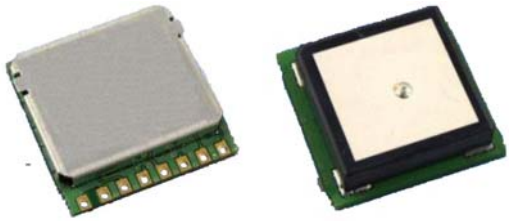
SUP800F



SUP800F Flash-based

167 Channel GPS Smart Antenna Module
7-DOF IMU & 1MByte Flash Integrated
Accurate Heading Even When Static
Accurate Altitude Change Detection
125K Point Data Logging

The SUP800F8 is a compact all-in-one GPS receiver module solution, integrating 3-axis accelerometer, 3-axis magnetometer, and barometric pressure sensor, intended for a broad range of Original Equipment Manufacturer (OEM) products, where accurate heading when static, accurate altitude change detection, fast and easy system integration and minimal development risk is required.

The SUP800F GPS receiver's -165dBm tracking sensitivity allows continuous position coverage in nearly all application environments. Its high performance search engine is capable of testing 16,000,000 time-frequency hypotheses per second, offering industry-leading signal acquisition and TTFF speed.

The receiver is optimized for applications requiring high performance, low power, and low cost; suitable for a wide range of OEM configurations including navigation, tracking, and time synchronization products.

Features

- 167 Channel GPS L1 C/A Code
- Perform 16 million time-frequency hypothesis testing per second
- Open sky hot start 1 sec
- Open sky cold start 29 sec
- Cold start sensitivity -148dBm
- Signal detection better than -165dBm
- Heading accuracy better than 5 degrees when static
- Auto-calibration
- 1MByte Flash 125K Point Data Logging
- Multipath detection and suppression
- Jamming detection and mitigation
- SBAS (WAAS / EGNOS support)
- Accuracy 2.5m CEP
- Maximum update rate 10Hz
- Tracking current 42mA
- RoHS compliant

Applications

- Marine Navigation

TECHNICAL SPECIFICATIONS

Receiver Type	L1 C/A code, 167-channel Venus 8 engine
Accuracy	Position 2.5m CEP Velocity 0.1m/sec Time 10nsec Heading better than 5 degrees when static Altitude change detection 20cm
Startup Time	1 second hot start under open sky 29 second cold start under open sky (average)
Reacquisition	1s
Sensitivity	-165dBm tracking
Multi-path Mitigation	Advanced multi-path detection and suppression
Update Rate	Supports 1 / 2 / 4 / 5 / 8 / 10 Hz update rate (1Hz default)
Dynamics	4G (39.2m/sec^2)
Operational Limits	Altitude < 18,000m or velocity < 515m/s
Serial Interface	3V LVTTL level
Protocol	NMEA-0183 V3.01 GPGGA, GPGLL, GPGSA, GPGSV, GPRMC, GPVTG[*1] 115200 baud, 8, N, 1
Datum	Default WGS-84 User definable
Input Voltage	3.0V ~ 3.6V DC
Current Consumption	

