P20E

High-precision and high-reliability integrated navigation module

V2.5

REVISIONS

Version	Release notes	Date
V2.0		2021-11
V2.5	Add calibration instructions, add GPCAL protocol description, andSupplemental improvements to AT commands and custom NMEA statement protocols Increase the description of product model, increase some technical parameters.Complementary latitude, longitude, angle and velocity accuracy	2023-9

catalogs

一. Products

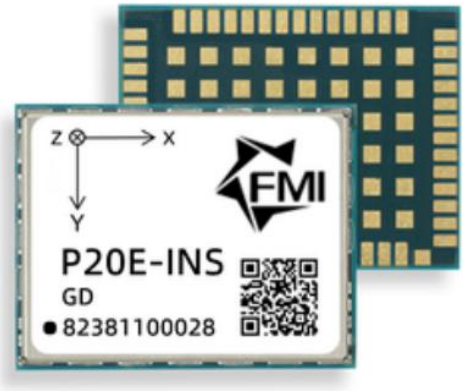
1. Product Overview

P20E is high accuracy, high reliability centimeter-level combined navigation and positioning modules, while featuring high integration, small size, good I/O compatibility, and low power consumption.

Integrated GNSS receiver and IMU (P20E-INS only) supporting BDS, GPS, GALILEO, GLONASS, QZSS, and adopting multi-band RTK and combined navigation technology, it can realize centimeter-level accuracy.

It can simultaneously receive and interpret more than 65 multi-frequency global navigation and positioning satellite signals, provide highly reliable positioning data even when there is serious satellite signal blockage, and provide uninterrupted navigation and positioning output, which provides a reliable navigation and positioning solution for difficult scenarios such as urban canyons.

Adopting the 54-PIN LGA package with good I/O compatibility in line with the market, the size is only 22mm*17mm*2.8mm to be compatible with the past hardware design and reduce the design risk. At the same time provides a wealth of development documentation and library function resources, can make the development work easier and faster.



2. Technical characteristics

- Support BDS, GPS, GALILEO, GLONASS, QZSS multi-satellite solution.
- Compatible with mainstream module I/O and size
- Fast RTK initialization, typically better than 5s
- path-2-path localization techniques
- Support for NTRIP RTCM3.X Ground Enhancement Data

3. application scenario

- High-precision GNSS receivers, handheld terminals
- Airports, ports, terminals, warehouses
- Unmanned systems: drones, unmanned vehicles, unmanned ships
- Precision agriculture, machine control

二. Technical Parameters

GNSS		
Receive Type	GPS / QZSS: L1, L5 BEIDOU: B1I, B2a GALILEO: E1, E5a GLONASS: G1	
Horizontal accuracy	≤ 8mm + 1ppm	
Speed Accuracy	≤ 5 cm/s	
Acquisition	Cold start ≤27s Hot start 2s	
Fixed solution convergence time	≤ 10s (short baseline or VRS under open sky)	
path-2-path Accuracy	sub-meter scale	
Antenna	single antenna	
capture sensitivity	-148 dBm	
Tracking & Nav.	-165 dBm	
Channels	135	
Carrier phase observation accuracy	< 0.01 cycle	
Navigation output frequency	Up to 10Hz	
Operational limits	Velocity	515m/s
	Altitude	18km
Power and environment		
Supply voltage	3.3v	
Antenna Voltage	3.3v	
PPS	1.8V (rising edge)	
Power	160mA×3.3V	
Operating temp	-40°C to 85°C	
Storage temp	-40°C to 90°C	
Humidity	95% non-condensing	

IMU (P20E-INS only)	
gyros	Range ± 1000 deg/s Zero bias stability ± 4.5 deg/h Angular random wander 0.17 deg/√h
accelerometer	Range ± 16 g Zero bias stability ± 0.3 mg Velocity random wandering 0.04 m/s/√h
Roll and pitch accuracy	≤ 0.02° (1σ)
Heading accuracy	≤ 0.2° (1σ)
Inertial Estimation Accuracy	≤ 1% * D (1σ, vehicle load)
data sampling rate	100Hz
connector	
hardware interface	2 UART 1 PPS
Product Specification	
sizes	22mm * 17mm * 2.8mm
seal inside	LGA
pin	54-pin

