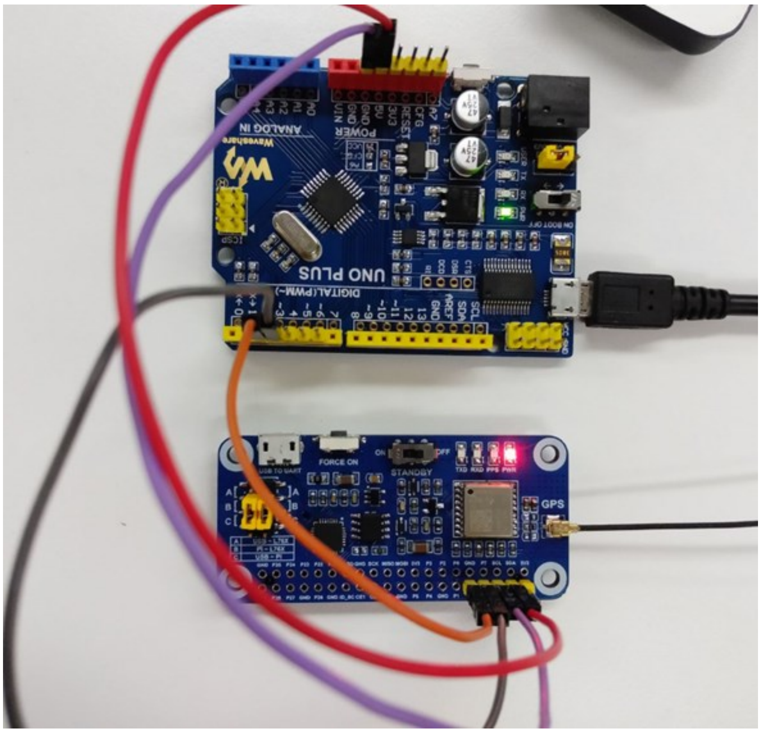
Raspberry Pi: Raspberry Pi examples include wiringpi and python codes

STM32: STM32 examples based on STM32F103

ARDUINO EXAMPLES

The development board used here is UNO PLUS

HARDWARE CONNECTION

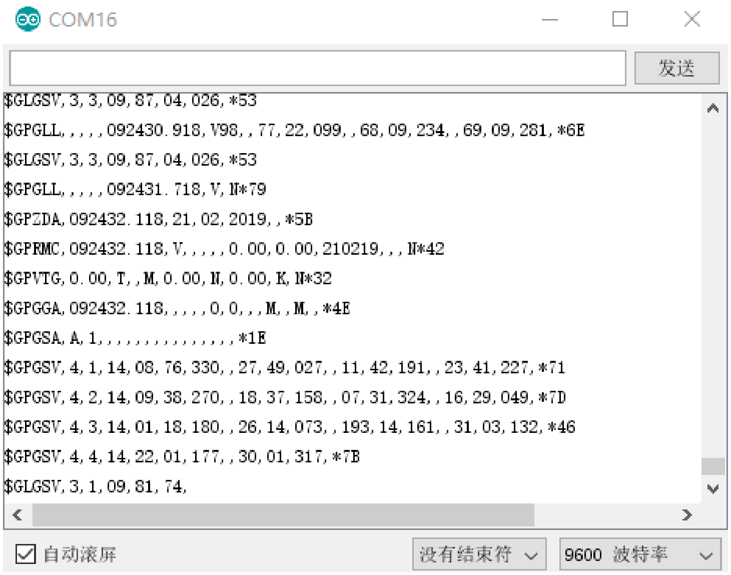


Connect L76X GPS HAT to UNO PLUS by Dupont lines, short B by yellow jumpers

L76X GPS HAT	Arduino
5V	5V
GND	GND
RXD	2
TXD	3

EXPECTED RESULT

It requires about 35s to locate (first time). Open serial monitor and set baud rate to 9600. Data printed first is original data. Time: L76X GPS HAT output time.