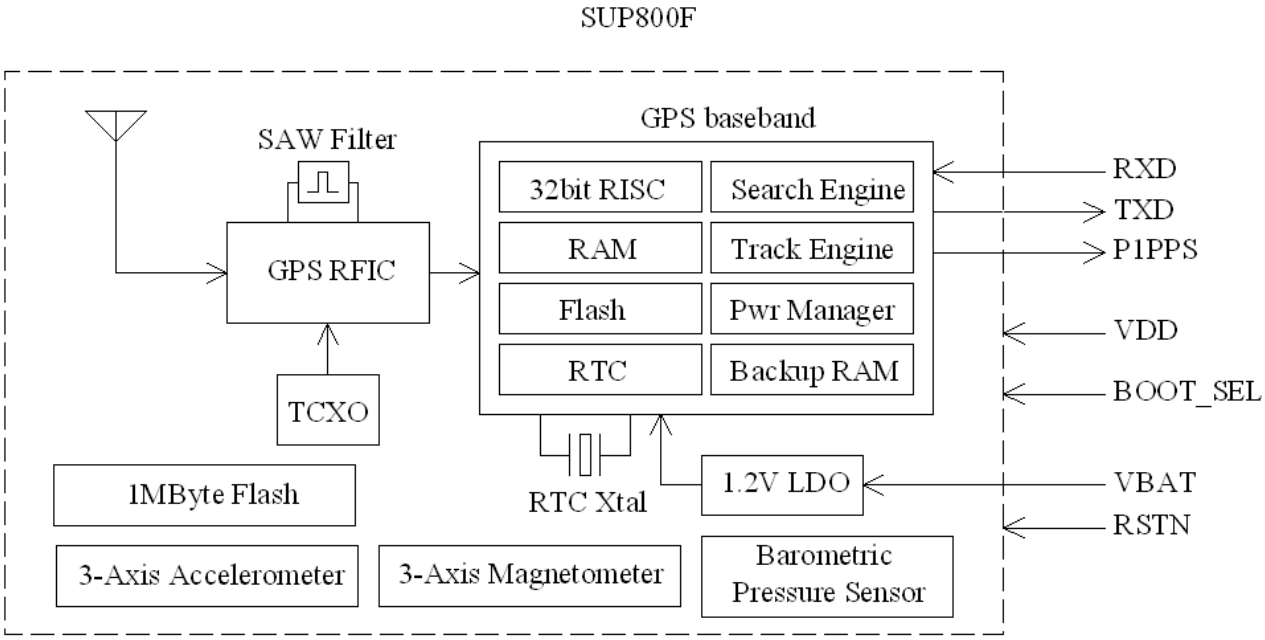
	Acquisition				Tracking
Number of Search Engine	2	4	6*	8	
Current Consumption	48mA	54mA	60mA	70mA	42mA

* default 6 search engine used

Dimension	22mm L x 22mm W
Weight:	9g
Operating Temperature	-40°C ~ +85°C
Storage Temperature	-55 ~ +100°C
Humidity	5% ~ 95%

