INSTALLATION AND OPERATION

USER MANUAL

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CLAP-B7

CompactSize GNSS/INS

High Precision Integrated Navigation OEM Board

Revision History

Version	Revision History	Date
V0.1	Initial released revision	Jun. 2018
V0.8	Revisement	Aug. 2019
R1.0	Align the reference commands book to R2.9 version	Feb. 2020
R1.1	Add the description of inrush current	Jul. 2020

Disclaimer

Foreword

This document describes the information of the hardware, installation, specification and the use of of UNICORECOMM CLAP-B7 product.

This Manual includes a general introduction to UNICORECOMM CLAP-B7 product, it's recommended to use this manual in a purposeful way, such as for RTK, heading and DGPS, on the basis of the actual product purchased.

Audience

This manual is applied to the technical personnel, who possess the expertise of GNSS receivers and inertial integrated navigation systems.

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1 Product Introduction

1.1 Hope You Enjoy Using CLAP-B7

Dear users, we hope you enjoy using the CLAP-B7 integrated navigation product designed and developed by Unicore Communications, Inc.

The CLAP (Concurrent Localization & Attitude Pilot) -B7 product is a GNSS/MEMS INS integrated navigation OEM board, which integrates a miniaturized high-performance inertial measurement unit (IMU) on a compact high performance GNSS board. The absolute accuracy of GNSS positioning coupled with a high-precision gyro and accelerometer provides the stable, continuous three-dimensional position, velocity and attitude solution. Even when the GNSS signal is completely blocked, the results of the solution can remain stable and continuous, and provide extraordinary and outstanding continuous performance in compact size.

This manual will guide you to learn the advanced technology and wide-ranging features of CLAP-B7.

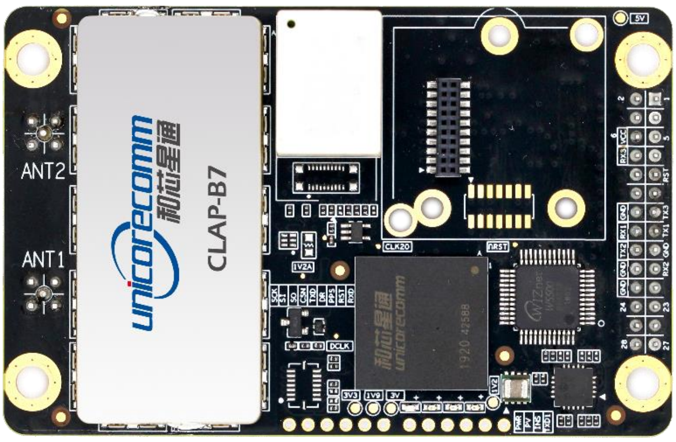


Figure 1-1 CLAP-B7 Integrated Navigation Board

1.2 Key Features

1) Compact size and high-performance integrated navigation board.
   Dimension: 46 x 71 x 17.1mm
2) Best-in-class 5ns RMS PPS output
3) "WINS" (Wheel INS) optimization technology for vehicles and wheeled robots
4) Combined algorithm of INS/GNSS/Odometer

5) Built-in UNICORECOMM high performance and high precision GNSS borad
6) 100Hz positioning output/original IMU measurement output
7) Support BDS B1/B2 +GPSL1/L2+GLONASS L1/L2+Galileo E1/E5b
8) Support both single and dual-antenna modes
9) 3.3~5VDC input

1.3 Technical Specifications

1.3.1 Performance Specifications

<table>
<tr><td>Channels</td><td>432 channels, based on Nebulas-II SoC chip</td><td>Cold Start</td><td>＜40sec</td></tr>
<tr><td rowspan="4">Frequencies</td><td rowspan="4">BDS B1/B2
GPS L1/L2
GLONASS L1/L2
Galileo E1/E5b
QZSS L1/L2
SBAS L1</td><td>Initialization Time</td><td>＜5s (typical value)</td></tr>
<tr><td>Initialization Reliability</td><td>＞99.9%</td></tr>
<tr><td>Differential Data</td><td>RTCM 2.x/3.x
CMR</td></tr>
<tr><td>Data Formats</td><td>NMEA-0183，Unicore*</td></tr>
<tr><td>Positioning (RMS)</td><td>Single point: 1.5m
SBAS*: 80cm
DGPS: 40cm
PPP*: 20cm
RTK: 1cm+1ppm</td><td rowspan="2">RAW Data Update Rate</td><td rowspan="2">IMU 100Hz
GNSS* 20Hz</td></tr>
<tr><td>Velocity Accuracy (RMS)</td><td>0.02m/s</td></tr>
<tr><td>Time Accuracy (RMS)</td><td>5ns，peak to peak value: 35ns（24h）</td><td rowspan="2">GNSS/INS Result Update Rate</td><td rowspan="2">100Hz</td></tr>
<tr><td>Heading Accuracy (RMS)</td><td>0.2 degree/1m baseline</td></tr>
</table>

* Optional, non-standard configuration, authorization is required.

1.3.2 Physical Characteristics

Dimensions 46 x 71 x 17.1mm
Weight 22g (without antennas and cables)
MTBF 30000 hour
Lifetime 15 year

1.3.3 Environment

IMU calibration temperature: -10℃~75℃

Operating temperature: -25 ℃ ~85 ℃

Storage temperature: -40 ℃ ~85 ℃

Humidity: 95% non-condensing

Vibration: GJB150.16-2009

1.3.4 Electrical Characteristics

Input voltage: 3.3~5 VDC

Power consumption: <3W

Power-on impulse current[1]: <3A

Maximum ripple: ±50mV

1.3.5 IMU Performance[1]

Gyroscope	Range (°/s)	2000
	Bias Instability (°/hr)	8
	ARW (°/√hr)	0.34
Accelerometer	Rang (g)	40
	Bias Instability (μg)	13
	VRW (m/s/√hr)	0.037

1.3.6 Interfaces

UART x 3, maximum baud rate: 921.6kbps

PPS x 1

LAN x 1

EVENT x 1

MMCX x 2

[1] Since the product has capacitors inside, inrush current will occur during power-on. Evaluate in the actual environment in order to check the effect of the supply voltage drop by inrush current in the system.

1.3.7 Performance[2]

	Outage Duration	Positioning Mode	Position Accuracy (m) RMS		Velocity Accuracy (m/s) RMS		Attitude Accuracy (deg) STD		
			Horizontal	Vertical	Horizontal	Vertical	Roll	Pitch	Heading
CLAP -B7	00s	RTK	0.02	0.03	0.02	0.03	0.1	0.1	0.150
		SP	1.50	2.0	0.02	0.03	0.1	0.1	0.150
	10s	RTK	0.50	0.60	0.12	0.18	0.2	0.2	0.35
		SP	2.0	3.0	0.12	0.18	0.2	0.2	0.35

Note:

1. IMU parameters refer to typical working conditions.

2. Typical values. Performance specifications are subject to GNSS system performance, satellite geometry, baseline length, ionospheric and tropospheric conditions, multipath effects and the presence of natural or unnatural interference sources.

2 Hardware

2.1 Appearance

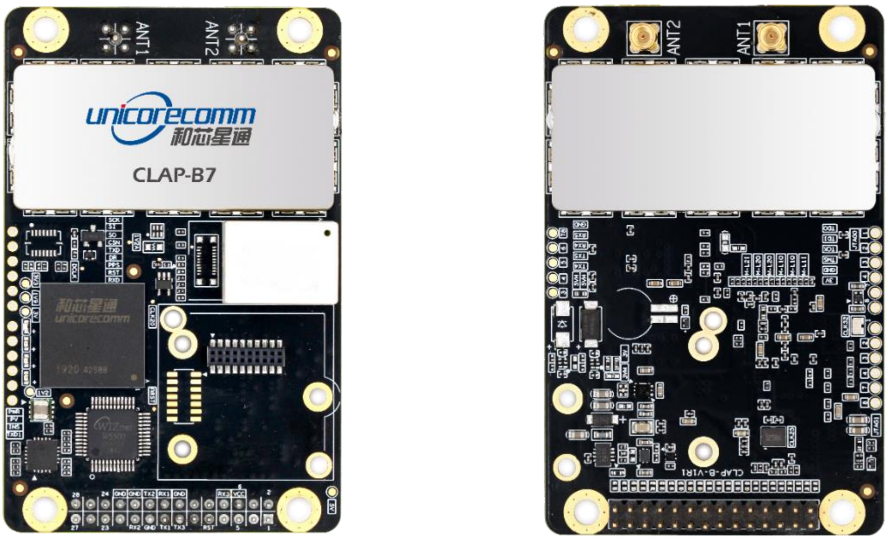
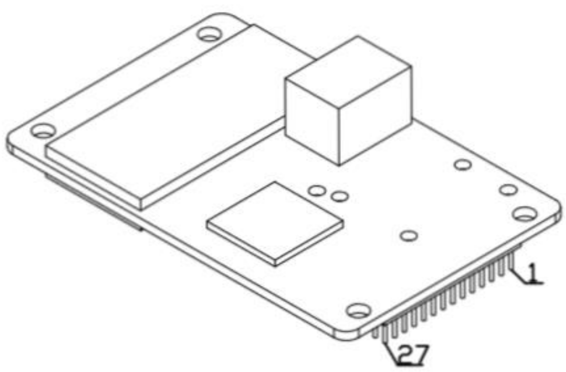


Figure 2-1 CLAP-B7 Appearance

2.2 Dimensions

Table 2-1 CLAP-B7 Dimensions

Parameter	Value（mm）	Tolerance
Length	71.1	-0.2mm +0.5mm
Width	45.7	±0.2mm
Height (PCB)	1.6	±10%
RF Connector	4.5	±0.2mm
Shield	2.0	±0.2mm
PIN Distance	5.9	±0.2mm
IMU（ADIS16470）Height	10.2	±0.2mm