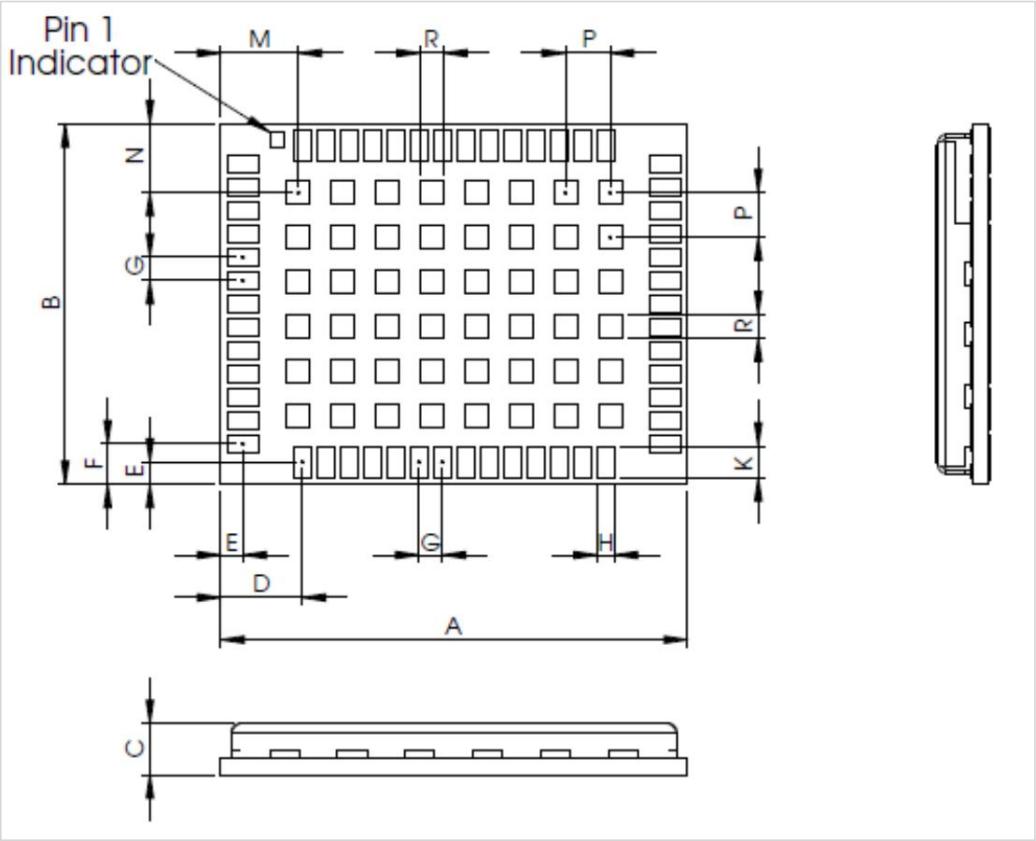
三. Hardware design

1. Pin Definitions

1	GND	ground
2	RF_IN	antenna port
3	GND	ground
4	NC	vacant
5	NC	vacant
6	NC	vacant
7	VCC_RF	Antenna Power Supply, 3.3V Output
8	NC	vacant
9	NC	vacant
10	NC	vacant
11	SDIO_D2	SDIO data line, 1.8V logic level
12	GND	ground
13	SDIO_CLK	SDIO clock line, 1.8V logic level
14	GND	ground
15	SDIO_D1	SDIO data line, 1.8V logic level
16	SDIO_D3	SDIO data line, 1.8V logic level
17	SDIO_D0	SDIO data line, 1.8V logic level
18	SDIO_CMD	SDIO command line, 1.8V logic level
19	NC	vacant
20	NC	vacant
21	NC	vacant
22	NC	vacant
23	NC	vacant
24	NC	vacant
25	NC	vacant
26	RXD2	Serial 2 Receive Port
27	TXD2	Serial 2 Transmit Port
28	NC	vacant
29	NC	vacant
30	NC	vacant
31	NC	vacant
32	GND	ground
33	VCC	3.3V power input
34	VCC	3.3V power input
35	NC	vacant
36	NC	vacant