*1: GPGGA, GPGSA, GPGSV, GPRMC, GPVTG are default output message

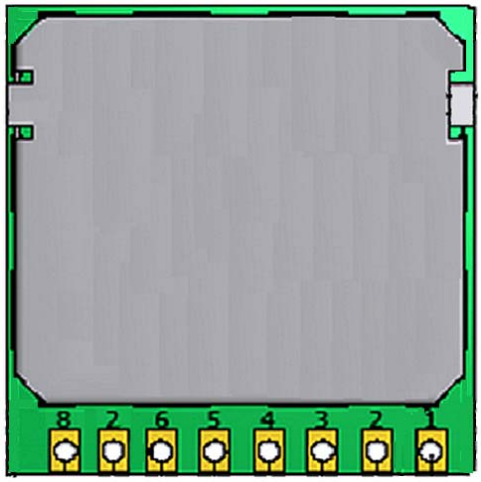
BLOCK DIAGRAM



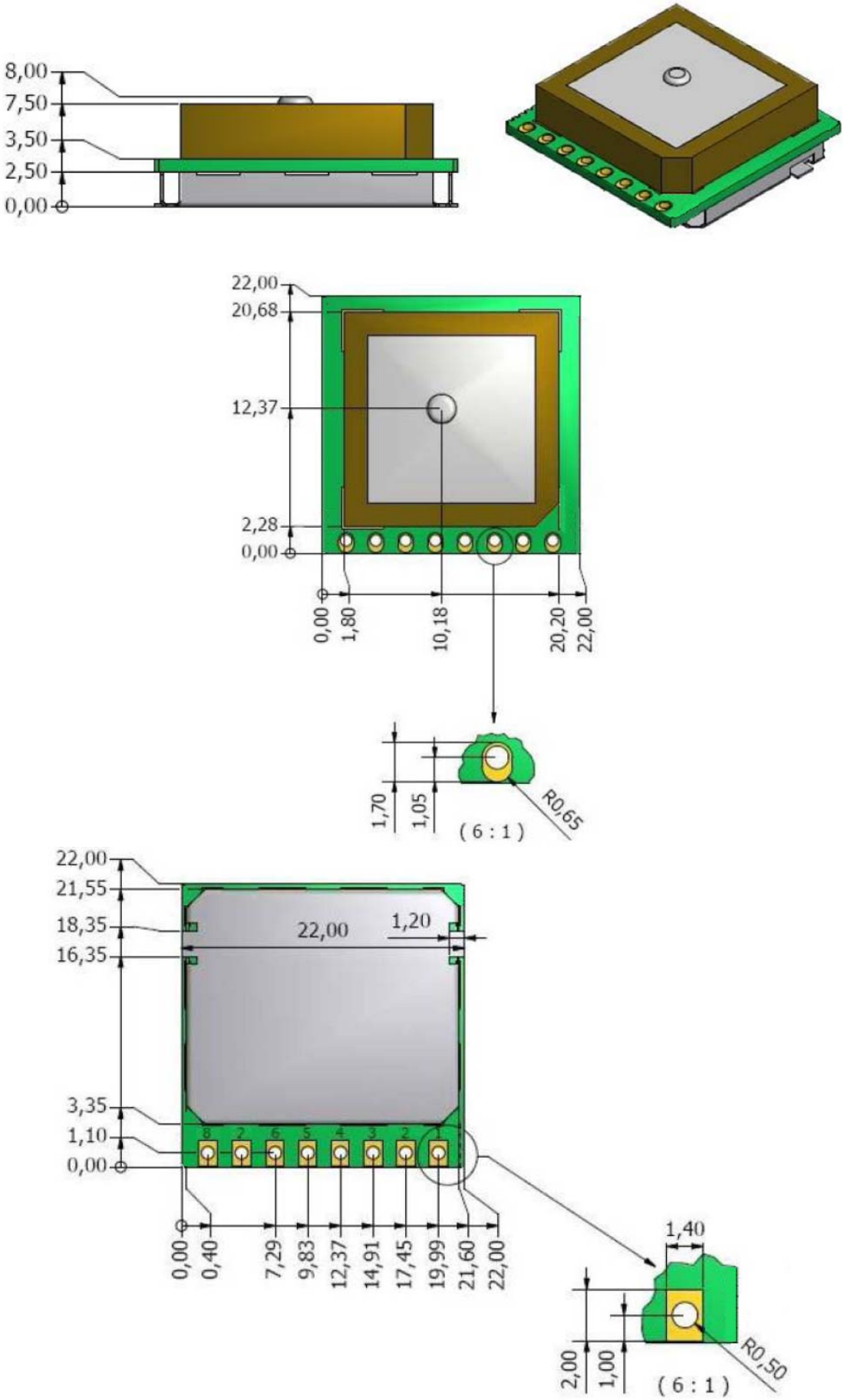
Module block schematic

PIN CONNECTION DESCRIPTION

Pin No.	Name	Descript
1	RXD	UART input, 3.3V LVTTL
2	TXD	UART output, 3.3V LVTTL
3	GND	System ground
4	VDD	Main supply input, 3.0V ~ 3.6V
5	VBAT	Backup supply voltage for RTC and SRAM, 2.5V ~ 3.6V For minimal design without backup supply, VBAT can be tied to VDD, but it'll cold start every time powering up.
6	P1PPS	1 pulse per second time mark output
7	BOOT_SEL	No connection or connect to VDD for normal use, running from internal Flash. Connect to GND for loading firmware into empty or corrupted Flash memory running from ROM.
8	RSTN	Active low reset input, can be left unconnected.

