NS-M-GPSM

NMEA GPS/GLONASS/BEIDOU
9 AXIS E-COMPASS
INERTIAL MEASURMENT UNIT

Operating Manual

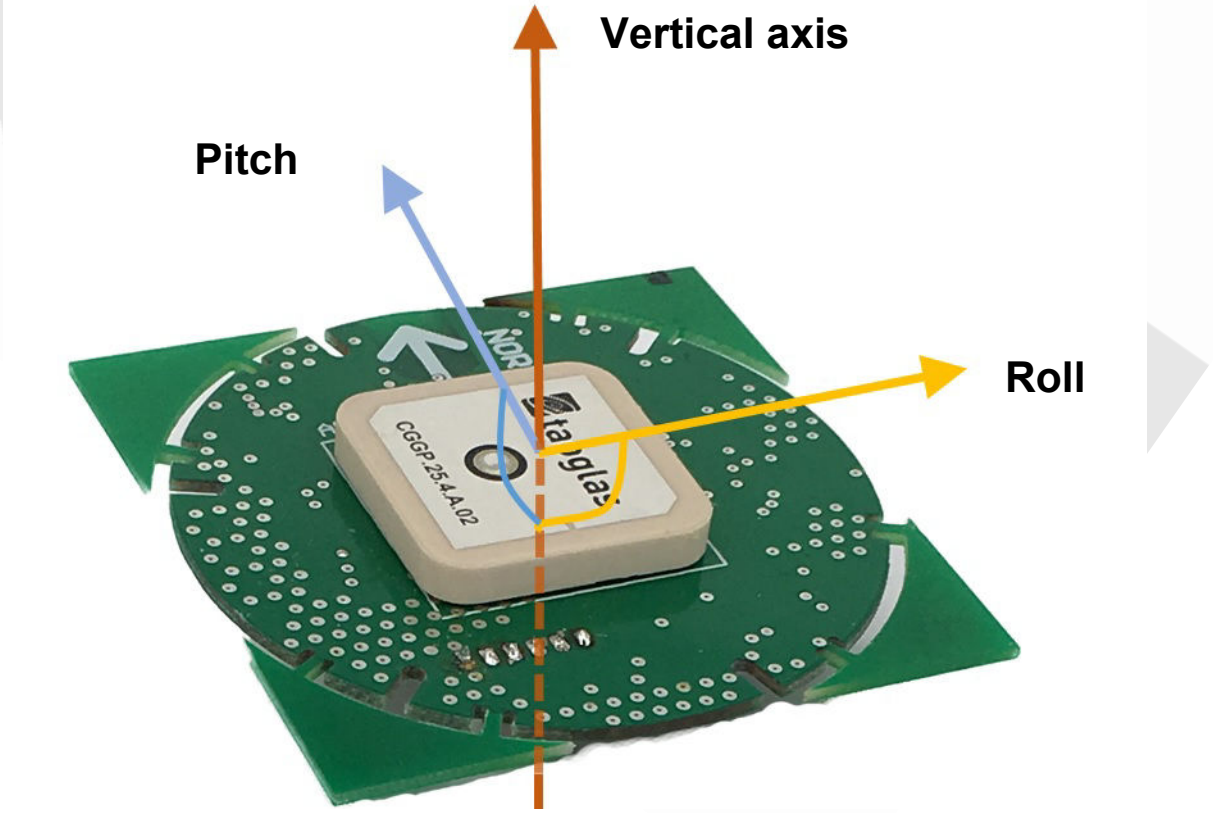
v1.5

Table of content

The ***9 AXIS E-COMPASS*** is a new generation IMU featuring a GPS/ GLONASS receiver coupled with a 9 axis AHRS unit providing 3D orientation by integrating gyroscopes and data fusing with accelerometers and magnetometers.

Electrical characteristics:

- Low power consumption, 450mW
- Power supply : 5V-15.5V (Version 1), 5V-28V (Version 2), overvoltage and reverse polarity protected
- Embedded firmware upgrade through proprietary NMEA messages
- Runtime user calibration
- 9 axis inertial measurement unit (IMU) magnetometers, accelerometers & gyroscopes data fusing with proprietary algorithm
- Onboard SIRF STAR V or UBLOX GNSS chipset for precise positioning and highest sensitivity
- Windows graphical user interface (9 axis E-Compass Manager) for easy setup, monitoring and upgrades



Proprietary NMEA commands

General header format is $PNOVA.
All messages end/must end with carriage return “\r\n”.