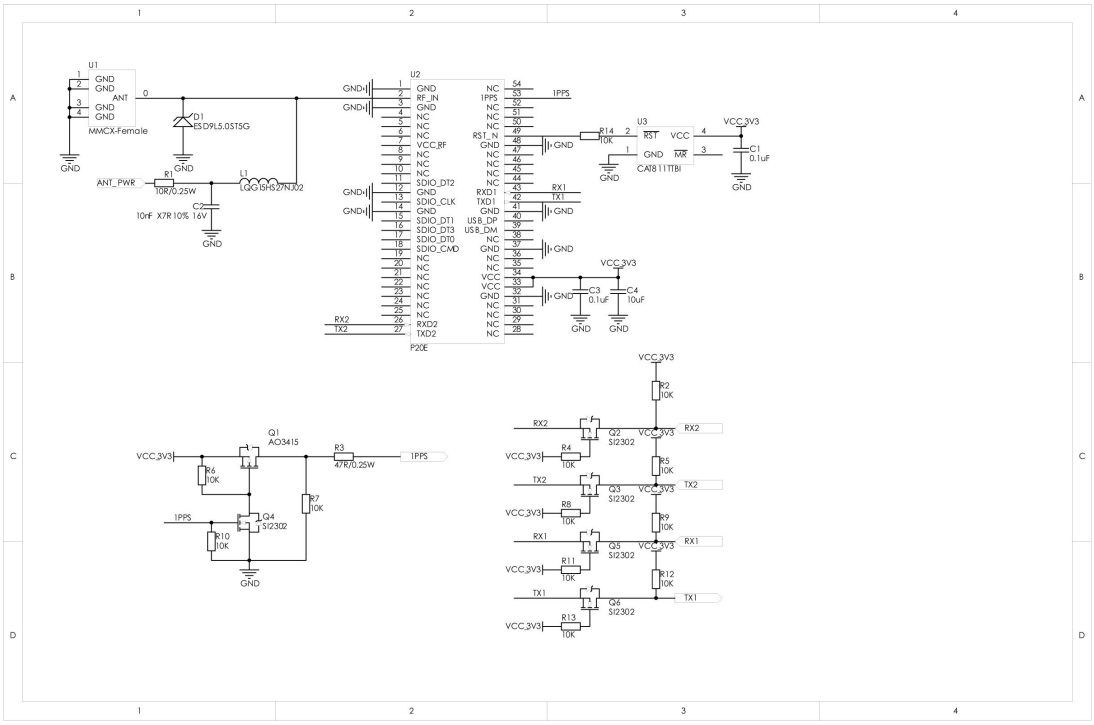
37	GND	ground
38	NC	vacant
39	USB_DM	USB Differential to Negative
40	USB_DP	USB Differential Pair Positive
41	GND	ground
42	TXD1	Serial port 1 sends
43	RXD1	Serial port 1 receive
44	NC	vacant
45	NC	vacant
46	NC	vacant
47	NC	vacant
48	GND	ground
49	RST_N	reset pin
50	NC	vacant
51	NC	vacant
52	NC	vacant
53	1PPS	1PPS output, 1.8V logic level
54	NC	vacant