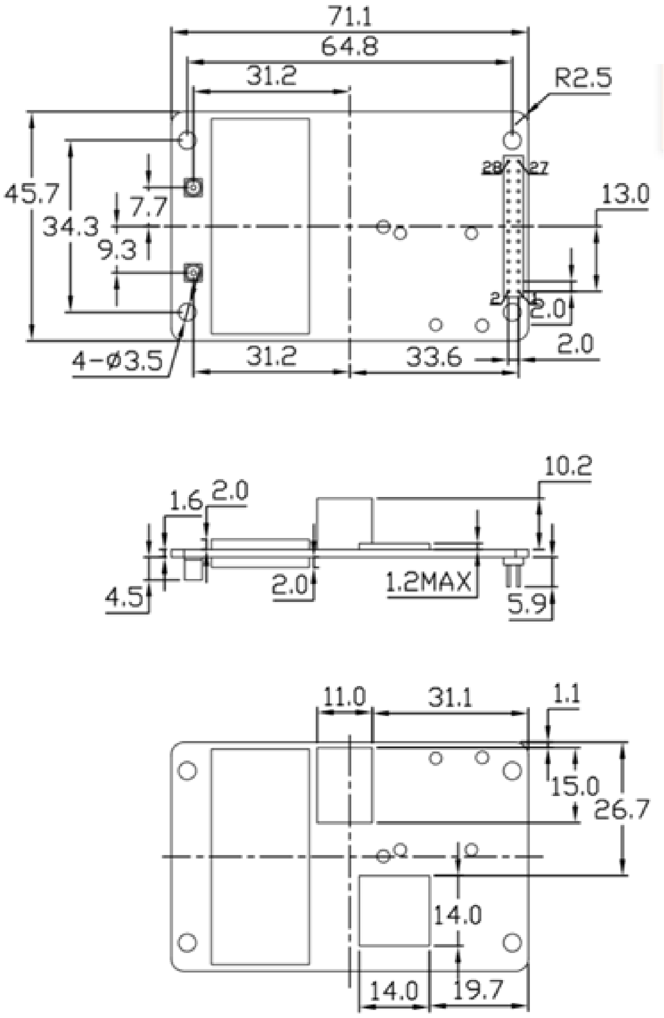
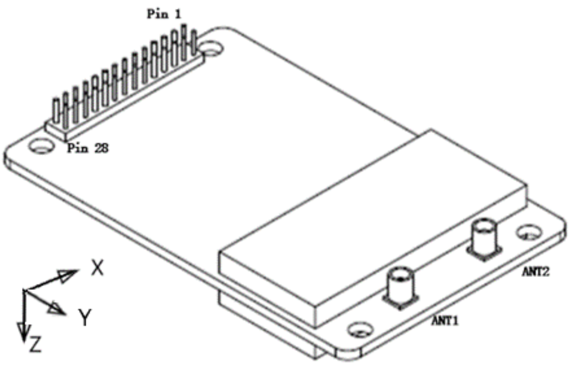


Figure 2-2 CLAP-B7 Mechanical Diagram (unit: mm)



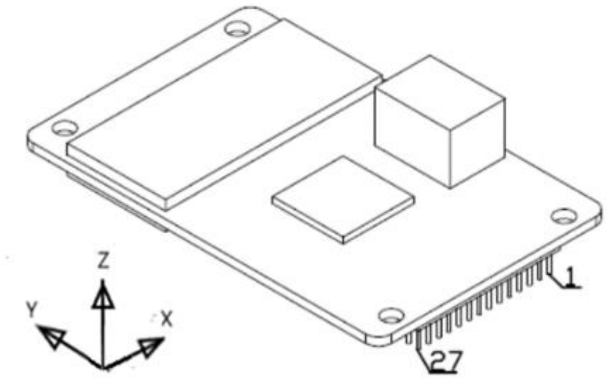


Figure 2-3 CLAP-B7 Axis Definition

Note: ANT1 is the master antenna MMCX interface, ANT2 is the slave antenna MMCX interface. When CLAP-B7 is used as a base station, only connect ANT1; when it is used as a moving base station and provides heading function, the master antenna is connected to ANT1 and the slave antenna is connected to ANT2. By default, the heading information output by the board is the angle from True North to the baseline vector in a clockwise direction. The baseline vector is from ANT1 to ANT2.

2.3 Connector and Pin Definition

The RF interface type of ANT1 and ANT2 on CLAP-B7 is MMCX, model number: MMCX6251N1-3GT30G-50, brand: Amphenol, the digital connector of CLAP-B7 is a dual row pin header (28 pin), model number: CH71283V100, brand: CviLux, PIN pitch: 2.0mm; pin length: 3.9mm; seat thickness: 2.0mm.

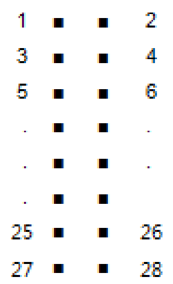


Figure 2-4 Connector Pin Definition

Table 2-2 CLAP-B7 Pin Descriptions

Pin	Signal	I/O	Description	Comments
1	RSV	--	--	--
2	RSV	--	--	--
3	RSV	--	--	--
4	TPO_MID	Power	3.3V LAN Power	Connect to the Center Tap
5	NC	--	--	--
6	VCC	Power	Power input	3.3V ~5VDC
7	RSV	--	--	--
8	RXD3	I	Input received data via COM3	LVTTL
9	RESETIN_N	I	Reset input	LVTTL，low active(>20ms)
10	FRESET_N	I	Restore to factory default settings (user configuration will be reset)	LVTTL, low active (> 5s)
11	EVENT	I	Event input	LVTTL, event widths are greater than or equal to 500ns
12	SPEED/CAN_RX	I	Odometer pulse input/CAN_RX	LVTTL, odometer-pulse input or CAN_RX. Choose one between odometer-pulse input and CAN_RX, and it's required to customize
13	TXD3	O	Output transmitted data via COM3	LVTTL
14	GND	Power	Digital and power ground	
15	TXD1	O	Output transmitted data via COM1	LVTTL
16	RXD1	I	Input received data via COM1	LVTTL
17	GND	Power	Digital and power ground	
18	TXD2	O	Output transmitted data via COM2	LVTTL
19	RXD2	I	Input received data via COM2	LVTTL

Pin	Signal	I/O	Description	Comments
20	GND	Power	Digital and power ground	
21	PV	O	Position valid	LVTTL, high active (RTK FIX is activated when CLAP-B7 works as a rover station) If an LED indicator is required, lead the pin to the anode of the LED diode.
22	GND	Power	Digital and power ground	
23	PPS	O	Pulse per second	LVTTL
24	FOWARD/CAN_TX	I/O	Odometer direction/CAN_TX	Odometer direction, internal pull up, 1: forward 0: backward or CAN_TX, LVTTL. Choose one between odometer direction and CAN_TX, and customization required
25	TPO+	O	Positive electrode of Ethernet sending data, Differential pair.	Connect to TD+
26	TPI+	I	Positive electrode of Ethernet receiving data, Differential pair	Connect to RD+
27	TPO-	O	Negative electrode of Ethernet sending data, Differential pair	Connect to TD-
28	TPI-	I	Negative electrode of Ethernet receiving data, Differential pair	Connect to RD-

Note: pin12, pin24 (CAN function port) and pin25, 26, 27, 28 (Network port) functions cannot be supported at the same time, only one of two is supported. That is, Option 1: pulse odometer and network function can be used at the same time, and CAN function is not supported; Option 2: CAN function is supported, pulse odometer and network function are not supported.

2.4 LED Indicators

There are four LED indicators on the CLAP-B7 board, which represent TXD1 state, power state, GNSS state and INS state respectively.

Table 2-3 CLAP-B7 LED Status Indicators

LED	Colour	Off	On	Flashing Slow (1Hz)	Flashing Fast (>1Hz)
TXD1	Green	No data in TXD1	TXD1 data transmission		
Power	Red	No power	Power on	N/A	N/A
PV (GNSS status)	Green	Waiting for GNSS time	GNSS time is calculating	GNSS position has been solved normally	N/A
INS status	Yellow	Waiting for GNSS time	Connectting to the IMU	INS enters the navigation mode and the solution is normal	Pure inertial extrapolation time (Dr Age) is more than 2 minutes

2.5 Absolute Maximum Ratings

Please note that exceeding the maximum tolerance may cause irreversible damage to the internal components of the product.

Table 2-4 Absolute Maximum Ratings

Item	Pin	Min	Max	Unit
Power Supply (VCC)	Vcc	-0.3	5.5	V
I/O Pin Voltage	--	-0.3	3.6	V
Maximum ESD Stress	VESD (HBM)		±2000	V

2.6 I/O Threshold Characteristics

Talbe 2-5 I/O Threshold Characteristics

Item	Min	Typical Value	Max	Unit	Condition
Low Level Input Voltage	-0.3		0.9	V	
High Level Input Voltage	2.4		3.6	V	
Low Level Output Voltage	0		0.45	V	Iout= 4 mA
High Level Output Voltage	2.85		3.3	V	Iout =4 mA

2.7 Antenna Characteristics

Table 2-6 Antenna Characteristics

Item	Min	Typial Value	Max	Unit	Condition
Antenna Gain	20	30	36	dB	
Antenna Feed	4.75	5	5.25	V	< 100mA

3 Hardware Design

3.1 Design in Considerations

To ensure that CLAP-B7 works properly, the following signals need to be correctly connected:

- provide reliable power supply to VCC pins and connect all the GND pins of the board to ground
- ANT1and ANT2 MMCX interfaces provide 5±0.25V feed, 50 ohm impedance matching of ANT1 and ANT2 is strongly recommended
- Ensure COM1 is connected to the host. COM1 is required for receiving positioning data and upgrading firmware.
- FRESET_N on the board is used to restore factory settings and RESETIN is a fast reset. Please connect correctly to ensure that the board can be reset reliably.