$PNOVA00: Information message

General comment sent by the IMU for user information

Format: $PNOVA00,....,...,...*xx
xx: checksum

- Example : Welcome message : $PNOVA00,NOVASAIL 9 axis E-Compass,bootloader 1.0,software 1.1*xx

$PNOVA01: Baud rate selection

Serial baud rate configuration message

Format: $PNOVA01,aa...a*xx

aa...a: baud rate selection 4800, 9600, 14400, 19200, 38400
xx: checksum

- Example: $PNOVA01,38400*

Acknowledgement: $PNOVA01,BAUD RATE OK*xx

NOTE: *the baud rate is saved into non volatile memory*

$PNOVA02: NMEA GPHDT message rate selection

Set the rate of the standard $GPHDT NMEA message

Format: $PNOVA02,aaaa*xx

aaaa: rate selection 01Hz, 05Hz or 10Hz
xx: checksum

- Example: $PNOVA02,05Hz*

Acknowledgement: $PNOVA02,RATE SET*xx

NOTE: *the rate is saved into non volatile memory*

$PNOVA03: NMEA $GPGMS message rate selection

Set the rate in second for the $GPGMS NMEA message
Format: $PNOVA03,aa*xx

aa: rate selection in seconds. 00 second disable permanently the GPGMS message.
xx: checksum

- Example: $PNOVA03,05* (GPGMS is sent every 5 seconds)

Acknowledgement: $PNOVA03,RATE SET*xx

NOTE: *the rate is saved into non volatile memory*

$PNOVA04: Enable/Disable standard NMEA message output

Enable or disable the output of all NMEA messages.

Format: $PNOVA04,aaa*xx

aaa: "ON" to enable, "OFF" to disable
xx: checksum

- Example: $PNOVA04,OFF*

Acknowledgement: $PNOVA04,OK*xx

Proprietary NMEA commands

$PNOVA05: NMEA GPHDM message rate selection

Set the rate of the standard $GPHDM NMEA message

Format: $PNOVA05,aaaa*xx

aaaa: rate selection 01Hz, 05Hz or 10Hz
xx: checksum

- Example: $PNOVA05,05Hz*

Acknowledgement: $PNOVA02,RATE SET*xx

NOTE: *the rate is saved into non volatile memory*

$PNOVA06: NMEA GPHDG message rate selection

Set the rate of the standard $GPHDG NMEA message

Format: $PNOVA06,aaaa*xx

aaaa: rate selection 01Hz, 05Hz or 10Hz
xx: checksum

- Example: $PNOVA06,05Hz*

Acknowledgement: $PNOVA02,RATE SET*xx

NOTE: *the rate is saved into non volatile memory*

$PNOVA10: Get magnetic declination, minimum speed, time threshold computation parameters

Format: $PNOVA10*xx

Acknowledgement $PNOVA10,aa.a,b,cdd.d,e*xx
Format:
- aa.a minimum speed (knots) selection, 01.0, 01,1...19.9,20.0
- b: minimum time in sec, 1, 2...8, 9
- cdd.d: magnetic declination

- c: W (West) or E (East)
- dd.d: 00.0 to 90.0 degrees

- e: ‘0’ fixed magnetic variation,‘1’ automatic computation of variation
- *xx: checksum*

Example: $PNOVA10,07.6,5,W12.3,0*xx for 7.6 knots and 5 seconds minimum threshold for auto computation parameters, 12.3 degrees west declination, fixed

$PNOVA11: Set magnetic declination, minimum speed, time threshold computation parameters

Format: $PNOVA11,aa.a,b,cdd.d,e*xx
- aa.a minimum speed (knots) selection, 01.0, 01,1...19.9,20.0
- b: minimum time in sec, 1, 2...8, 9
- cdd.d: magnetic declination
  - c: W (West) or E (East)
  - dd.d: 00.0 to 90.0 degrees
- e: ‘0’ fixed magnetic variation,‘1’ automatic computation of variation
- *xx: checksum*

Example: $PNOVA11,02.3,3,E03.2,1*xx for 2.3 knots and 3 seconds minimum threshold for auto computation parameters, 3.2 degrees east declination, automatic computation of the magnetic variation (also call declination)

Acknowledgement $PNOVA11,OK*xx

$PNOVA51: Dummy acknowledgment

IMU acknowledgment message, no information.
Format: $PNOVA51*xx

Acknowledgement $PNOVA11,NS*xx

$PNOVA61: Get factory calibration values

The acknowledgement of this message returns the factory calibration values of the IMU for the magnetometers, accelerometers and gyroscopes.
Format: $PNOVA61*xx