2. Size Package

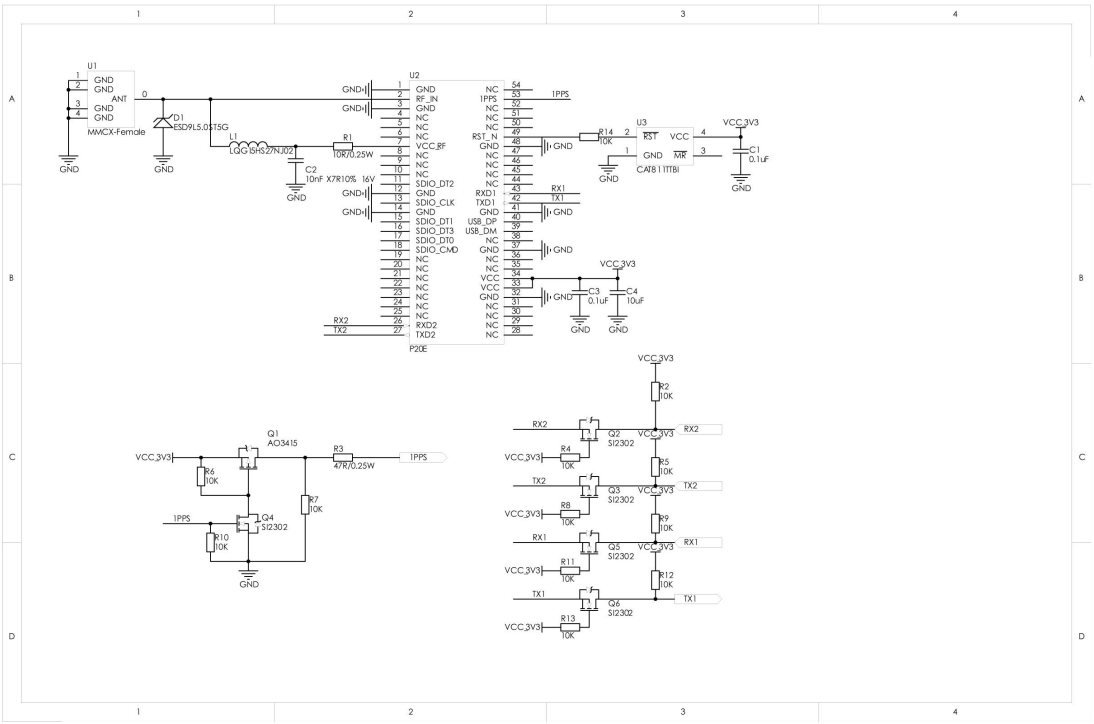


Symbol	Min.(mm)	Typ.(mm)	Max.(mm)
A	21.80	22.00	22.35
B	16.80	17.00	17.20
C	2.70	2.80	2.90
D	3.65	3.85	4.05
E	0.85	1.05	1.25
F	1.70	1.90	2.10
G	1.05	1.10	1.15
H	0.70	0.80	0.96
K	1.20	1.50	1.80
M	3.45	3.65	3.85
N	3.05	3.25	3.45
P	2.05	2.10	2.15
R	0.88	1.10	1.32