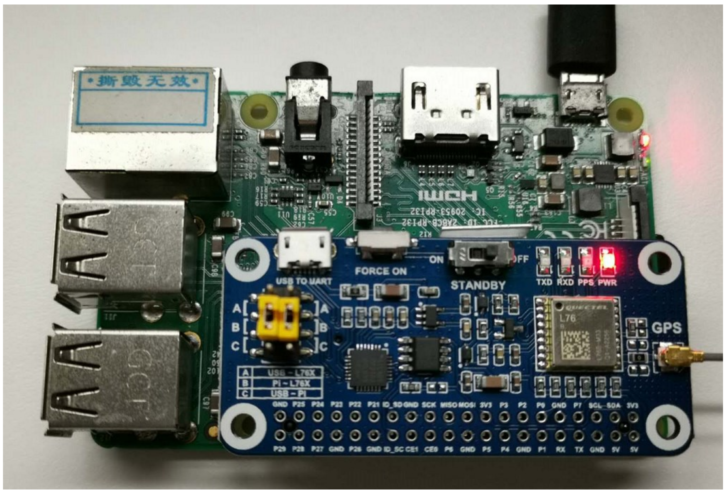


```
$GLGSV,3,3,09,87,04,026,*53
$GPGLL,,,,,092430.918,V98,,77,22,099,,68,09,234,,69,09,281,*6E
$GLGSV,3,3,09,87,04,026,*53
$GPGLL,,,,,092431.718,V,N*79
$GPZDA,092432.118,21,02,2019,,*5B
$GPRMC,092432.118,V,,,,,0.00,0.00,210219,,,N*42
$GPVTG,0.00,T,,M,0.00,N,0.00,K,N*32
$GPGGA,092432.118,,,,,0,0,,,M,,M,,*4E
$GPGSA,A,1,,,,,,,,,,,,,,,*1E
$GPGSV,4,1,14,08,76,330,,27,49,027,,11,42,191,,23,41,227,*71
$GPGSV,4,2,14,09,38,270,,18,37,158,,07,31,324,,16,29,049,*7D
$GPGSV,4,3,14,01,18,180,,26,14,073,,193,14,161,,31,03,132,*46
$GPGSV,4,4,14,22,01,177,,30,01,317,*7B
$GLGSV,3,1,09,81,74,
```

☑ 自动滚屏　没有结束符　9600 波特率

RASPBERRY PI EXAMPLES

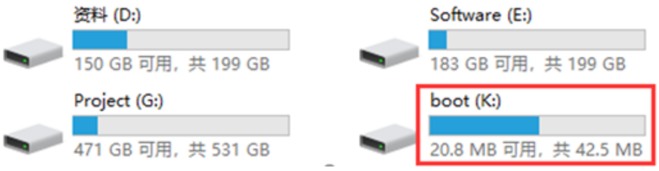
HARDWARE CONNECTION



Plug L76X GPS HAT to Raspberry Pi, short B by yellow jumpers

COPY EXAMPLES

Insert SD card (which has installed Raspbian image) to PC by card reader



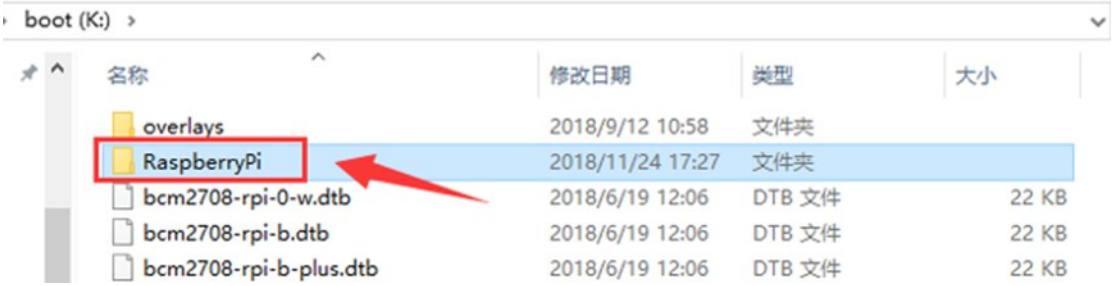
资料 (D:)
150 GB 可用，共 199 GB

Software (E:)
183 GB 可用，共 199 GB

Project (G:)
471 GB 可用，共 531 GB

boot (K:)
20.8 MB 可用，共 42.5 MB

Copy Raspberry Pi examples (the folder we download and unzip above) to BOOT directory of SD card

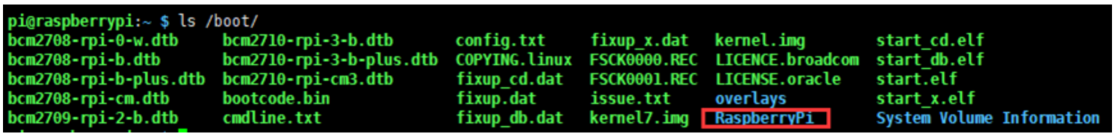


boot (K:) ›

名称	修改日期	类型	大小
overlays	2018/9/12 10:58	文件夹	
RaspberryPi	2018/11/24 17:27	文件夹	
bcm2708-rpi-0-w.dtb	2018/6/19 12:06	DTB 文件	22 KB
bcm2708-rpi-b.dtb	2018/6/19 12:06	DTB 文件	22 KB
bcm2708-rpi-b-plus.dtb	2018/6/19 12:06	DTB 文件	22 KB

Exit and insert the card to Raspberry Pi, then start.