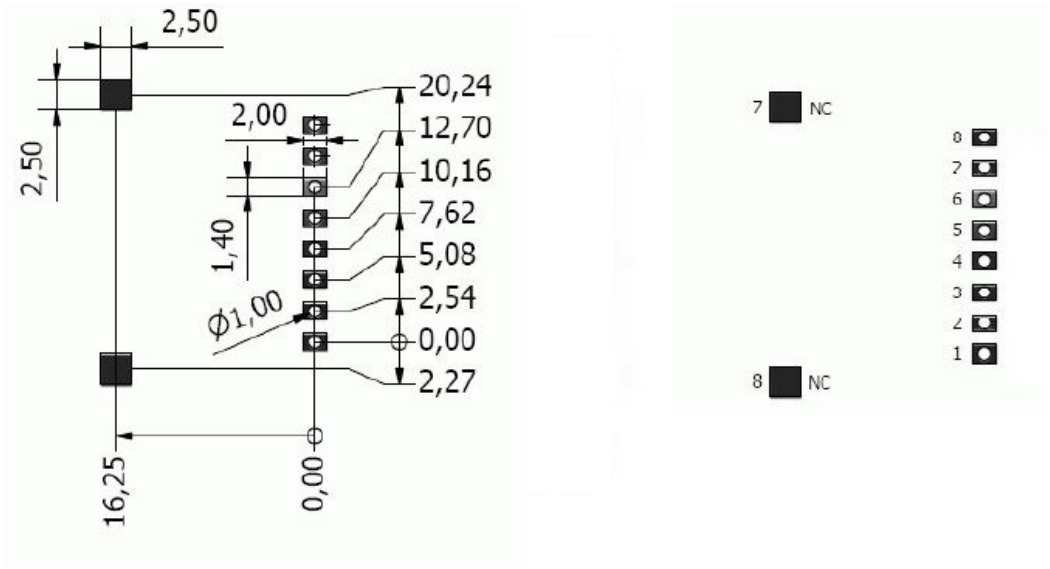


MECHANICAL DIMENSIONS

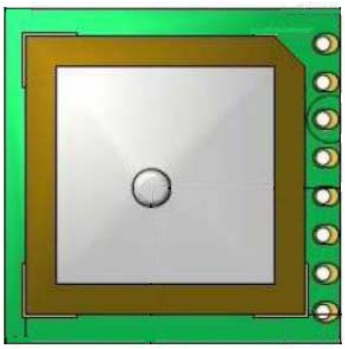


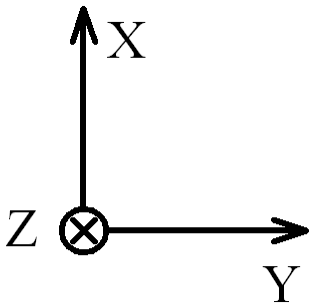
PCB MOUNTING

The SUP800F can be mounted on the application PCB using standard 2.54mm pitch 1x 8 pin header. Two dummy soldering pads on the RF shield are used to fix the module to the application PCB. When soldering the 1x8 pin header, shorter the pins protruding on the side of the patch antenna the better.



INSTALLATION





When installing SUP800F into equipment, correct alignment is essential to achieve good performance. It should be mounted far away from dynamic magnetic interference as possible, i.e. high current motors. It should also be mounted away from vibration when possible.

SUP800F has sensor axis orientation shown as above. When installing, X-axis should point forward, and Z-axis point downward toward ground.

MAGNETIC CALIBRATION

SUP800F has on-board magnetometer to determine heading when static or moving a low speed, where GPS heading practically does not work. For the magnetometer to function correctly, it needs to be calibrated against the surrounding (magnetic) environment after equipment containing SUP800F is installed. SUP800F can perform magnetic calibration by itself automatically; calibration is done after an accumulated rotation of 360-degrees is done over the required axis. If needing SUP800F to give correct heading upon initial use, it then requires calibration after installation.