Pay attention to the following items in the design to obtain good performance:

- Power supply: stable and low ripple power is necessary for good performance. Peak to peak valude of the ripple voltage should be less than 50mVpp. In addition to using LDO to ensure the purity of power supply, it also needs to be considered as follows:
  - Widen power supply wiring or use partitioned copper surface to transmit the current
  - Layout LDO as close as possible to the board
  - Avoid walking through the high–power or high inductance devices such as magnetic coil.
- UART interfaces: ensure that the signals and baud rate of the main equipment are consistent with that of CLAP-B7 card.

- The antenna line should be as short and smooth as possible, avoid sharp bends or angles and pay attention to impedance matching
- Avoid circuitry running directly below CLAP-B7
- Keep the board as far away from the high-power high-temperature air and heating devices as possible.

3.2 CLAP-B7 Reference Design

The reference design of CLAP-B7 CAN is as follow:

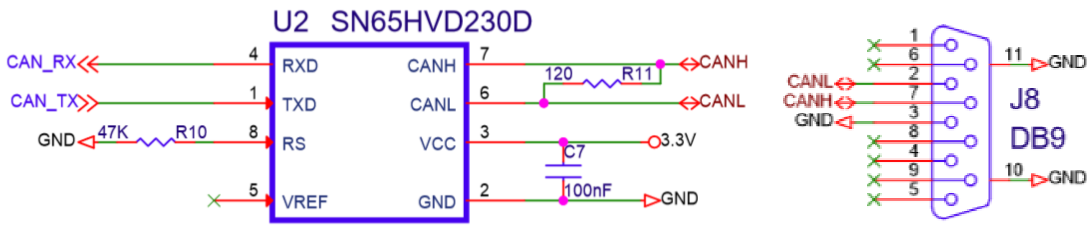


Figure 3-1 CLAP-B7 CAN Reference Design

The reference design of CLAP-B7 LAN is as follow:

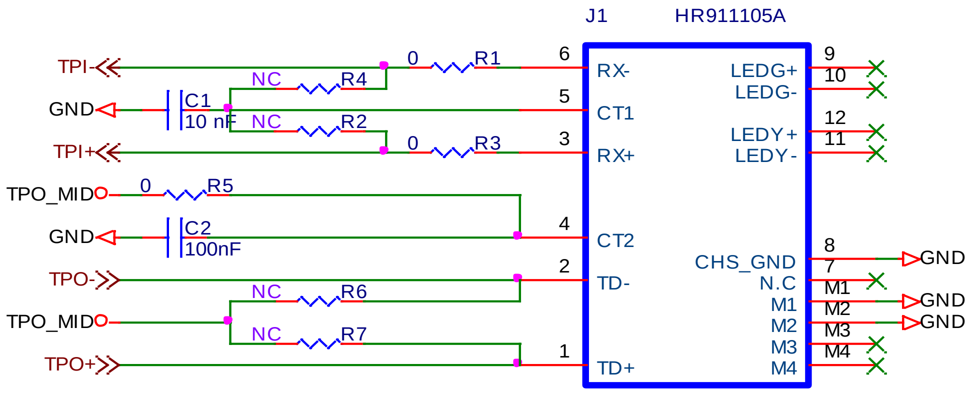


Figure 3-2 CLAP-B7 LAN Reference Design

Note: R2, R4, R6 and R7 are used for reserved impedance matching. Normally, no welding is required.

3.3 Pins

Table 3-1 Notes for Pins

	Pin	I/O	Description	Notes
Power Supply	VCC	Power	Power supply	Stable, pure and low ripple power, the peak-to-peak value of the ripple voltage should not exceed 50mVpp
	ANT1/ANT2	Power	Antenna power supply	Power supply for active antennas
	GND	Power	Ground	Connect all the GND signals to ground. Better use copper pour surface.
UART	TXD1	O	Transmit data via COM1	COM1 output, leave unconnected if not used
	RXD1	I	Receive data via COM1	COM1 input, leave unconnected if not used
	TXD2	O	Transmit data via COM2	COM2 output, leave unconnected if not used
	RXD2	I	Receive data via COM2	COM2 input, leave unconnected if not used
	TXD3	O	Transmit data via COM3	COM3 output, leave unconnected if not used
	RXD3	I	Receive data via COM3	COM3 input, leave unconnected if not used
System	FRESET_N	I	Restore factory default settings	External reset signal, LVTTL, low active. That is, first keep the high level, pull it low for more than 5s, and then pull it high to restore the factory settings. Pull up if not used.
	RESETIN_N	I	Hardware Reset	External reset signal, LVTTL, low active, keep it greater than 20ms. Leave unconnected if not used

3.4 Antenna

The antenna input interfaces of CLAP-B7 board, which contain ANT1 and ANT2 MMCX interface, provide antenna feeding of 5±0.25V. Pay attention to 50 ohm impedance matching when the CLAP-B7 board connects to active antennas.

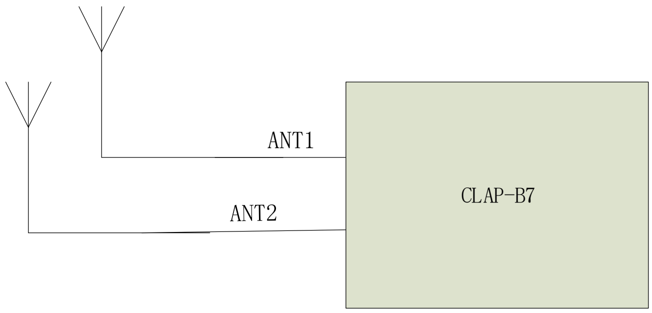


Figure 3-3 CLAP-B7 Antenna Connection Diagram

Note: since the antenna feed output of ANT1 and ANT2 on the CLAP-B7 board card has no short-circuit protection, special attention shall be paid to avoid short circuit during the installation and testing, and please do not plug and unplug the antenna when CLAP-B7 is powered on.

4 Installation and Configuration

4.1 ESD Handling Precautions

CLAP-B7 is an ESD sensitive device and requires special precautions when handling.

- Electrostatic discharge may cause damages to the device. All operations mentioned in this section shall be carried out on an antistatic workbench, using an antistatic wristband and a conductive foam pad. If the antistatic workbench is not available, wear an antistatic wrist strap and connect the other end to a metal frame for the anti-static protection
- Hold the edge of the board, and do NOT directly touch the electronic components

Please check carefully whether the components are excessively loose or are damaged when taking out the card.

4.2 Installation Guide

The user can assemble CLAP-B7 flexibly according to the application scenarios and market needs. The following figure shows a typical installation of the CLAP-B7 using the Evaluation Kit (EVK).

Please prepare the following items before installing the equipment to complete the installation quickly.

- CLAP-B7 EVK suite (or evaluation board)
- User manual
- *Unicore Reference Commands Manual for High Precison GNSS Board and Module_V2_R2.9* and CLAP-B_ Commands and Logs Reference Book.
- UPrecise software
- Qualified GNSS antennas
- Cables connectting MMCX Interfaces to GNSS Antennas
- PC or Laptop with serial ports (Windows 7 and above), with UPrecise installed

For users using the CLAP-B7 evaluation kit, align CLAP-B7 positioning holes and pins with EVK.

Note: If the EVK connector hole is 24-pin, connect the middle 24 pins of the board with the connector). EVK provides power supply and standard communication interfaces to the board to communicate with peripheral devices, such as PC, CAN and USB devices, etc.

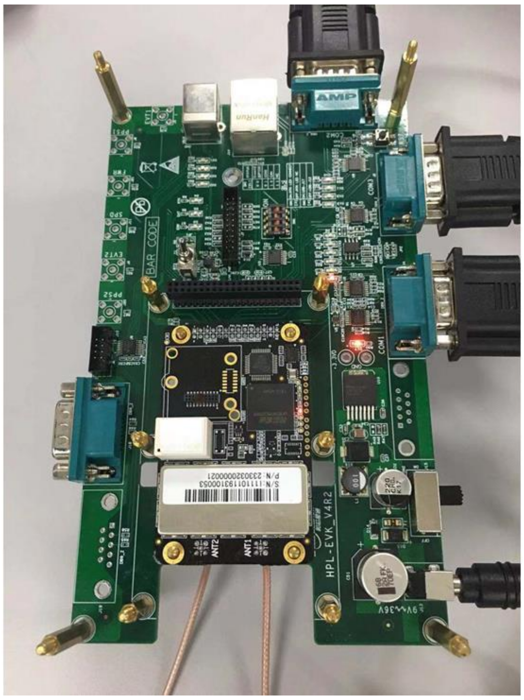


Figure 4-1 CLAP-B7 Board and Evaluation Kit（EVK）

Note:

The RF connector of the board is MMCX, and please select the appropriate cable according to the packaging. The input signal gain of the antenna connector shall be within 25 to 36dB. Plug and unplug the MMCX RF head vertically, and the number of this operation is limited. Improper plugging or unplugging will lead to the damage of RF head or MMCX male connector head.

Since the antenna feed output of ANT1 and ANT2 on the CLAP-B7 board has no short-circuit protection, special attention shall be paid to avoid short circuit during the installation and testing, and please do not plug and unplug the antenna when CLAP-B7 is powered on.