Check it: **ls /boot**

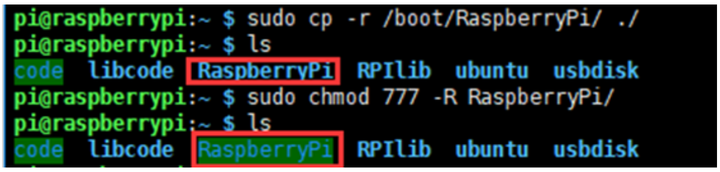


```
pi@raspberrypi:~ $ ls /boot/
bcm2708-rpi-0-w.dtb     bcm2710-rpi-3-b.dtb       config.txt     fixup_x.dat    kernel.img        start_cd.elf
bcm2708-rpi-b.dtb       bcm2710-rpi-3-b-plus.dtb  COPYING.linux  FSCK0000.REC   LICENCE.broadcom  start_db.elf
bcm2708-rpi-b-plus.dtb  bcm2710-rpi-cm3.dtb       fixup_cd.dat   FSCK0001.REC   LICENSE.oracle    start.elf
bcm2708-rpi-cm.dtb      bootcode.bin              fixup.dat      issue.txt      overlays          start_x.elf
bcm2709-rpi-2-b.dtb     cmdline.txt               fixup_db.dat   kernel7.img    RaspberryPi       System Volume Information
```

Copy it to /home/pi

sudo cp -r /boot/RaspberryPi/ ./

sudo chmod 777 -R RaspberryPi/



```
pi@raspberrypi:~ $ sudo cp -r /boot/RaspberryPi/ ./
pi@raspberrypi:~ $ ls
code  libcode  RaspberryPi  RPIlib  ubuntu  usbdisk
pi@raspberrypi:~ $ sudo chmod 777 -R RaspberryPi/
pi@raspberrypi:~ $ ls
code  libcode  RaspberryPi  RPIlib  ubuntu  usbdisk
```

INSTALL LIBRARIES

Examples should be used with libraries installed

Install **wiringPi**:

```
sudo apt-get install git
sudo git clone git://git.drogon.net/wiringPi
cd wiringPi
sudo ./build
```

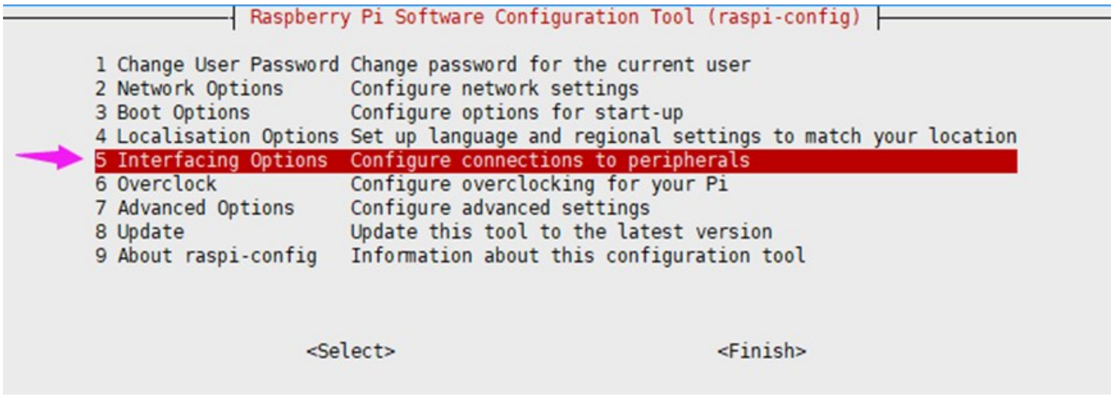
Install **python:**

```
sudo apt-get install python-pip
sudo pip install RPi.GPIO
sudo pip install spidev
sudo apt-get install python-imaging
sudo apt-get install python-smbus
sudo apt-get install python-serial
```