2D calibration is for applications that cannot be easily turned upside down, such as boats and cars. 3D calibration is for applications that can be easily turned upside down, rotated over the 3-axis, such as model boats and planes. 3D calibration offers slightly better performance than 2D calibration.

The default firmware shipped works with 2D calibration. 3D calibration firmware can be downloaded from http://navspark.mybigcommerce.com/sup800f-gps-antenna-module-7-dof-imu/

2D Calibration

The unit should be powered, put in level orientation, and kept stationary. It is to be rotated around the vertical Z-axis, 360-degrees in no less than 5 seconds, make 2 rounds. If installed in boat or car that cannot be rotated, make 360-degrees turn twice.

3D Calibration

The unit should be powered, put in level orientation, and kept stationary. From the level orientation, it is to be rotated around the X-axis, 360-degrees in no less than 5 seconds, make 2 rounds. From the level orientation, it is to be rotated around the Y-axis, 360-degrees in no less than 5 seconds, make 2 rounds. From the level orientation, it is to be rotated around the Z-axis, 360-degrees in no less than 5 seconds, make 2 rounds

ESD HANDLING PRECAUTION

SUP800F is sensitive to ESD and require special precautions when handling. Particular care must be observed when handling due to risk of electrostatic discharge. Follow below guidelines:

1. Avoid hand touching the patch antenna and the 8 interface pins.

2. When mounting SUP800F to the application PCB, first connect the ground pin.

NMEA MESSAGES

The full descriptions of supported NMEA messages are provided at the following paragraphs.

GGA - Global Positioning System Fix Data
Time, position and fix related data for a GPS receiver.

Structure:
$GPGGA,hhmmss.sss,ddmm.mmmm,a,dddmm.mmmm,a,x,xx,x.x,x.x,M,,,,xxxx*hh<CR><LF>
1 2 3 4 5 6 7 8 9 10 11

Example:
$GPGGA,111636.932,2447.0949,N,12100.5223,E,1,11,0.8,118.2,M,,,,0000*02<CR><LF>

Field	Name	Example	Description
1	UTC Time	111636.932	UTC of position in hhmmss.sss format, (000000.000 ~ 235959.999)
2	Latitude	2447.0949	Latitude in ddmm.mmmm format Leading zeros transmitted
3	N/S Indicator	N	Latitude hemisphere indicator, ‘N’ = North, ‘S’ = South
4	Longitude	12100.5223	Longitude in dddmm.mmmm format Leading zeros transmitted
5	E/W Indicator	E	Longitude hemisphere indicator, 'E' = East, 'W' = West
6	GPS quality indicator	1	GPS quality indicator 0: position fix unavailable 1: valid position fix, SPS mode 2: valid position fix, differential GPS mode
7	Satellites Used	11	Number of satellites in use, (00 ~ 16)
8	HDOP	0.8	Horizontal dilution of precision, (00.0 ~ 99.9)
9	Altitude	108.2	mean sea level (geoid), (-9999.9 ~ 17999.9)
10	DGPS Station ID	0000	NULL, no DGPS support
11	Checksum	02	

Checksum field is the 8-bit exclusive OR of all characters in the sentence starting after '$' and before '*'

GLL – Latitude/Longitude
Latitude and longitude of current position, time, and status.