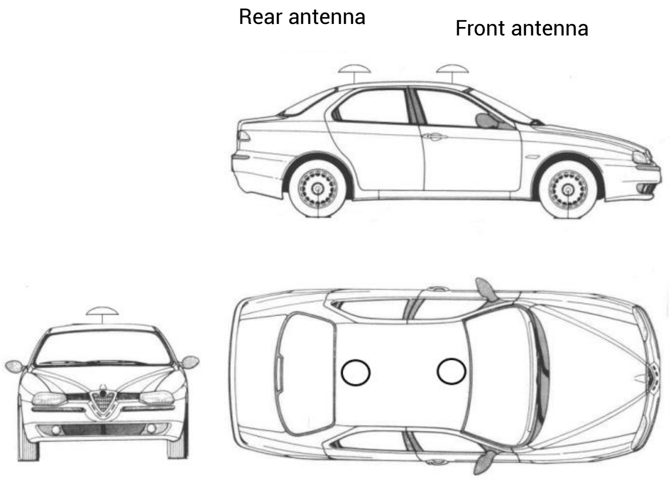


Figure 4-2 CLAP-B7 Antenna Installation Schema

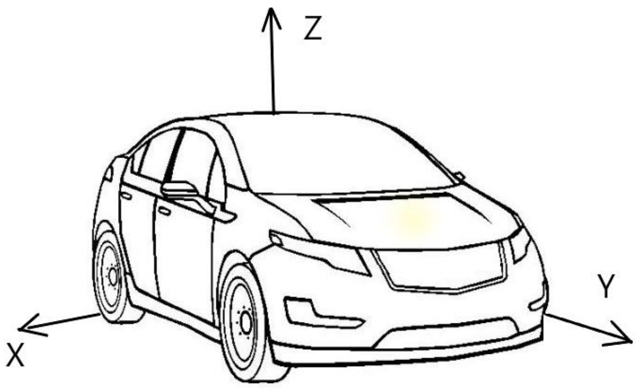


Figure 4-3 Carrier Coordinate System Schema

1. First, mount the CLAP-B7 and two measurement antennas on the carrier as shown in Figure 4-2. In order to maximize positioning and attitude accuracy, and minimize the risk of damage, the antenna should be firmly mounted on a stable structure that will not sway or collapse. Choose a position as broad as possible so that each satellite above the horizon can be tracked without being obstructed. At the same time, the antenna should be installed at a position with less multipath interference.

When installing the antenna, the ANT1 interface on the CLAP-B7 board corresponds to the master antenna, and the ANT2 interface corresponds to the slave antenna.

2. Refer to Figure 4-3 for the carrier coordinate system when installing the CLAP-B7. The Y direction is the carrier's moving direction, the X direction is the right-hand side direction perpendicular to the moving direction, and the XYZ axis is orthogonal, following the right-hand criterion. The XYZ axis of the CLAP-B7 board should coincide with the carrier coordinate system XYZ. Ensure that the CLAP-B7 is installed firmly and reliably during the operation. Its relative position with respect to the carrier and the phase center of the antenna is constant, and will not be affected by the carrier's dynamical change.
3. Connect the CLAP-B7 board to the two measuring antennas through antenna cables according to Figure 4-4, and connect to the serial port and differential radio (or other differential link) of the laptop through the data cable.
4. Start UPrecise installed on the laptop and connect receiver through the software.
5. Connect 12VDC power adapter to EVK power supply and power up CLAP-B7 board.
6. Operate on CLAP-B7 via UPrecise and record relevant data.
7. Set the parameters of the master and slave antenna arm according to section 5.7 and 5.8 after CLAP-B7 is assembled.
8. Refer to chapter 5 for other relevant instruction configurations, such as extrapolation time, alignment speed threshold, etc.

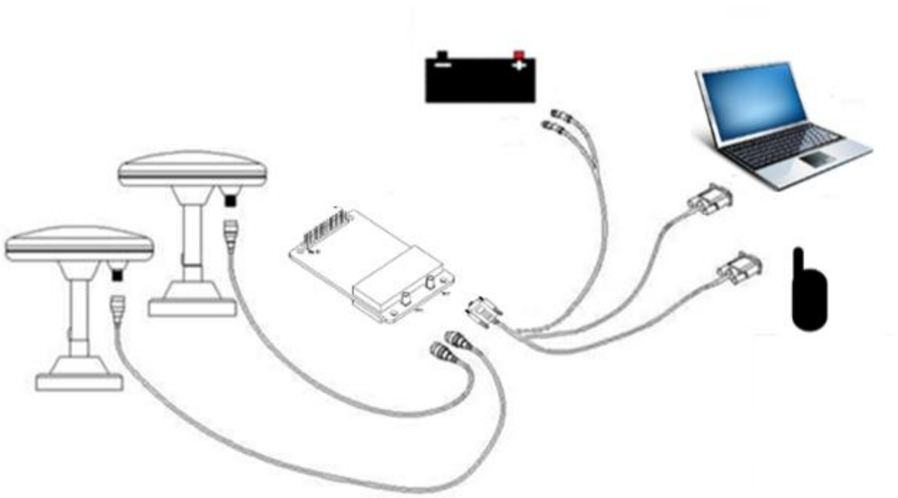


Figure 4-4 CLAP-B7 Connection Diagram

4.3 Configuration and Output

Unicore UPrecise software provides a graphical interface to control and display the operation of the receiver. The features of UPrecise software include:

- Connect to the receiver and configure the baud rate, etc.
- Display the approximate position of satellite, PRN, and Signal/Noise Ratio in a graphical window (Constellation View)
- The trajectory window of the present and historical points, and display the position, velocity and time (Trajectory View)
- Graphic interface for data logging, and send commands to the receiver (Logging Control View)
- Console window for sending commands to the receiver (Console View)
- Display the track points
- TTFF test

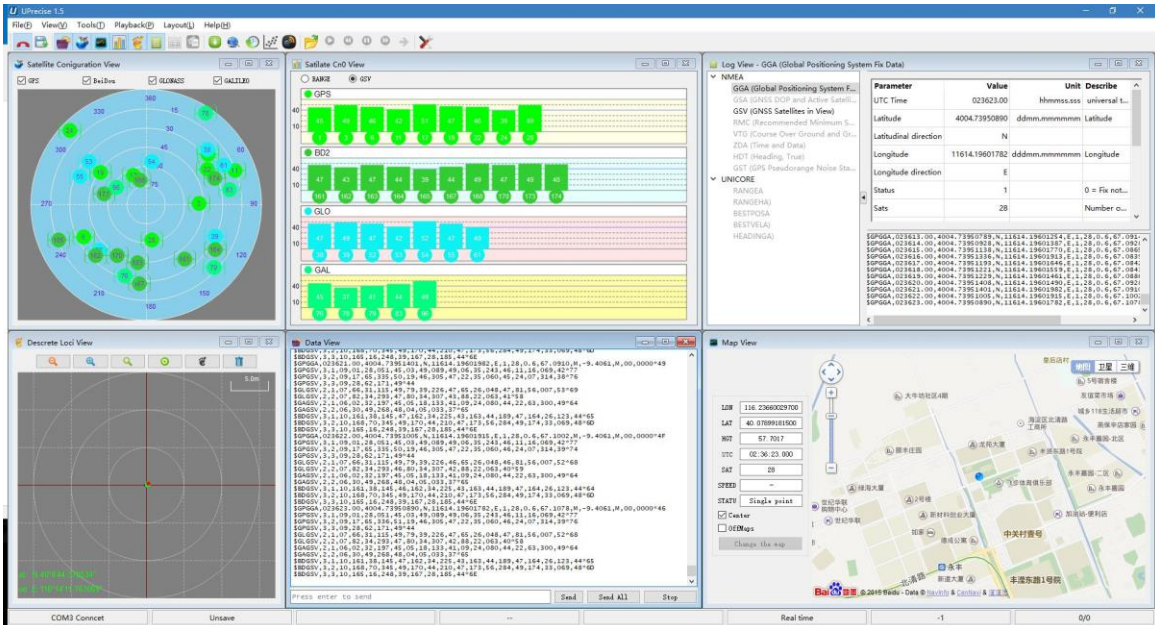


Figure 4-5 UPrecise Overview

4.4 UPrecise Operating Steps

1. Install the devices according to the section 4.2 Installation Guide and power up.

2. Click “file - > connect”. Set the baud rate.

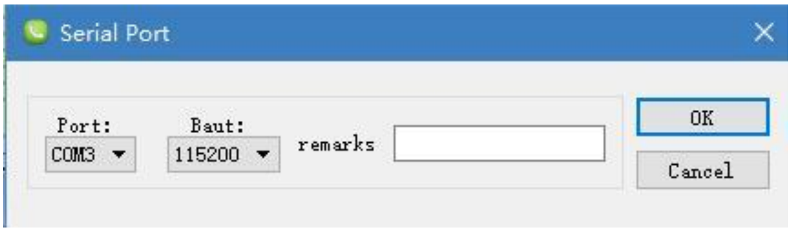


Figure 4-6 Serial Port Configuration

3. Click the “receiver settings” button to configure the NMEA message output. It is recommended to configure GPGGA, GPGSV, and other statements. Or in the dialog window, click on "Send all Message" to complete all the NMEA message output (1Hz for default update rate). In the data session window, right click to adjust font size of output log, stop/restore log outputs, or clear logs.