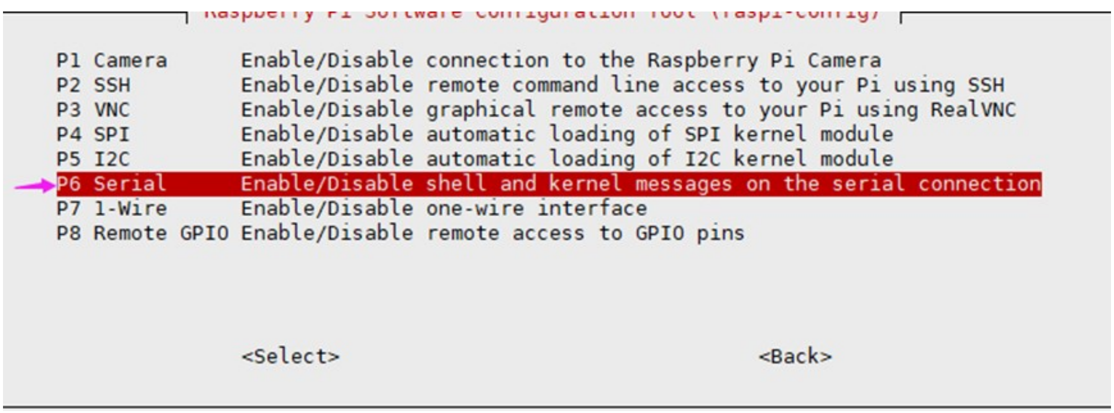
ENABLE SERIAL PORT

UART interface should be used for communicating, so we need to enable hardware serial of Raspberry Pi.

sudo raspi-config

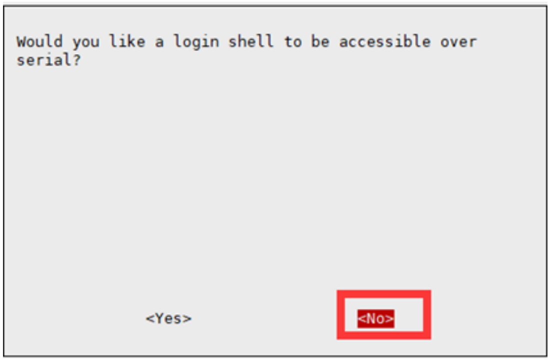


```
Raspberry Pi Software Configuration Tool (raspi-config)

1 Change User Password Change password for the current user
2 Network Options      Configure network settings
3 Boot Options         Configure options for start-up
4 Localisation Options Set up language and regional settings to match your location
5 Interfacing Options  Configure connections to peripherals
6 Overclock            Configure overclocking for your Pi
7 Advanced Options     Configure advanced settings
8 Update               Update this tool to the latest version
9 About raspi-config   Information about this configuration tool

            <Select>                        <Finish>
```

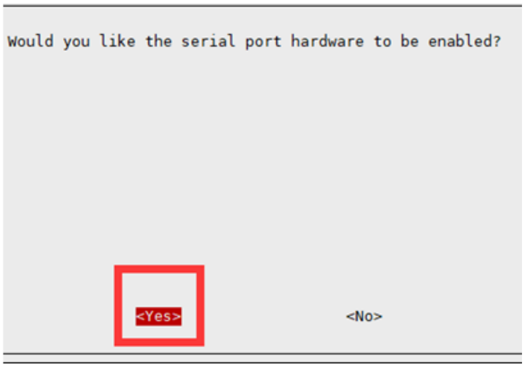


```
Raspberry Pi Software Configuration Tool (raspi-config)

P1 Camera      Enable/Disable connection to the Raspberry Pi Camera
P2 SSH         Enable/Disable remote command line access to your Pi using SSH
P3 VNC         Enable/Disable graphical remote access to your Pi using RealVNC
P4 SPI         Enable/Disable automatic loading of SPI kernel module
P5 I2C         Enable/Disable automatic loading of I2C kernel module
P6 Serial      Enable/Disable shell and kernel messages on the serial connection
P7 1-Wire      Enable/Disable one-wire interface
P8 Remote GPIO Enable/Disable remote access to GPIO pins

            <Select>                        <Back>
```

Disable login shell function and then enable hardware serial



```
Would you like a login shell to be accessible over
serial?

          <Yes>                <No>
```



```
Would you like the serial port hardware to be enabled?

          <Yes>                <No>
```

INSTALL MINICOM

minicom is a serial assistant tool for Linux.