Structure:
$GPGLL,ddmm.mmmm,a,dddmm.mmmm,a,hhmmss.sss,A,a*hh<CR><LF>
1 2 3 4 5 6 7 8

Example:
$GPGLL,2447.0944,N,12100.5213,E,112609.932,A,A*57<CR><LF>

Field	Name	Example	Description
1	Latitude	2447.0944	Latitude in ddmm.mmmm format Leading zeros transmitted
2	N/S Indicator	N	Latitude hemisphere indicator ‘N’ = North ‘S’ = South
3	Longitude	12100.5213	Longitude in dddmm.mmmm format Leading zeros transmitted
4	E/W Indicator	E	Longitude hemisphere indicator 'E' = East 'W' = West
5	UTC Time	112609.932	UTC time in hhmmss.sss format (000000.000 ~ 235959.999)
6	Status	A	Status, ‘A’ = Data valid, ‘V’ = Data not valid
7	Mode Indicator	A	Mode indicator ‘V’ = Data not valid ‘A’ = Autonomous mode
8	Checksum	57	

GSA – GNSS DOP and Active Satellites
GPS receiver operating mode, satellites used in the navigation solution reported by the GGA or GNS sentence and DOP values.

Structure:
$GPGSA,A,x,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,x.x,x.x,x.x*hh<CR><LF>
1 2 3 3 3 3 3 3 3 3 3 3 3 4 5 6 7

Example:
$GPGSA,A,3,05,12,21,22,30,09,18,06,14,01,31,,1.2,0.8,0.9*36<CR><LF>

Field	Name	Example	Description
1	Mode	A	Mode 'M' = Manual, forced to operate in 2D or 3D mode 'A' = Automatic, allowed to automatically switch 2D/3D
2	Mode	3	Fix type 1 = Fix not available 2 = 2D 3 = 3D
3	Satellite used 1~12	05,12,21,22,30,09,18,06,14,01,31,,	Satellite ID number of satellite used in solution, up to 16 transmitted. 01 ~ 32 are for GPS; 33 ~ 64 are for WAAS (PRN minus 87); 193 ~ 197 are for QZSS;
4	PDOP	1.2	Position dilution of precision (00.0 to 99.9)
5	HDOP	0.8	Horizontal dilution of precision (00.0 to 99.9)
6	VDOP	0.9	Vertical dilution of precision (00.0 to 99.9)
7	Checksum	36	

GSV – GNSS Satellites in View

Number of satellites (SV) in view, satellite ID numbers, elevation, azimuth, and SNR value. Four satellites maximum per transmission.

Structure:

$GPGSV,x,x,xx,xx,xx,xxx,xx,…,xx,xx,xxx,xx *hh<CR><LF>

1 2 3 4 5 6 7 4 5 6 7 8

Example:

$GPGSV,3,1,12,05,54,069,45,12,44,061,44,21,07,184,46,22,78,289,47*72<CR><LF>
$GPGSV,3,2,12,30,65,118,45,09,12,047,37,18,62,157,47,06,08,144,45*7C<CR><LF>
$GPGSV,3,3,12,14,39,330,42,01,06,299,38,31,30,256,44,32,36,320,47*7B<CR><LF>

Field	Name	Example	Description
1	Number of message	3	Total number of GSV messages to be transmitted (1-4)
2	Sequence number	1	Sequence number of current GSV message
3	Satellites in view	12	Total number of satellites in view (00 ~ 16)
4	Satellite ID	05	Satellite ID number, 01 ~ 32 are for GPS; 33 ~ 64 are for WAAS (PRN minus 87); 193 ~ 197 are for QZSS
5	Elevation	54	Satellite elevation in degrees, (00 ~ 90)
6	Azimuth	069	Satellite azimuth angle in degrees, (000 ~ 359)
7	SNR	45	C/No in dB (00 ~ 99) Null when not tracking
8	Checksum	72	

RMC – Recommended Minimum Specific GNSS Data
Time, date, position, course and speed data provided by a GNSS navigation receiver.