4. View and use various views of UPrecise and configure or input commands as required.

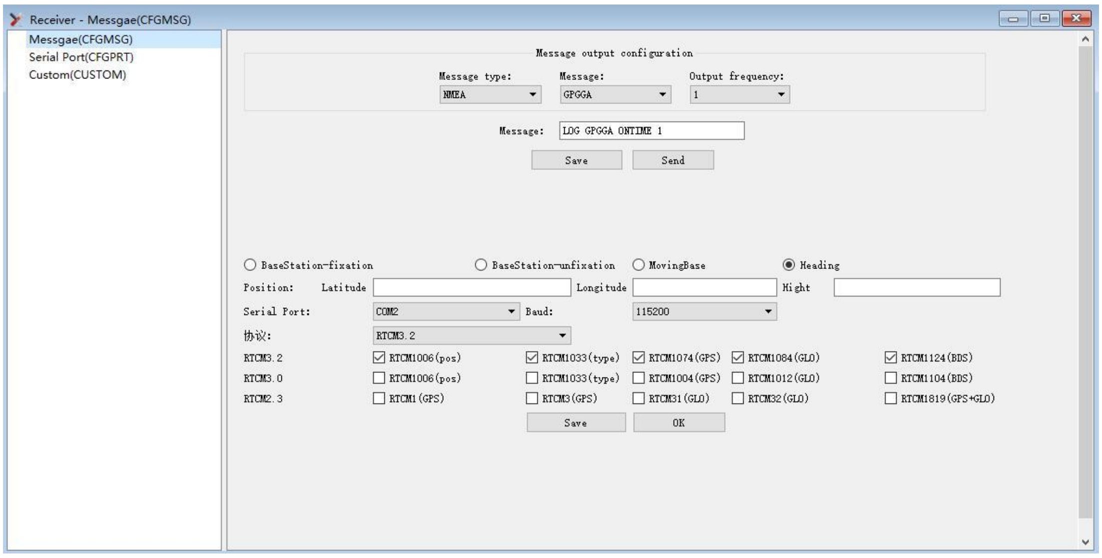


Figure 4-7 Receiver Settings

5 Configuration Commands

This chapter only lists the default common configuration commands of CLAP-B7. For other setting commands, please refer to *Unicore Reference Commands Manual for High Precison GNSS Board and Module_V2_R2.9*. The functions of base station, moving base station, Heading2, and standalone positioning of the slave antenna require custom authorization before use. The general version of CLAP-B7 does not include these four functions. CLAP-B7 supports simplified ASCII format. Simplified ASCII format without checksum bits makes it easier for users to enter commands. All commands consist of a command header and configuration parameters (if the parameter field is empty, the command has only one header), and the header field contains the command name or header. Common commands are shown in the following table:

Table 5-1 Common Instructions

Command	Description
freset	Restore factory defaults
version	Query the hardware version, firmware version of the receiver
config	Query the serial port status of receiver
mask BDS	Disable the BDS satellite system BDS, GPS, GLO, and GAL can be disabled respectively
unmask BDS **unmask**	Enable the BDS satellite system BDS, GPS, GLO, GAL can be enabled respectively; the receiver tracks all satellite systems by default
config com1 115200	Set com1 baud rate as 115200 Com1, com2 and com3 can be set respectively as any one of following: 9600, 19200, 38400, 57600, 115200, 230400,460800,921600
unlog	Disable all output from the current serial port
saveconfig	Save configuration to NVM (nonvolatile memory)
Base/Rover Station Configurations	
mode rover	Rover mode by default
NMEA0183 Output Message	

Command	Description
gpgga comx 1	Set the output frequency of GGA message as 1 Hz Message type and update rate can be set; 1, 0.5, 0.2 and 0.1 correspond to output frequency of 1Hz, 2Hz, 5Hz and 10Hz respectively; Message types include GGA, RMC, ZDA, VTG and NTR
gphdt comx 1	Output current heading information Heading information includes: HDT, TRA
INS Configuration	
CONFIG INS ENABLE	Enable INS
CONFIG INS DISABLE	Disable INS
CONFIG IMUTOANT OFFSET x y z [a] [b] [c]	set the lever arm for the master GNSS antenna， x/y/z is the offset along the direction of X/Y/Z， a/b/c is the error of offset， units are all meters.
CONFIG IMUTOANT2 OFFSET x y z [a] [b] [c]	set the lever arm for the slave GNSS antenna， x/y/z is the offset along the direction of X/Y/Z， a/b/c is the error of offset， units are all meters.
CONFIG INSSOL OFFSET xoffset yoffset zoffset	Set the offset from the IMU for the output position and velocity of the INS solution，xoffset/yoffset/zoffset is the offset along X /Y /Z， unit: meter.
CONFIG INS AZIMUTH azimuth azSTD	Initial heading angle and STD configuration， azimuth is the initial INS heading， azSTD is the standard deviation of heading angle, unit: deg
CONFIG INS ATTITUDE pitch roll azimuth pitchSTD rollSTD azSTD	For initial attitude angles and STD configuration, pitch, roll and azimuth are INS initial pitch, roll and heading angles, pitchSTD, rollSTD and azSTD are standard deviation of pitch error, roll error and heading err respectively, unit: degree
LOG configuration for IE post-processing	
Log rangeb ontime 1	Output 1Hz GNSS original observation information

Command	Description
Log rawimuxb ontime 0.01	Output 100Hz IMU original observation information
Log gpsephemb ontime 1800	Output GPS ephemeris data
Log bdsephemerisb ontime 1800	Output BDS ephemeris data
Log gloephemerisb ontime 1800	Output GLONASS ephemeris data
Log galephemerisb ontime 1800	Output Galileo ephemeris data
Saveconfig	Save configuration to NVM (nonvolatile memory)

5.1 RTK Rover Configuration

RTK rover station receives differential correction data sent from reference stations. CLAP-B7 can adaptively identify RTCM data input interface and format, and receive satellite signals for RTK positioning calculation to achieve RTK high-precision positioning. Common commands for RTK rover station configurations are as follows:

log gpgga ontime 1//GPGGA output 1Hz

saveconfig

5.2 Heading Configuration

The GNSS heading is the angle from TRUE north of the master antenna to slave antenna vector in a clockwise direction. CLAP-B7 supports directional output by default. The common instructions are as follow:

gphdt com1 1 // ghpdt 1Hz output

saveconfig

5.3 Configure INS Devices to Be Enabled

This section describes receivers with integrated on-board MEMS chips. The INS function of CLAP-B7 is enabled by default setting.

When the enable command of the inertial navigation is sent to the receiver and the receiver responds correctly, the inertial navigation device starts to work. If only a single antenna is connected, the receiver enters the GNSS+INS joint positioning mode when the receiver's attitude angles are initialized by command or the carrier's movement speed reaches the initialization speed threshold or higher. If dual antennas are connected, when the receiver's attitude angles are initialized by commands, or the dual antenna lever arms are properly configured and the direction finding and position function of dual antennas in the static scene perform normally, the inertial navigation system alignment is completed and the receiver enters the GNSS+INS joint positioning mode. After the inertial navigation device is enabled, the receiver and the carrier must be firmly connected.

Command Format:

CONFIG INS [parameter]

Abbreviated ASCII Syntax:

CONFIG INS ENABLE

Table 5-2 INS Configuration

Log Header	Device	Parameter	Description
CONFIG	INS	Enable	Enable INS:CONFIG INS ENABLE
		Disable	Disable INS:CONFIG INS DISABLE

5.4 Configure INS Device Installation Angles

This command is used to set the installation angles of the board, which is relative to the vehicle's XYZ direction. It is required that the XYZ axis of the receiver inertial device must be consistent with the vehicle.

Command Format:

CONFIG INS ANGLE [parameter]

Abbreviated ASCII Syntax:

CONFIG INS ANGLE 0 9000 18000// The Y axis of the inertial navigation module is rotated 90 degrees with respect to the Y axis of the carrier coordinate (right-handed spiral), and the Z axis of the inertial navigation module is rotated 180 degrees with respect to the Z axis of the carrier coordinate (right-handed spiral)

Table 5-3 INS Installing Angle Configuration

Log Header	Device	Angle	Number	Parameter	Description
CONFIG	INS	ANGLE	1	ANGLEX	Rotation angle from vehicle X-axis to INS module X-axis (right-handed coordinate system), unit: 0.01 degree, range: 0-36000
			2	ANGLEY	Rotation angle from vehicle Y-axis to INS module Y-axis (right-handed coordinate system), unit: 0.01 degree, range: 0-36000
			3	ANGELZ	Rotation angle from vehicle Z-axis to INS module Z-axis (right-handed coordinate system), unit: 0.01 degree, range: 0-36000

5.5 Configure INS Timeout

This command is used to set the output duration of INS system when losing GNSS signals, in seconds.

Command Format:

CONFIG INS TIMEOUT [parameter]

Abbreviated ASCII Syntax:

CONFIG INS TIMEOUT 60

Table 5-4 INS Maximum Prediction Time Configuration

Log Header	Device	Field	ASCII Value	Description
CONFIG	INS	TIMEOUT	1-1000	Time to continue positioning after losing GNSS satellite signals (UM, UB series boards, default value=200, (CLAP-B default=300), seconds
			> 1000	Non-recommended value

5.6 Configure INS Alignment Velocity Threshold

This command sets the speed threshold for inertial navigation alignment. When the receiver is only connected to a single antenna, if the carrier's operating speed is lower than this threshold, the inertial navigation system cannot complete the alignment and the integrated navigation function cannot be enabled; When the receiver is connected to dual antennas, configure the dual antenna lever arms properly, and the direction finding and position function of dual antennas in the static scene are performed normally, and then the inertial navigation system complete the alignment, and the speed threshold no longer takes effect.

Command Format:

CONFIG INS ALIGNMENTVEL [parameter]

Abbreviated ASCII Syntax:

CONFIG INS alignmentvel 5.0

Table 5-5 INS Velocity Threshold Configuration

Log Header	Device	Field	ASCII Value	Parameters Description
CONFIG	INS	alignmentvel	velocity	Set the velocity threshold of INS calibration speed, unit: meters/second, default threshold: 5m/s

5.7 Configure Lever Arm between IMU & Master Antenna

This command is used to input the offset between IMU and the phase center of GNSS master antenna, that is, the lever arm distance from INS to the master antenna. The measurement of the lever arm parameters should be as accurate as possible, especially in the RTK mode, and the error should be within 1mm. Any error in the lever arm parameters will be transferred into the error of the INS position. X, Y and Z represent the vectors from the IMU to the phase center of the master antenna. Fields a, b, and c are used to input any possible errors in the measurement. For example, if the offset 'X' is measured in centimeters, enter 0.01 in the 'a' field.