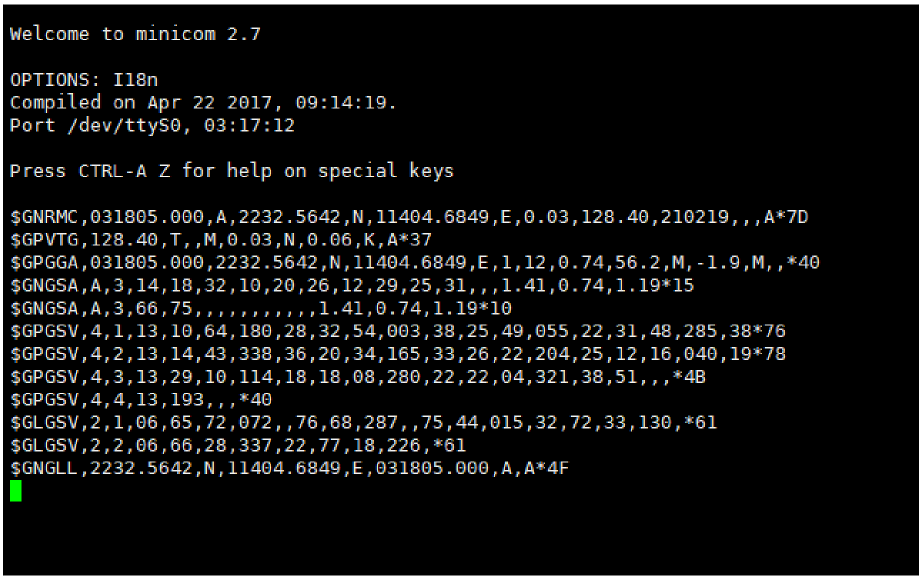
Install minicom:

sudo apt-get install minicom

Using minicom:

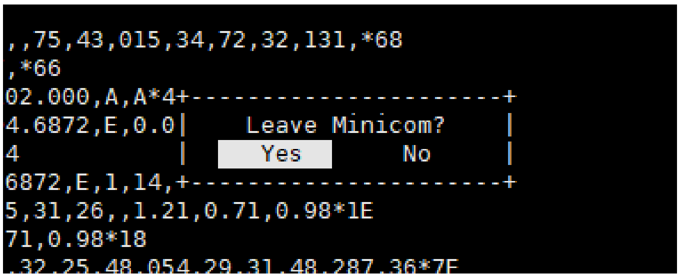
minicom -D /dev/ttyS0 -b 9600

【Note】If you use Raspberry Pi zero, the serial port should be ttyAMA0, you can confirm the port by command: ls -l /dev/serial0 The default baud rate of minicom is 115200, here we use parameters -b 9600 to set it as 9600



```
Welcome to minicom 2.7

OPTIONS: I18n
Compiled on Apr 22 2017, 09:14:19.
Port /dev/ttyS0, 03:17:12

Press CTRL-A Z for help on special keys

$GNRMC,031805.000,A,2232.5642,N,11404.6849,E,0.03,128.40,210219,,,A*7D
$GPVTG,128.40,T,,M,0.03,N,0.06,K,A*37
$GPGGA,031805.000,2232.5642,N,11404.6849,E,1,12,0.74,56.2,M,-1.9,M,,*40
$GNGSA,A,3,14,18,32,10,20,26,12,29,25,31,,,1.41,0.74,1.19*15
$GNGSA,A,3,66,75,,,,,,,,,,,1.41,0.74,1.19*10
$GPGSV,4,1,13,10,64,180,28,32,54,003,38,25,49,055,22,31,48,285,38*76
$GPGSV,4,2,13,14,43,338,36,20,34,165,33,26,22,204,25,12,16,040,19*78
$GPGSV,4,3,13,29,10,114,18,18,08,280,22,22,04,321,38,51,,,*4B
$GPGSV,4,4,13,193,,,*40
$GLGSV,2,1,06,65,72,072,,76,68,287,,75,44,015,32,72,33,130,*61
$GLGSV,2,2,06,66,28,337,22,77,18,226,*61
$GNGLL,2232.5642,N,11404.6849,E,031805.000,A,A*4F
```

If you want to exit, you can press Ctrl + A, press X and choose Yes, then Enter.



```
,,75,43,015,34,72,32,131,*68
,*66
02.000,A,A*4+----------------------+
4.6872,E,0.0|     Leave Minicom?    |
4           |    Yes         No     |
6872,E,1,14,+----------------------+
5,31,26,,1.21,0.71,0.98*1E
71,0.98*18
,32,25,48,054,29,31,48,287,36*7E
```

RUNNING CODES

Enter RaspberryPi folder (The directory of example) and run it with commands:

wiringPi code:

```
cd ~/RaspberryPi/wiringpi
sudo ./main
```

python code：

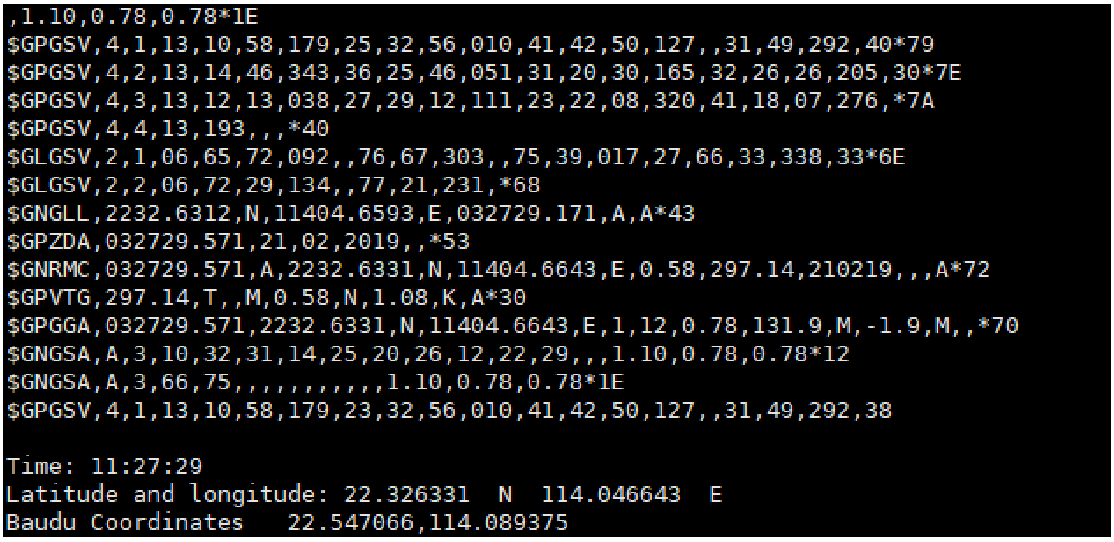
```
cd ~/RaspberryPi/python
sudo python main.py
```

EXPECTED RESULT

It requires about 35s to locate (first time).

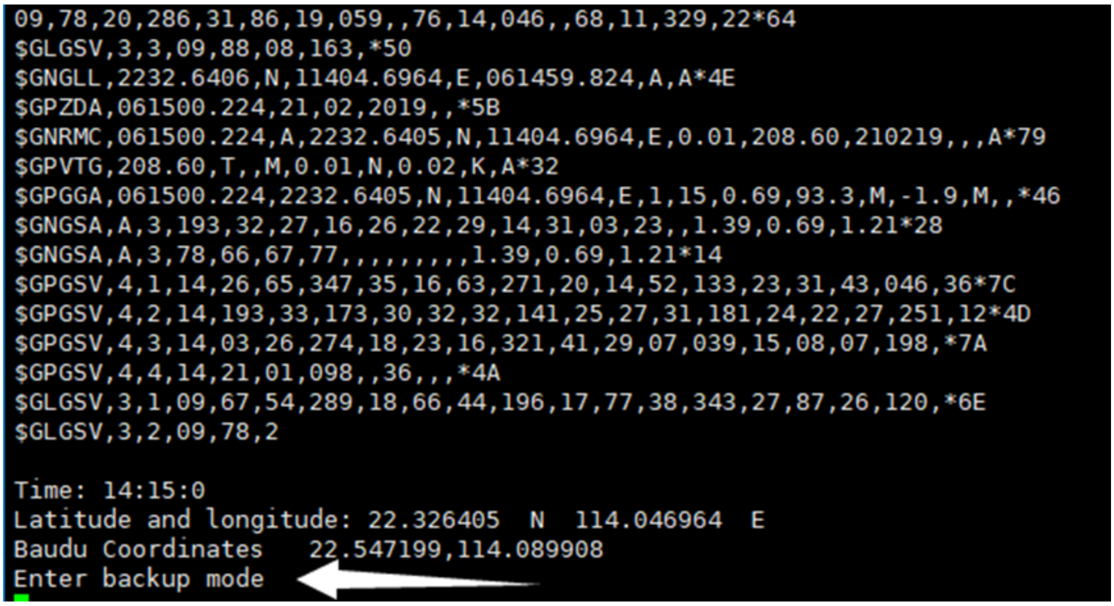
Data printed first is original data.

Time: L76X GPS HAT output time.



```
,1.10,0.78,0.78*1E
$GPGSV,4,1,13,10,58,179,25,32,56,010,41,42,50,127,,31,49,292,40*79
$GPGSV,4,2,13,14,46,343,36,25,46,051,31,20,30,165,32,26,26,205,30*7E
$GPGSV,4,3,13,12,13,038,27,29,12,111,23,22,08,320,41,18,07,276,*7A
$GPGSV,4,4,13,193,,,*40
$GLGSV,2,1,06,65,72,092,,76,67,303,,75,39,017,27,66,33,338,33*6E
$GLGSV,2,2,06,72,29,134,,77,21,231,*68
$GNGLL,2232.6312,N,11404.6593,E,032729.171,A,A*43
$GPZDA,032729.571,21,02,2019,,*53
$GNRMC,032729.571,A,2232.6331,N,11404.6643,E,0.58,297.14,210219,,,A*72
$GPVTG,297.14,T,,M,0.58,N,1.08,K,A*30
$GPGGA,032729.571,2232.6331,N,11404.6643,E,1,12,0.78,131.9,M,-1.9,M,,*70
$GNGSA,A,3,10,32,31,14,25,20,26,12,22,29,,,1.10,0.78,0.78*12
$GNGSA,A,3,66,75,,,,,,,,,,,1.10,0.78,0.78*1E
$GPGSV,4,1,13,10,58,179,23,32,56,010,41,42,50,127,,31,49,292,38

Time: 11:27:29
Latitude and longitude: 22.326331  N  114.046643  E
Baudu Coordinates   22.547066,114.089375
```