Structure:
$GPRMC,hhmmss.sss,A,dddmm.mmmm,a,dddmm.mmmm,a,x.x,x.x,ddmmyy,x.x,a,a*hh<CR><LF>
1 2 3 4 5 6 7 8 9 10 11 12 13
Example:
$GPRMC,111636.932,A,2447.0949,N,12100.5223,E,000.0,000.0,030407,003.9,W,A*12<CR><LF>

Field	Name	Example	Description
1	UTC time	0111636.932	UTC time in hhmmss.sss format (000000.00 ~ 235959.999)
2	Status	A	Status 'V' = Navigation receiver warning 'A' = Data Valid
3	Latitude	2447.0949	Latitude in dddmm.mmmm format Leading zeros transmitted
4	N/S indicator	N	Latitude hemisphere indicator 'N' = North 'S' = South
5	Longitude	12100.5223	Longitude in dddmm.mmmm format Leading zeros transmitted
6	E/W Indicator	E	Longitude hemisphere indicator 'E' = East 'W' = West
7	Speed over ground	000.0	Speed over ground in knots (000.0 ~ 999.9)
8	Course over ground	000.0	Course over ground in degrees (000.0 ~ 359.9)
9	UTC Date	030407	UTC date of position fix, ddmmyy format
10	Magnetic variation	003.9	Magnetic variation in degrees Easterly variation (E) subtracts from True course Westerly variation (W) adds to True course
11	E/W Indicator	W	'E' = East 'W' = West
12	Mode indicator	A	Mode indicator 'N' = Data not valid 'A' = Autonomous mode 'D' = Differential mode 'E' = Estimated (dead reckoning) mode
13	checksum	12	

Course over ground comes from GPS velocity derived heading when speed is over 10Km/hr, or when magnetometer is un-calibrated. Below 10Km/hr, course over ground comes from magnetometer when the magnetometer is calibrated. For speed below 10Km/hr and magnetometer is un-calibrated, course over ground is derived from GPS velocity, which can become more inaccurate as speed is lowered.

VTG – Course Over Ground and Ground Speed
The Actual course and speed relative to the ground.

Structure:
GPVTG,x.x,T,x.x,M,x.x,N,x.x,K,a*hh<CR><LF>
1 2 3 4 5 6

Example:
$GPVTG, 000.0,T,356.1,M,000.0,N,0000.0,K,A*32<CR><LF>

Field	Name	Example	Description
1	Course	000.0	True course over ground in degrees (000.0 ~ 359.9)
2	Course	356.1	Magnetic course over ground in degrees (000.0 ~ 359.9)
3	Speed	000.0	Speed over ground in knots (000.0 ~ 999.9)
4	Speed	0000.0	Speed over ground in kilometers per hour (0000.0 ~ 1800.0)
5	Mode	A	Mode indicator 'N' = not valid 'A' = Autonomous mode 'D' = Differential mode 'E' = Estimated (dead reckoning) mode
6	Checksum	32	

Course comes from GPS velocity derived heading when speed is over 10Km/hr, or when magnetometer is un-calibrated. Below 10Km/hr, course comes from magnetometer when the magnetometer is calibrated. For speed below 10Km/hr and magnetometer is un-calibrated, course is derived from GPS velocity, which can become more inaccurate as speed is lowered.

STI,004,001 – Pitch, Roll, Yaw, Pressure, Temperature

An output message, ID 0x004, sub ID 0x001, contains pitch, roll, yaw information in NED coordinate, and also pressure and temperature information