The IMU should be positioned as close to the GNSS master antenna as possible in the horizontal direction to improve the accuracy.

Command Format:

CONFIG IMUTOANT OFFSET x y z [a] [b] [c]

Abbreviated ASCII Syntax:

CONFIG IMUTOANT OFFSET 0.54 0.32 1.20 0.03 0.03 0.05

Table 5-6 Set IMU to Master Antenna Offset

Log Header	Field	Parameters Description
CONFIG IMUTOANT OFFSET	X	X offset, unit: m, range:-100~100;
	Y	Y offset, unit: m, range:-100~100;
	Z	Z offset, unit: m, range:-100~100;
	a	Error of the X-axis offset, unit: meter, range: 0.01~10; 0.01m defaults to the minimum value for 10% of the X-axis offset
	b	Error of the Y-axis offset, unit: meter, range: 0.01~10; 0.01m defaults to the minimum value for 10% of the Y-axis offset
	c	Error of the Z-axis offset, unit: meter, range: 0.01~10;0.01m defaults to the minimum value for 10% of the Z-axis offset

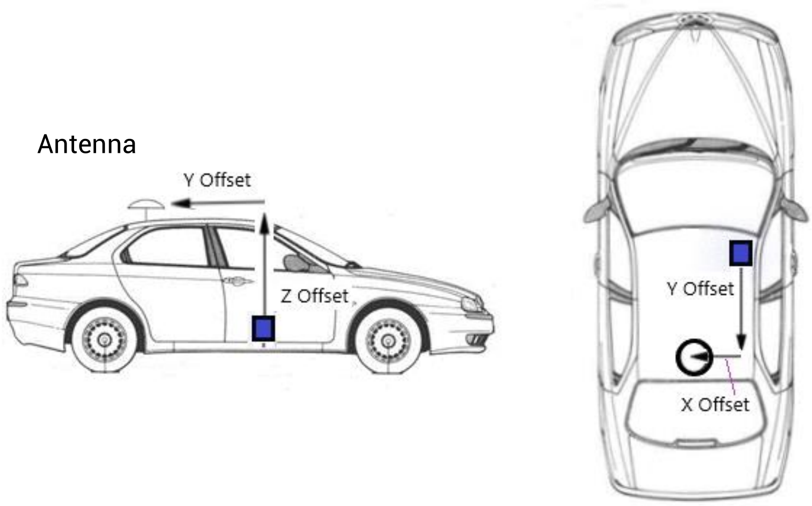


Figure 5-1 IMU to Antenna Offset

When proceeding the installation per Figure 5-1, the offset is –X, -Y, -Z.

5.8 Configure Lever Arm between IMU & Slave Antenna

This command is used to input the offset between IMU and the phase center of GNSS slave antenna, that is, the lever arm parameters from INS to the slave antenna. The measurement of the lever arm parameters should be as accurate as possible, especially in the RTK mode; the error should be within 1 mm. Any error in the lever arm parameters will be transferred into the error of the INS position directly. X, Y and Z represent the vectors from IMU to the phase center of the slave antenna. Fields a, b, and c are used to input any possible errors in the measurement. For example, if the offset 'X' is measured in centimeters, enter 0.01 in the 'a' field.

In general, the master GNSS antenna is installed behind the forward axis (Y-axis) of IMU, and the slave GNSS antenna is installed in front of the forward axis (Y-axis) of IMU. When inputting the lever arm parameters of both the master GNSS antenna and the slave GNSS antenna, the receiver will calculate the angular deviation between the Y-axis of IMU and the baseline of the dual antennas. The command format is similar to that of command CONFIG IMUTOANT OFFSET.

Command Format:

CONFIG IMUTOANT2 OFFSET x y z [a] [b] [c]

Abbreviated ASCII Syntax:

CONFIG IMUTOANT2 OFFSET 0.24 0.32 1.20 0.03 0.03 0.05

Table 5-7 Set IMU to Slave Antenna Offset

Log Header	Field	Parameters Description
CONFIG IMUTOANT2 OFFSET	X	X offset, unit: m, range:-100~100;
	Y	Y offset, unit: m, range:-100~100;
	Z	Z offset, unit: m, range:-100~100;
	a	Error of the X-axis offset, unit: meter, range: 0.01~10; 0.01m defaults to the minimum value for 10% of the X-axis offset
	b	Error of the Y-axis offset, unit: meter, range: 0.01~10; 0.01m defaults to the minimum value for 10% of the Y-axis offset

Log Header	Field	Parameters Description
	c	Error of the Z-axis offset, unit: meter, range: 0.01~10; 0.01m defaults to the minimum value for 10% of the Z-axis offset

5.9 Configure INS Output Position Offset

The command CONFIG INS OFFSET is used to set the position offsets of IMU, when INS position and velocity are output. This command offsets the values output by INSPVA relative to the IMU coordinate axis, in meters.

Command Format:

CONFIG INSSOL OFFSET xoffset yoffset zoffset

Abbreviated ASCII Syntax:

CONFIG INSSOL OFFSET 0.15 0.15 0.25

Table 5-8 Configure INS Output Position Offset

Log Header	Field	Parameters Description
CONFIG INSSOL OFFSET	X offset	X-axis offset, unit: meter, range: -100~100
	Y offset	Y-axis offset, unit: meter, range: -100~100
	Z offset	Z-axis offset, unit: meter, range: -100~100

5.10 Configure Initial Azimuth and STD of INS

The command CONFIG INS AZIMUTH is used for the initial azimuth and STD configuration. This command can take the azimuth obtained through other approaches as the initial alignment azimuth to input. The azimuth is the weakest component of a coarse alignment and is also the easiest to know from an external source. To obtain good system performance, the azimuth value must be accurate when inputting it. Sending the command CONFIG INS AZIMUTH resets the composite filter, which may take at least 30 seconds to realign. However, it still takes some time and vehicle maneuverability to converge the combined filter, before which, the system performance is poor.

Command Format:

CONFIG INS AZIMUTH azimuth azSTD

Abbreviated ASCII Syntax:

CONFIG INS AZIMUTH 90 5

In this example, the initial azimuth is set to 90 degrees, which means the Y axis of CLAP points east, within a standard deviation of five degrees .

Table 5-9 Configure INS Initial Azimuth and Standard Deviation

Log Header	Field	Parameters Description
CONFIG INS AZIMUTH	azimuth	Initial azimuth of INS, unit: degree, range: 0~360. (north by east is positive）
	azSTD	Standard deviation of azimuth, unit: degree，range: 0.0002778 ~45. (0.0002778 degrees are about one arcsecond)

5.11 Configure Initial Attitude Angles and STD of INS

The command CONFIG INS AZIMUTH is used for the initial attitude angles and STD configuration. The pitch, roll and azimuth obtained via other approaches can be used as the initial alignment attitude angles input through this command, and the coarse alignment is not proceeded when completing alignment process with this command.

The considerations and special conditions for this command are listed below.

1 The alignment must be instantly entered. This command enables the system to start faster and enter the navigation mode. However, the input value must be accurate, otherwise the system performance will be affected.

2 If it is unsure of the input angle, increase the STD value of the input angle.

3 Sending the command CONFIG INS ATTITUDE resets the composite filter, and the command takes effect immediately. But it still takes some time and vehicle maneuverability to converge the combined filter, before which, the system performance is poor.

Command Format:

CONFIG INS ATTITUDE pitch roll azimuth pitchSTD rollSTD azSTD

Abbreviated ASCII Syntax:

CONFIG INS ATTITUDE 0 0 90 5 5 5

In this example, the initial pitch and roll are set to 0 degree, the initial azimuth is set to 90 degrees, within a standard deviation of five degrees. This means that CLAP-B7 is basically mounted horizontally with the Y axis pointing east, which is within the standard deviation of five degrees.

Table 5-10 Configure INS Initial Attitude and Standard Deviation

Log Header	Field	Parameters Description
CONFIG INS ATTITUD	pitch	The initial pitch of INS, unit: degree, range: -90~90. (along the X-axis, the right-hand spiral is positive）
	roll	The initial roll of INS, unit: degree, range: -90~90. (along the Y-axis, the right-hand spiral is positive）
	azimuth	The initial azimuth of INS, unit: degree, range: 0~360. (north by east is positive)
	pitchSTD	Standard deviation of the pitch, unit: degree, range: 0.0002778 ~45
	rollSTD	Standard deviation of the roll, unit: degree, range: 0.0002778 ~45
	azSTD	Standard deviation of the azimuth, unit: degree, range: 0.0002778~45. (0.0002778 degrees is about one arcsecond)

6 Firmware Upgrade

UC_ComDownload is designed for the firmware upgrade of CLAP-B7. It is recommended to upgrade the firmware through COM1.