3. Reference Design



Antenna external power supply



Antenna internal power supply

四. Command and transport protocols

1. AT Commands

Command	Functional Description
AT+WARM_RESET	Hot start, reset RTK algorithm engine
AT+COLD_RESET	Cold start, reset modular system, equivalent to power failure reboot
AT+READ_PARA	Read the current configuration information, including firmware version number, parameter configuration, Device ID and other important information
AT+VERSION	Read firmware version number
AT+PORT_NAME or AT+THIS_PORT	Read current serial port number, UART1 or UART2
AT+BAUDRATE=UART1,115200 or AT+BAUD_RATE=UART1,115200	Set the communication baud rate of the serial port, support common communication baud rate, the highest to 921600, the default is 115200
AT+NAVI_RATE=5	Set the RTK engine solving frequency, unit hz, support 1, 5, 10, default 5hz. this frequency is the upper limit of the output frequency of NMEA statement such as GGA. For example, if NAVI_RATE is set to 5hz, the maximum output frequency of GPGGA can only be 5hz.
AT+SAVE_ALL	Save the current configuration. Many commands need to be saved and rebooted to take effect. Examples include BAUD_RATE and NAVI_RATE
AT+GPGGA=UART1,1	Configure the GGA output frequency of UART1 to be 1hz. 0 means no output, the output frequency supports fractional frequency such as 0.1hz, and the maximum support is 10hz.
AT+GPRMC=UART1,1	Configure the RMC output frequency of UART1 to 1hz. ditto
AT+GPSAT=UART1,1	Configure the GSA and GSV output frequency of UART1 to 1hz. ditto
AT+GPGST=UART1,1	Configure the GST output frequency of UART1 to 1hz. ditto
AT+GPZDA=UART1,1	Configure the ZDA output frequency of UART1 to 1hz. ditto
AT+GPVTG=UART1,1	Configure the VTG output frequency of UART1 to 1hz. ditto
AT+GELOC=UART1,1	Set the GELOC output frequency of UART1 to 1hz. ditto
AT+GPFMI=UART1,1	Configure the FMI output frequency of UART1 to 1hz. as above. For the format of the customized statement, see 3. FMI Data Protocol
AT+GPREF=UART1,1	Set the REF output frequency of UART1 to 1hz. as above. For the format of the customized statement see 3.FMI Data Protocol
AT+GPLOG=UART1,1	Set the GPLOG output frequency of UART1 to 1hz. as above. For the format of the customized statement see 3.FMI Data Protocol
AT+GPIMU=UART1,1	Configure the IMU output frequency of UART1 to 1hz. up to 100hz can be supported. see 3 for customized statement format.FMI Data Protocol (P20E-INS only)

Command	Functional Description
AT+GPATT=UART1,1	Configure the ATT output frequency of UART1 to 1hz. up to 100hz can be supported. see 3 for customized statement format.FMI Data Protocol (P20E-INS only)
AT+RTCM3=UART1,1 or AT+RTCM=UART1,1	Output RTCM3 set in base station mode (MSM4 and 1005), output frequency 1hz
AT+OBS=UART1,1	Set the output OBS observations (module raw RTCM3, including MSM7, ephemeris and customized information, output frequency is the same as NAVI_RATE), the amount of data is relatively large, usually only used for R & D debugging
AT+NMEA_HEAD=0	Sets the NMEA message header for GGA and RMC statements, 0 for GNGGA/GNRMC and 1 for GPGGA/GPRMC. default is 0.
AT+FMI_EXT=1	Sets the GPFMI message extension, with 0 being off and 1 being on. See 3.FMI Data Protocol <E1>~<E10> for extended field definitions
AT+GELOC_SN=ABC	Setting the SN string in a GELOC statement
AT+UART_OFF=UART1 or AT+UARTOFF=UART1s	Batch close all output information of serial port
AT+RTK_DIFF=X	Set the differential age threshold in (minutes), after exceeding which the module will exit the RTK state (default value 0 is 30min)
AT+MFS=6	*Set fixed solution algorithm parameters, MFS threshold, integer, default 6, maximum setting 31
AT+MDS=8	*Set AR algorithm parameters, MDS threshold, integer, default 8, maximum setting 31
AT+DELTA=1	*Set the internal DELTA parameter, unit 10s, maximum setting is 15, default is 0
AT+MINI_CN0=35	*Set the algorithm's internal carrier-to-noise ratio threshold, integer in dB, default is 35, maximum setting is 63
AT+VEL_MODE=1	*Set the algorithm's internal speed calculation mode: 0 - baseband provided speed, 1 - Doppler calculated speed, default 0
AT+VEL_RMS=1.0	*Set the speed RMS threshold with a resolution of 0.05 and a default value of 1.0
AT+WORK_MODE=13	Setting the operating mode of the inertial guidance (13: vehicle, 8: pedestrian) (P20E-INS only)
AT+IMU_ANGLE=α,β,γ	Setting the P20 mounting angles as detailed in the Module Mounting Help Manual (P20E-INS only)
AT+DR_TIME=180	Set inertial guidance estimation time in seconds (P20E-INS only)
AT+LEVER_ARM= X,Y,Z	Setting the boom vector based on the IMU coordinate system of the module, in meters (P20E-INS only)
AT+LEVER_ARM2= X,Y,Z	Boom setup based on carrier coordinate system in meters, see Module Installation Help Manual for details (P20E-INS only)
AT+ALIGN_VEL=3	Set the minimum start-up speed of the inertial guidance in meters per