Code will set the module to Backup mode after running for one miniature, you need to type any character and Enter to wake it up.



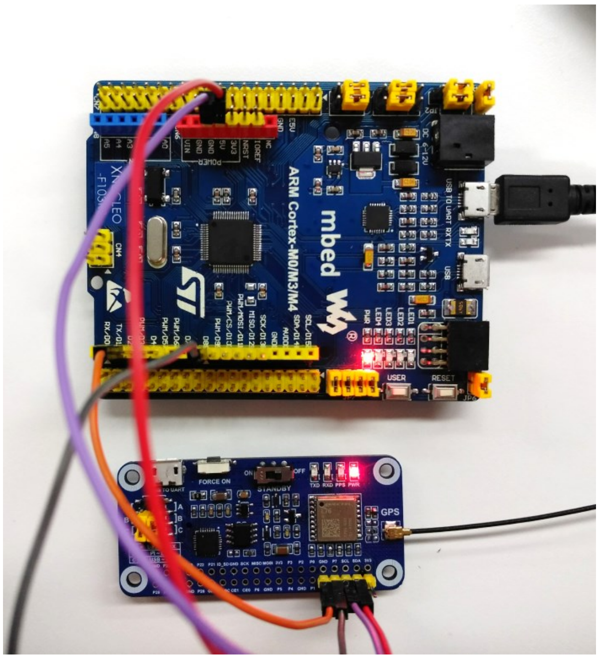
```
09,78,20,286,31,86,19,059,,76,14,046,,68,11,329,22*64
$GLGSV,3,3,09,88,08,163,*50
$GNGLL,2232.6406,N,11404.6964,E,061459.824,A,A*4E
$GPZDA,061500.224,21,02,2019,,*5B
$GNRMC,061500.224,A,2232.6405,N,11404.6964,E,0.01,208.60,210219,,,A*79
$GPVTG,208.60,T,,M,0.01,N,0.02,K,A*32
$GPGGA,061500.224,2232.6405,N,11404.6964,E,1,15,0.69,93.3,M,-1.9,M,,*46
$GNGSA,A,3,193,32,27,16,26,22,29,14,31,03,23,,1.39,0.69,1.21*28
$GNGSA,A,3,78,66,67,77,,,,,,,,,1.39,0.69,1.21*14
$GPGSV,4,1,14,26,65,347,35,16,63,271,20,14,52,133,23,31,43,046,36*7C
$GPGSV,4,2,14,193,33,173,30,32,32,141,25,27,31,181,24,22,27,251,12*4D
$GPGSV,4,3,14,03,26,274,18,23,16,321,41,29,07,039,15,08,07,198,*7A
$GPGSV,4,4,14,21,01,098,,36,,,*4A
$GLGSV,3,1,09,67,54,289,18,66,44,196,17,77,38,343,27,87,26,120,*6E
$GLGSV,3,2,09,78,2

Time: 14:15:0
Latitude and longitude: 22.326405  N  114.046964  E
Baudu Coordinates   22.547199,114.089908
Enter backup mode
```

【Note】Even the default baud rate of L76X GPS HAT is 9600, it is changed to 115200 in code. If you find that 9600 cannot work next time, please check if it is changed.

STM32 EXAMPLE

The development board used here is Waveshare XNUCLEO-F103RB, whose chip is STM32F103RBT6. The code is based on HAL

HARDWARE CONNECTION



Wire L76X GPS HAT to STM32 board, short B by yellow jumpers. And connect USB to UART (USART1) interface of STM32 board to PC