Step 1. Double click “UC_ComDownload.exe”, as shown below:

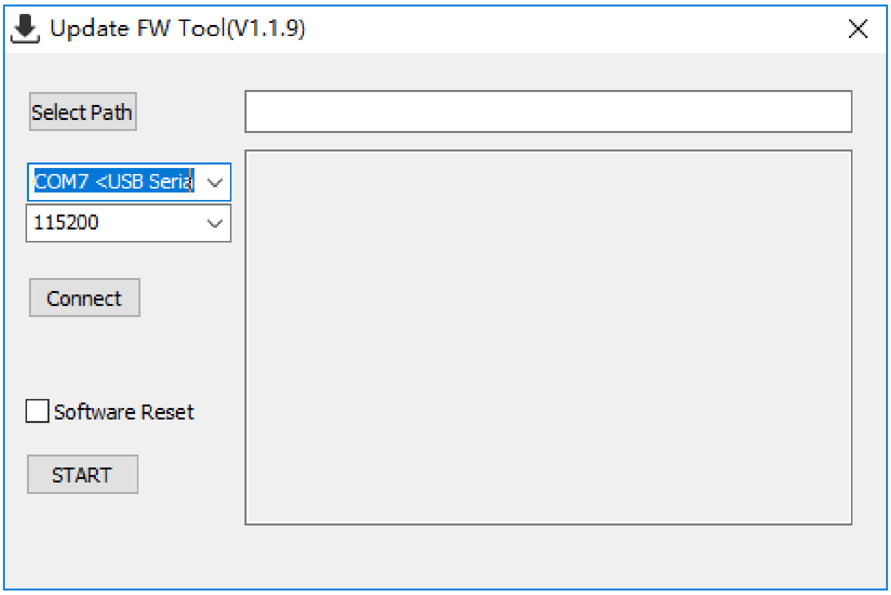


Figure 6-1 Open UC_ComDownload

Step 2. Click “Selet Path” and choose the firmware storage location.

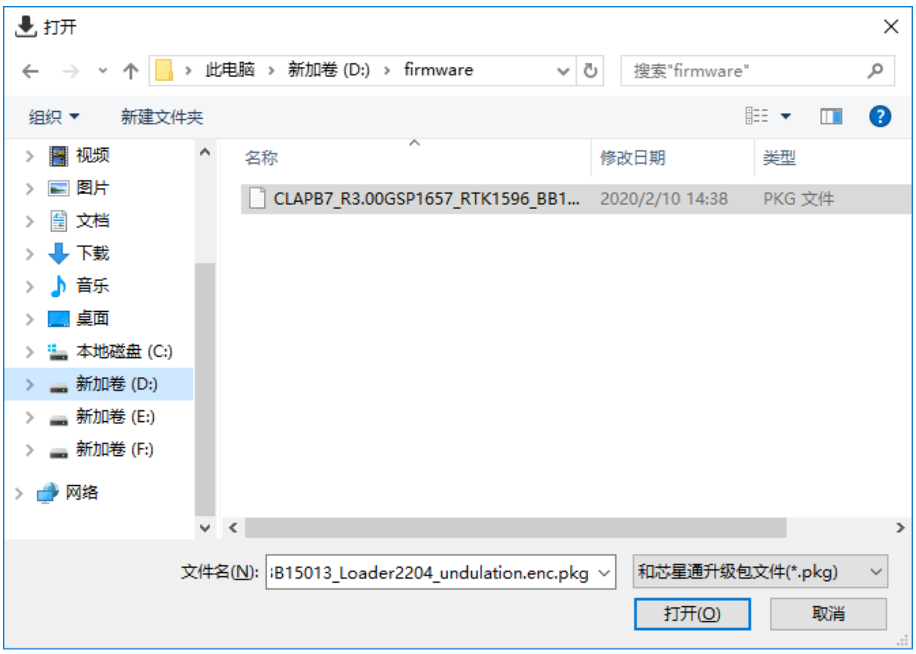


Figure 6-2 Specify the Firmware Storage Path

Step 3. Select the serial port and set the baud rate, 460800bps is recommended.

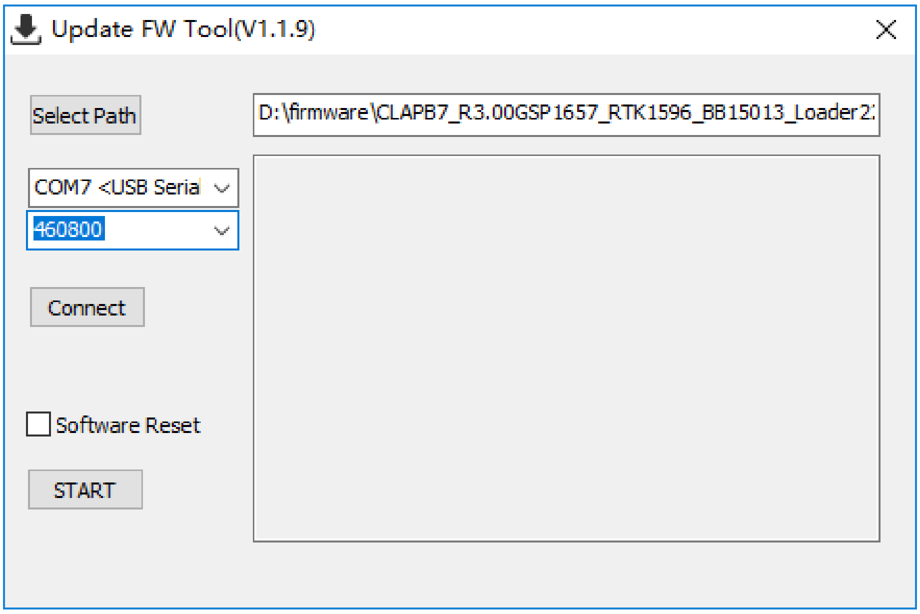


Figure 6-3 Set the Serial Port and Baud Rate

Note: COM1 is recommended for Firmware upgrade.

Step 4. Click "Connect" and the following dialogs pop up.

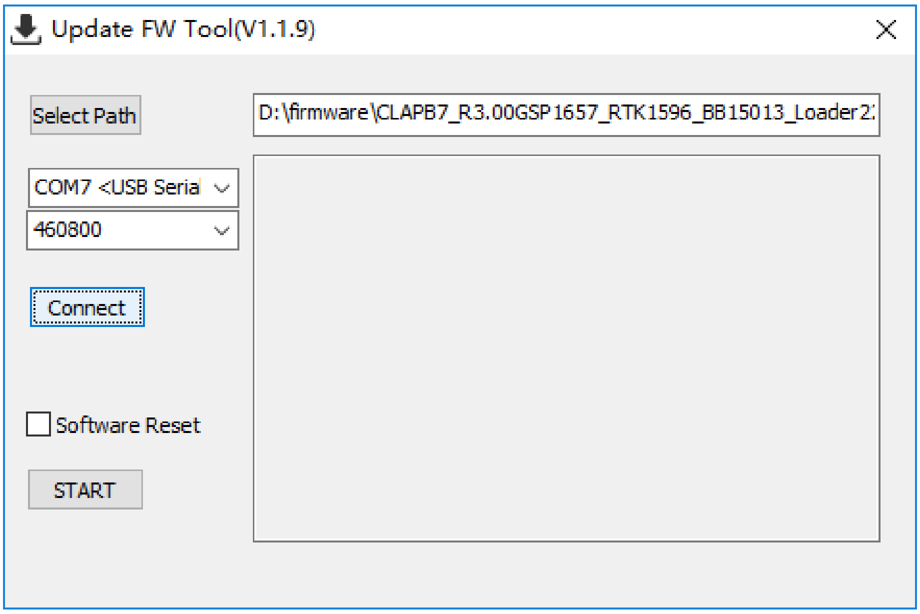


Figure 6-4 Click "Connect"

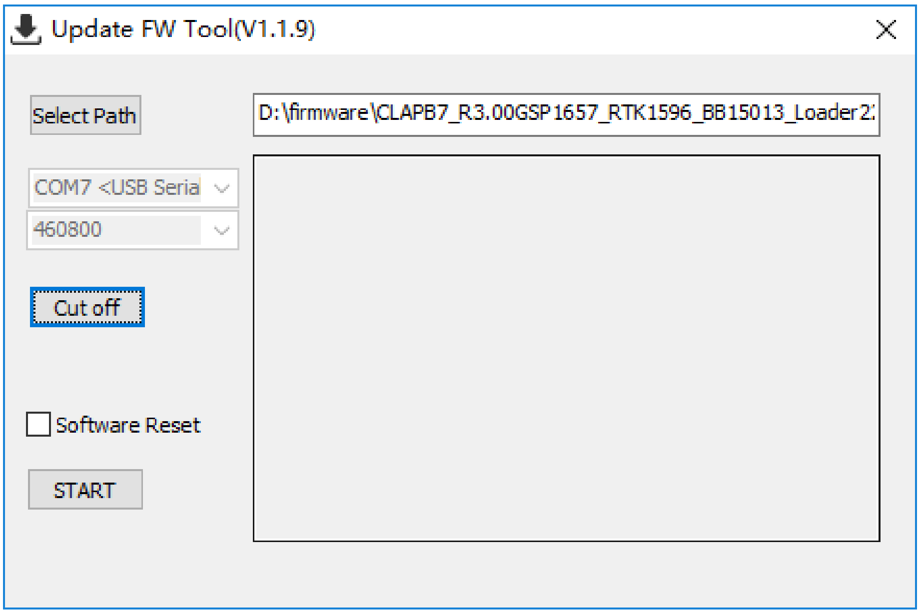


Figure 6-5 Connection succeeded

Step 5. Check “Software Reset”, then click “START”, the dialog shown in the Figure 6-7 Click “START” pops up. Power up the board and the dialog shown in the Figure 6-8 Firmware Upgradinng pops up.