Command	Functional Description
	second (P20E-INS only)
AT+PVE_MODE=4	Set the inertial guidance PVE mode, default value is 0, robot mode is 4 (P20E-INS only)
AT+INSTALL_CAL=1	Turns on the trigger calibration process, which is turned on when the in-vehicle mode is calibrated. See 3. FMI Data Protocol (P20E-INS only) for the format of the customized statement.
AT+AUTO_BASE=ENABLE	Base station coordinates are automatically estimated in base station mode. enable/disable
AT+BASE_LLH=LAT,LON,HGT	Base station mode manually sets the base station coordinates, latitude (in °), longitude (in °), and ellipsoid height (in m, not elevation). If the input is 0,0,0, it is equivalent to setting AT+AUTO_BASE=ENABLE
AT+ACTIVATE_KEY=KEY	Activate module RTK or combined navigation function
AT+PRODUCER=0	Set the manufacturer identification, 0 for FMI
AT+UPDATE_MODE	Enter firmware upgrade mode
AT+UPDATE_MODE_H=460800	Enter the firmware upgrade mode at the specified baud rate of 460800
AT+CORS_TYPE=0	Set the base station's decoding matching method for B2a signals. Default 0: p20E's own BTS signal, 1: Thousands of base stations, 2: Six-minute base stations, 3: Mobile base stations. As of 2022, the latest additions to RTCM3.3 have standardized the codec standard for B2a, and there is no need to set it.
AT+SHUT_DOWN	Shut down the system, it is recommended to send this command before powering down the system

All AT instructions end with a carriage return line feed (\r\n, ASCII code is 0x0D 0x0A)
Instructions that are grayed out are those that have expired or are no longer maintained and are not recommended for use.
The P20E supports 2 UART serial ports, each of which can be independently configured for NMEA statement output. The above AT commands all take UART1 as an example, and can also be replaced by UART2, for example, AT+GPGGA=UART2,1, sets the GGA output frequency of UART2 to 1hz. If you do not specify the UART number, then the default is set to the currently connected UART serial port, for example, the currently connected one is UART1, then AT+GPGGA=1 sets the GGA output frequency of UART1 to 1hz. output frequency to 1hz.
Some commands are added based on the latest firmware version and may not be supported by historical versions.
Instructions marked with an asterisk (*) in the function description will affect the algorithm's effect, so it is recommended to check with Feyman's R&D staff before modification.

2. Customized Parameter Configuration

mode	command set
vehicle mode	AT+WORK_MODE=13 AT+DR_TIME=300 AT+ALIGN_VEL=3 AT+VEL_MODE=1

mode	command set
Robotic mode (drones, pedestrians)	AT+WORK_MODE=8 AT+DR_TIME=10 AT+ALIGN_VEL=0.5 AT+PVE_MODE=4 AT+VEL_MODE=1
BTS mode	AT+UARTOFF=UART1 (base station-only mode turns off all extraneous NMEA messages) AT+RTCM=UART1,1 AT+BASE_LLH=LAT,LON,HGT (just set one with AT+AUTO_BASE=ENABLE) AT+AUTO_BASE=ENABLE

Please send: AT+SAVE_ALL to save when the command is set.
AT+WARM_RESET Reboot and take effect

Note: Mode in vehicle mode, robot mode (drone, pedestrian) only P20E-INS

The in-vehicle mode needs to be calibrated, refer to the document: P20E-INS in-vehicle mode calibration instructions

3. FMI data protocol

(1) GPFMI

$GPFMI,<1>,<2>,<3>,<4>,<5>,<6>,<7>,<8>,<9>,<10>,<11>,<12>.

<13>,<14>,<15>,<16>,<17>,<18>,<19>,<20>,<21>,<22>,<23>[,<E1& gt;~<E10>]*<24><CR><LF>

<1> UTC time in the format hhmmss.ss. ss

<2> Week number.