Structure:
$PSTI,004,001,x,x.x,x.x,x.x,x,x.x*hh<CR><LF>
1 2 3 4 5 6 7 8 9

Example:
$ PSTI,004,001,1,34.7,121.6,-48.2,99912,29.4*08<CR><LF>

Field	Name	Example	Description
1	ID	004	Proprietary NMEA message identifier
2	Sub ID	001	Proprietary NMEA message Sub identifier
3	Validity Flag	1	0: Magnetic calibration not done, pitch, roll and yaw result not valid yet 1: Magnetic calibration done, pitch, roll and yaw result is valid
4	Pitch	34.7	Rotation about local Y axis. Pitch angle is the angle between the longitudinal axis and the horizon. Its range is from 0 ~ +90 degrees for the axis points above horizon and 0 ~ -90 degrees for the axis points to ground.
5	Roll	121.6	Rotation about local X axis. Roll angle is the rotation angle around the longitudinal axis, Its range is from 0 ~ +180 degrees for rotate clockwise and 0 ~ -180 degrees for rotate counterclockwise.
6	Yaw	-48.2	Rotation about local Z axis. Yaw angle is the angle for a twisting around a vertical axis. By assigning magnetic north pole as 0 degrees, its range is from 0 ~ +180 degrees for twist clockwise and 0 ~ -180 degrees for twist counterclockwise.
7	Pressure	99912	Pressure in range 30,000 (Pa) ~ 110,000 (Pa)
8	Temperature	29.4	Temperature in range -40.0~85.0 degrees Celsius.
9	Checksum		

Prior to finishing magnetic calibration, when Validity Flag is 0, pitch, roll, yaw will output accelerometer values in X, Y, Z axis. After magnetic calibration is finished, Validity Flag becomes 1, pitch, roll, yaw will output correct values. Use pitch, roll, yaw output only when Validity Flag is 1.

SUP800F SPECIFIC BINARY MESSAGE

ACCELEROMETER, MAGNETOMETER, PRESSURE, TEMPERATURE DATA – Message of accelerometer, magnetometer, pressure and temperature data in binary format (ID: 0xCF, SUB ID: 0x01)

This is message provides data of accelerometer, magnetometer, pressure and temperature sensor in binary format. The payload length is 34 bytes

Structure:
<0xA0,0xA1>< PL><CF><01>< message body><CS><0x0D,0x0A>

Example:

A0	A1	00	22	CF	01	BD	4F	E1	54	BE	15	E9	E2	3F	6F	3C	B4	C0	C5	9D	2A	40	79	84	08	40	CE	FA	B0	00	01
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28

85	B1	41	F1	99	9A	B4	0D	0A
29	30	31	32	33	34			

Field	Name	Example(hex)	Description	Type	Unit
1	Message ID	CF		UINT8	
2	Message Sub-ID	01		UINT8	
3-6	G_X	BD4FE154	Acceleration value in X-axis	SPFP	g
7-10	G_Y	BE15E9E2	Acceleration value in Y-axis	SPFP	g
11-14	G_Z	3F6F3CB4	Acceleration value in Z-axis	SPFP	g
15-18	M_X	C0C59D2A	Magnetic value in X axis	SPFP	uT
19-22	M_Y	40798408	Magnetic value in Y axis	SPFP	uT
23-26	M_Z,	40CEFAB0	Magnetic value in Z axis	SPFP	uT
27-30	Pressure	000185B1	Pressure in unit of Pa	UINT32	Pa
31-34	Temperature	41F1999A	Temperature with accuracy in 0.1 degrees Celsius	SPFP	degree
Payload Length : 34 bytes					

See AN0028 for details on Venus8 GNSS Receiver Binary Protocol

The dynamic range for gravity is +/-4G and for magnetic data is +/-1,200uT.

ORDERING INFORMATION

Model Name	Description
SUP800F	Flash Version GPS Smart Antenna Module with 7-DOF IMU Integrated

Change Log

Ver 0.7, February 7, 2017

1. Maximum updated rate modified to 10Hz

Ver 0.6, August 5, 2014

1. Added magnetic variation to RMC
2. Added magnetic course to VTG

Ver 0.5, July 28, 2014

1. Added 1MByte data logging Flash description

Ver 0.4, July 17, 2014

2. Updated current consumption numbers.

Ver 0.3, July 14, 2014

1. Added SUP800F specific binary command.
2. Added Installation and Magnetic Calibration section

Ver 0.2, June 12, 2014

1. Added STI,004,001 message containing pitch, roll, yaw in formation.

Ver 0.1, June 10, 2014

1. Initial release