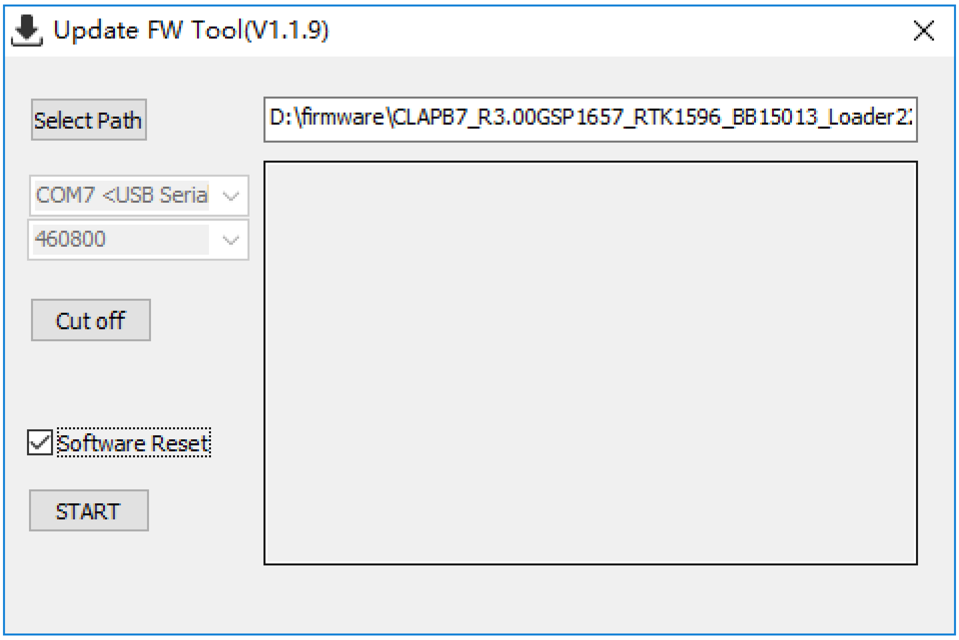


Figure 6-6 Select “Software Reset”

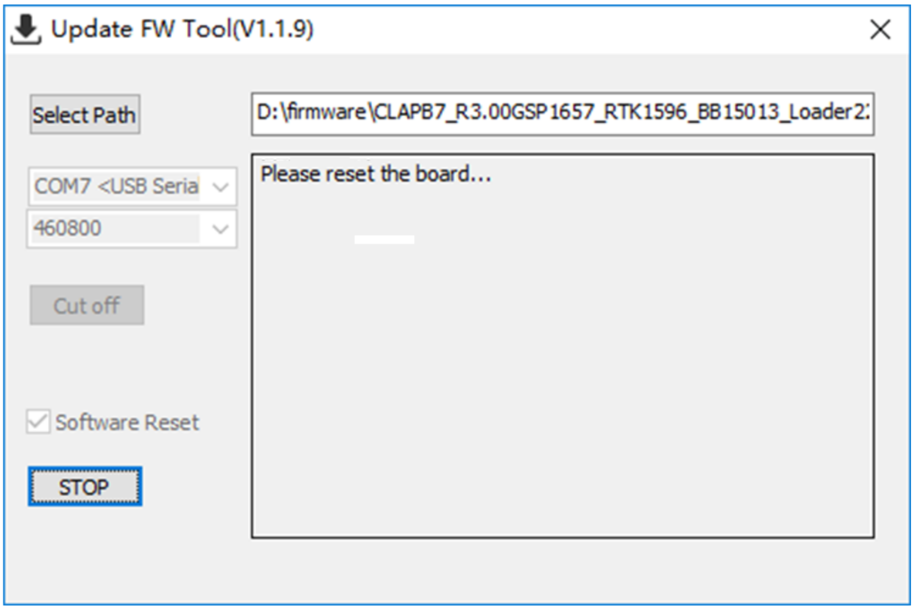


Figure 6-7 Click “START”

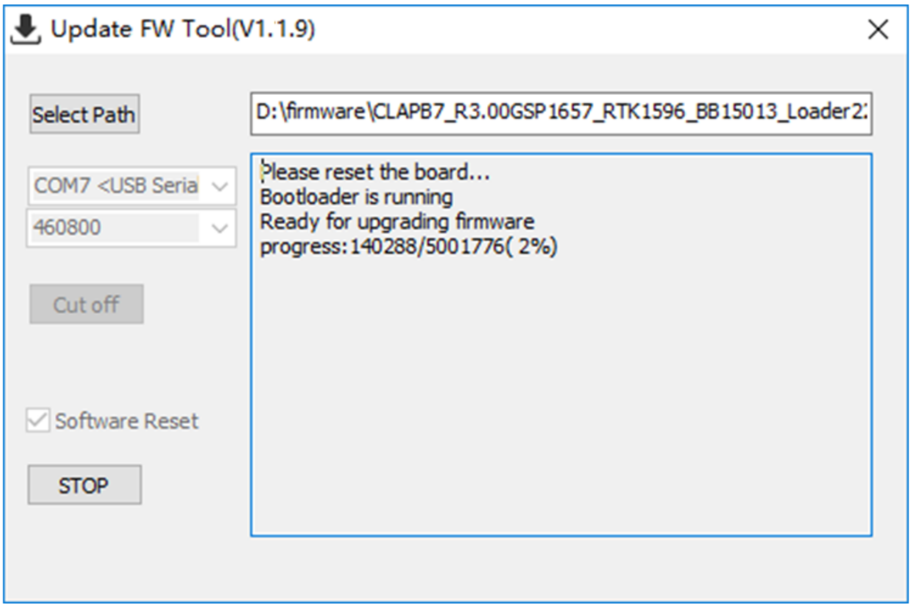


Figure 6-8 Firmware Upgradinng

Step 6. Wait for the dialog to display "Upgrade completed", then the firmware upgrade is completed. The user can send the command "versiona" to query the version number through the serial port to verify whether the upgrade was successful.

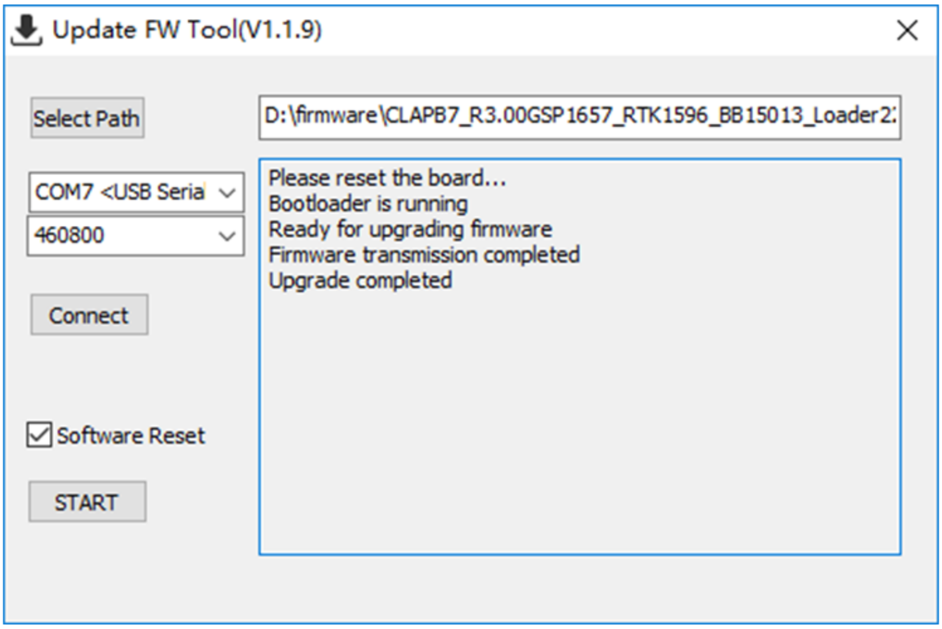


Figure 6-9 Firmware Upgrade Completed

7 Common Commands Setup

This chapter describes the default common commands of CLAP-B7. For more commands and details, refer to *Unicore Reference Commands Manual for High Precison GNSS Board and Module_V2_R2.9* and CLAP-B Reference Commands.

Table 7-1 COM1_RS232 Ouput (Baud Rate: 460800)

Ouput COM	Command	Format	Frequency
COM1	LOG COM1 GPGGA ONTIME 1	NMEA	1Hz
COM1	LOG COM1 GPGSA ONTIME 1	NMEA	1Hz
COM1	LOG COM1 GPRMC ONTIME 1	NMEA	1Hz
COM1	LOG COM1 GPHDT ONTIME 1	NMEA	1Hz
COM1	LOG COM1 GPGSV ONTIME 1	NMEA	1Hz
COM1	LOG COM1 INSPVAB ONTIME 0.01	Binary	100Hz
COM1	LOG COM1 BESTGNSSPOSB ONTIME 1	Binary	1Hz
COM1	LOG COM1 HEADINGB ONTIME 1	Binary	1Hz
COM1	LOG COM1 RAWIMUXB ONTIME 0.01	Binary	100Hz
COM1	LOG COM1 RANGEB ONTIME 1	Binary	1Hz
COM1	LOG COM1 RANGEB_1 ONTIME 1	Binary	1Hz
COM1	LOG COM1 GPSEPHEMB ONTIME 1800	Binary	1800s
COM1	LOG COM1 GLOEPHEMERISB ONTIME 1800	Binary	1800s
COM1	LOG COM1 BDSEPHEMERISB ONTIME 1800	Binary	1800s
COM1	LOG COM1 GALEPHEMERISB ONTIME 1800	Binary	1800s

Table 7-2 COM3 Data Input (Baud Rate: 115200)

COM	Data (Standard Input)	Format	Frequency
COM3	RTCM3.x	RTCM Binary	

Table 7-3 COM3 Data Output (Baud Rate: 115200)

Ouput COM	Command	Format	Frequency
COM3	LOG COM3 GPGGA ONTIME 1	NMEA0183	1Hz

Note: the above are only recommended configurations. COM1, COM2, and COM3 can be configured to output logs or receive differential data as required.

8 Packaging

CLAP-B7 boards are packed in cartons, 100 pcs CLAP-B7 boards per carton.

Table 8-1 CLAP-B7 Packing List

No.	Description
1	10 boxes per carton
2	10 anti-static packages per box
3	1 CLAP-B7 per anti-static package

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