<3> Time of week, seconds of week, in the format (ss.mmm)

<4> Latitude in degrees. Positive number is north latitude, negative number is south latitude. [-90, 90], 8 decimal places.

<5> Longitude in degrees. Positive numbers are east longitude, negative numbers are west longitude. [-180, 180], 8 decimal places.

<6> Elevation, in meters, 3 decimal places

<7> Standard deviation of latitude, in meters, 4 decimal places

<8> Standard deviation of longitude, in meters, 4 decimal places

<9> Standard deviation of elevation, in meters, 4 decimal places

<10> Velocity eastward, in meters per second, 3 decimal places

<11> Velocity northward, in meters per second (m/s), 3 decimal places

<12> Velocity in zenith direction, in meters per second, 3 decimal places

<13> Standard deviation of horizontal velocity, in meters per second, 3 decimal places

<14> Heading angle, in degrees, [0,360]°, 2 decimal places

<15> Pitch angle, unit (degrees), [-90, 90], 2 decimal places

<16> Rollover angle, in degrees [-90, 90], 2 decimal places

<17> Standard deviation of heading angle, in degrees, 4 decimal places

<18> Standard deviation of pitch angle, in degrees, 4 decimal places

<19> Standard deviation of roll angle, in degrees, 4 decimal places

<20> Baseline distance in meters, 3 decimal places

<21> Number of satellites visible from the antenna

<22> The number of observations fixed throughout the carrier week is only meaningful for fixed solutions

<23> Positioning quality indication, 0=invalid solution, 1=single-point solution, 2=differential solution, 4=fixed solution, 5=floating-point solution, 6=inertial guidance solution

If you set the FMI statement to expand, you will append 10 expansion fields

<E1> Fixed solution reference Ratio

<E2> Number of fixed-solution AR double-difference fuzzy degrees

<E3> Carrier-to-noise ratio average

<E4> Number of carrier non-integer observations

<E5> Number of delta observations

<E6> Inertial state, the content is a 32-bit unsigned integer in hexadecimal, each bit in the integer represents a state, and each state can be superimposed (initialization complete state: 08600002). The significance of each bit is as follows.

0X00000002: The inertial guidance program is running.

0X00001000: Invalid inertial guidance result

0X00400000: Inertial filter convergence complete

0X00200000: Installation parameter 1 estimated or loading complete

0X08000000: Installation parameter 2 estimated or loading complete

<E7> Reserved

<E8> Reserved

<E9> Reserved

<E10> Reserved

<24> heteroskedastic checksum

Sample Statement (with Extended Fields)

$GPFMI,092900.20,2248,466158.200,42.06414612,106.22805621,154.305,0.0077,0.0068,0.0166,-0.006,0.005,0.033,0.012,0.00,0.00,0.00,0.00, - 1.0000,-1.0000,-1.0000,185.578,38,40,4,1.74,19,43,,,08000002,,,,*4C

(2) GPIMU

$GPIMU,<1>,<2>,<3>,<4>,<5>,<6>,<7>,<8>*<9><CR><LF>

<1> UTC time in hhmmss.ss format

<2> x-axis acceleration (g)
<3> y-axis acceleration (g)
<4> z-axis acceleration (g)
<5> Gyro x-axis orientation (°/s)
<6> Gyro y-axis orientation (°/s)
<7> Gyro z-axis orientation (°/s)
<8> Sensor temperature (°C)
<9> heteroskedastic checksum

Example statement:
$GPIMU,062233.00,0.009,-0.005,-1.017,-0.580,0.214,0.092,28.118*75

(3) GPATT

$GPATT,<1>,<2>,<3>,<4>*<5><CR><LF>
<1> UTC time in hhmmss.ss format
<2> Roll angle (°)
<3> Pitch angle (°)
<4> Heading angle (°)
<5> heteroskedastic checksum