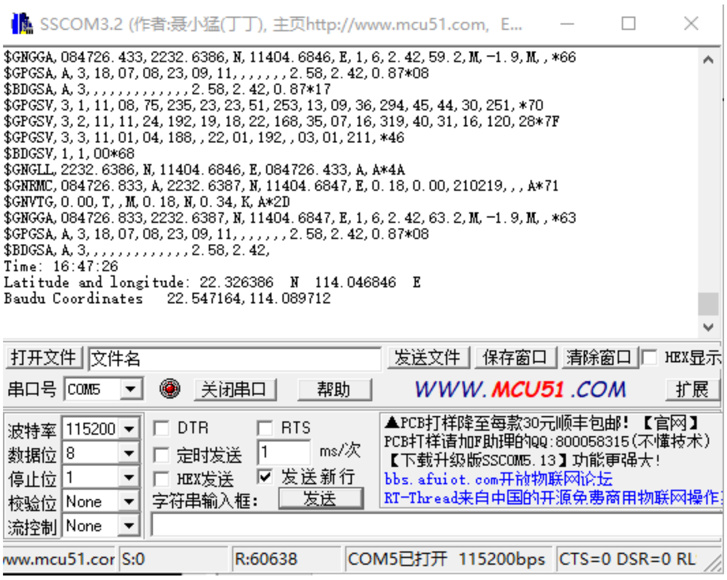
L76X GPS HAT	STM32
5V	5V
GND	GND
RXD	PA10
TXD	PA9

EXPECTED RESULT

Open serial assistant software in PC, set baud rate to 115200

Data printed first is original data.

Time: L76X GPS HAT output time.



SSCOM3.2 (作者:聂小猛(丁丁), 主页http://www.mcu51.com, E...

```
$GNGGA,084726.433,2232.6386,N,11404.6846,E,1,6,2.42,59.2,M,-1.9,M,,*66
$GPGSA,A,3,18,07,08,23,09,11,,,,,,,2.58,2.42,0.87*08
$BDGSA,A,3,,,,,,,,,,,,,2.58,2.42,0.87*17
$GPGSV,3,1,11,08,75,235,23,23,51,253,13,09,36,294,45,44,30,251,*70
$GPGSV,3,2,11,11,24,192,19,18,22,168,35,07,16,319,40,31,16,120,28*7F
$GPGSV,3,3,11,01,04,188,,22,01,192,,03,01,211,*46
$BDGSV,1,1,00*68
$GNGLL,2232.6386,N,11404.6846,E,084726.433,A,A*4A
$GNRMC,084726.833,A,2232.6387,N,11404.6847,E,0.18,0.00,210219,,,A*71
$GNVTG,0.00,T,,M,0.18,N,0.34,K,A*2D
$GNGGA,084726.833,2232.6387,N,11404.6847,E,1,6,2.42,63.2,M,-1.9,M,,*63
$GPGSA,A,3,18,07,08,23,09,11,,,,,,,2.58,2.42,0.87*08
$BDGSA,A,3,,,,,,,,,,,,,2.58,2.42,
Time:  16:47:26
Latitude and longitude: 22.326386  N  114.046846  E
Baudu Coordinates   22.547164,114.089712
```

打开文件 文件名 发送文件 保存窗口 清除窗口 □ HEX显示

串口号 COM5 ● 关闭串口 帮助 WWW.MCU51.COM 扩展

波特率 115200
数据位 8
停止位 1
校验位 None
流控制 None

□ DTR □ RTS
□ 定时发送 1 ms/次
□ HEX发送 ☑ 发送新行
字符串输入框: 发送

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RT-Thread来自中国的开源免费商用物联网操作

ww.mcu51.cor S:0 R:60638 COM5已打开 115200bps CTS=0 DSR=0 RL

FAQ

1. **TXD didn't flashing, data aren't printed to serial after powering on for about 1 minute. PWR lights normally?**

   - Please check if STANDBY switch is turn to OFF. Press FORCE_ON button for about 1s and check again. If there aren't data outputted still, check if you connect HAT correctly

2. **Why the baud rate doesn't change after send changing command?**

   - Please check if the current baud rate is correct. If the satellites searched are too much, the module cannot allows the baud rate to be smaller. In this case, you can use SET_NMEA_OUTPUT command to reduce the output data per time and try again.

3. **Why the locating is not accurate?**

   - The accuracy is influenced by environment. Weather reason: The humidity is every high when raining, which weaken the intensity of the GPS signal. It often raining in summer, therefore, the intensity of phone signals is weak. High building reason: high buildings shelter from satellite, make GPS intensity became weak. Area problem: Suburbs have less satellite coverage, so GPS intensity is weak in these areas. Interference problem: Sometime, signals from satellites will be interrupted by atmosphere ionosphere, buildings, forest, water and son on.

4. **Why the locating result is different with smart phone?**

   - L76X GPS HAT use satellite locating. Smart phone use AGPS, LBS, WIFI and Bluetooth locating as well except satellite. Smart phone locate much faster. And the multi-satellite system used by smart phone are different with L76X's