Example statement:
$GPATT,062157.00,0.00,0.00,999.99*48

(4) GPREF

$GPREF,<1>,<2>,<3>,<4>,<5>,<6>,<7>,<8>*<9><CR><LF>
<1> UTC time in hhmmss.ss format
<2> Reference station availability, 0 for normal, 1 for abnormal
<3> Reference station ECEF x-coordinate (m)
<4> Reference station ECEF y-coordinate (m)
<5> Reference station ECEF z-coordinate (m)
<6> Reference station status, 0 means normal, non-0 means abnormal
<7> Reference station type
<8> Reference Station ID
<9> heteroskedastic checksum

Example statement:
$GPREF,062025.00,0,-2120469.283,5384856.998,3083401.548,0,4,1492*5C

(5) GPLOG

$GPLOG,<1>,<2>,<3>,<4>,<5>*<6><CR><LF>
<1> UTC time in hhmmss.ss format
<2> Information of frequency points supported by modules, P20E supports 5 stars and 9 frequencies, arranged in the order of GRECJ, separated by internal comma and external parentheses. Separated by internal comma and external parentheses
<3> Number of observations per frequency point for floating-point solution , internal comma separated, external parentheses separated
<4> Number of observations per frequency point with fuzzy fixation, separated by internal commas and external parentheses
<5> Carrier-to-noise ratios averaged for each frequency point, separated by internal commas and external parentheses
<6> heteroskedastic checksum

语句示例：
$GPLOG,061941.20,(L1,L5,G1,E1,E5a,B1,B2a,L1,L5,),(8,5,5,6,8,12,7,3,3,),(6,4,0,3,5,11,7,2,2,),(40,47,40,39,43,41,47,40,48,)*28

(3) GPCAL

$GPCAL,<1>,<2>,<3>,<4>,<5>,<6>*<7><CR><LF>
<1> X-axis boom parameters
<2> Y-axis boom parameters
<3> Parameters of Z-axis arm bar

<4> Installation parameter 1

<5> Installation parameter 2

<6> Percentage of calibration progress, boom calibration before 60%, mounting parameter calibration after 60%.

<7> heteroskedastic checksum

Example statement:

$GNCAL,-1.220,0.004,0.345,0.000,0.000,90*4A

Note: GPIMU, GPATT, GPCAL in data protocol only support P20E-INS

4. Differential Data Protocol

P20 module can support two functions: receiving external base station data for RTK differential calculation and outputting RTCM3 data itself as a base station. Among them, receiving external differential supports RTCM3.2 and above version data (msm4-msm7).

The message types supported by the P20 module base station function output RTCM3.3 protocol are:

RTCM Message Type	Message Description
1005	Base station coordinates
1074	GPS observations
1084	GLO observations
1094	GAL observations
1114	QZSS observations
1124	BDS observations

五. Q&A

1. AT+COLD_RESET execution exception

Problem Description:

After sending AT+COLD_RESET, the module can't be restarted automatically (under normal circumstances, after sending COLD_RESET command about 10s will serial port have GGA), it needs external power failure restart to be able to.

Solution:

Check if there is a series resistor (10K) on reset pin 49, it is recommended to connect a resistor according to the reference circuit design.

Because in cold reset, the reset pin will actively pull down, the external IO drive capacity is too strong, may not pull down.

2. Product Model Description

P20E-INS compared to the P20E increased IMU inertial measurement unit, the above document added to the IMU-related parameters, commands and related instructions, P20E-INS and P20E in other parameters and functions are identical.

3. Firmware version number description

The complete version number of P20E consists of 4 parts, BV, RTK, SOC, DRIVER, each part is connected by _, each part of the version number mainly consists of the main version number and compile time, usually the main version number is relatively stable, every time you upgrade the version number to update the compile time.

The enc upgrade packages are generally named after the compilation time of the RTK part.

Each component can be upgraded independently to change its version (full and incremental upgrade packages)

Newer firmwares have a new Release Ver print that provides a simplified version number, consisting mainly of the compile times of the various components

Example of full version number: Version:B 2.8.8 May 30 2023 RTK v.1.5.2.p2De-18:08:43 May 30 2023_S0C FMI_P20E_V2.6.0_20230510_DRIVER 202206151