Acknowledgement:
$PNOVA61,aaaaa,bbbbb,ccccc,ddddd,eeeee,fffff,ggggg,hhhhh,iiiii,jjjjj,kkkkk,lllll*xx

aaaaa: magnetometer X axis zero bias (eg: 00200)
bbbbb: magnetometer Y axis zero bias
ccccc: magnetometer Z axis zero bias
ddddd: accelerometer X axis zero bias (eg. -0010)
eeeee: accelerometer Y axis zero bias
fffff: accelerometer Z axis zero bias
ggggg: gyroscope X axis zero bias (eg. -0080)
hhhhh: gyroscope Y axis zero bias
iiiii: gyroscope Z axis zero bias
jjjjj: accelerometer X axis +1G bias (eg. 16235)
kkkkk: accelerometer Y axis +1G bias
lllll: accelerometer Z axis +1G bias
xx : checksum

Example: $PNOVA61,00020,00217,-0122,00021,00089,-0256,16020,15678,16965*xx
NOTE: *this acknowledgement message returns 85 characters*

$PNOVA71: Get user calibration values

The acknowledgement of this message returns the user calibration values for the magnetometers, accelerometers and gyroscopes. The E-Compass should have been properly calibrated by the user so that the unit returns usable values

Format: $PNOVA71*xx

Acknowledgement:
$PNOVA71,aaaaa,bbbbb,ccccc,ddddd,eeeee,fffff,ggggg,hhhhh,iiiii,jjjjj,kkkkk,lllll*xx

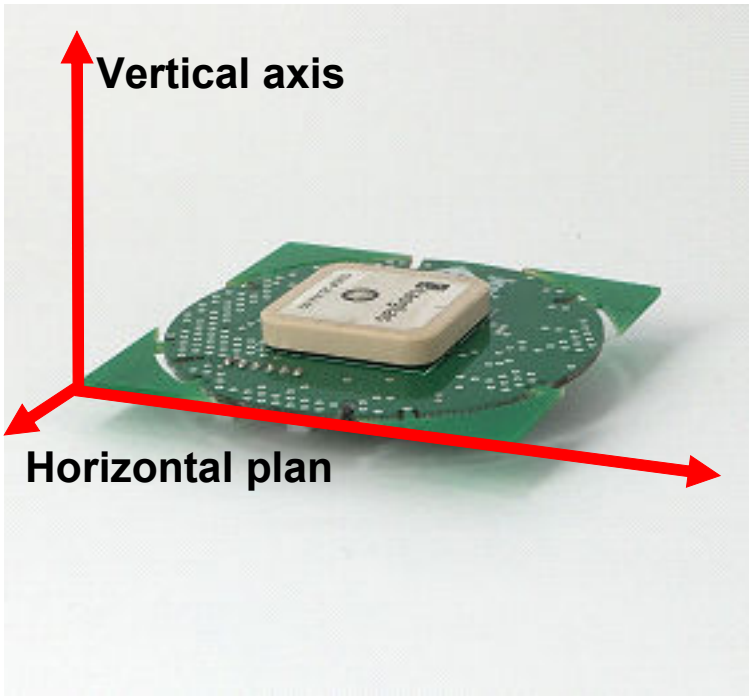
aaaaa: magnetometer X axis zero bias (eg: 00200)
bbbbb: magnetometer Y axis zero bias
ccccc: magnetometer Z axis zero bias
ddddd: accelerometer X axis zero bias (eg. -0010)
eeeee: accelerometer Y axis zero bias
fffff: accelerometer Z axis zero bias
ggggg: gyroscope X axis zero bias (eg. -0080)
hhhhh: gyroscope Y axis zero bias
iiiii: gyroscope Z axis zero bias
jjjjj: accelerometer X axis +1G bias (eg. 16235)
kkkkk: accelerometer Y axis +1G bias
lllll: accelerometer Z axis +1G bias
xx : checksum

Example: $PNOVA71,00040,00237,-0322,00525,00189,-0056,16543,15970,16345*xx

NOTE: *this acknowledgement message returns 85 characters.*

$PNOVA82: Runtime user calibration, horizontal plan

This message will start the static horizontal plan calibration. During the calibration the E-Compass must remain in a fixed position in the horizontal plan so that the IMU captures the zero bias of the accelerometer X/Y axis and the Gyroscope X/Y/Z axis
Format: $PNOVA82*xx



Acknowledgement:
- $PNOVA82,HORIZONTAL PLAN CALIBRATION STARTED* : the IMU is launching the calibration

Information message during the calibration:
- $PNOVA00,JITTER DETECTED* : the IMU is detecting too much jitter thus delaying the calibration

- $PNOVA00,UNIT NOT IN HORIZONTAL POSITION* : the IMU is detecting that the IMU board is not placed in the horizontal plan

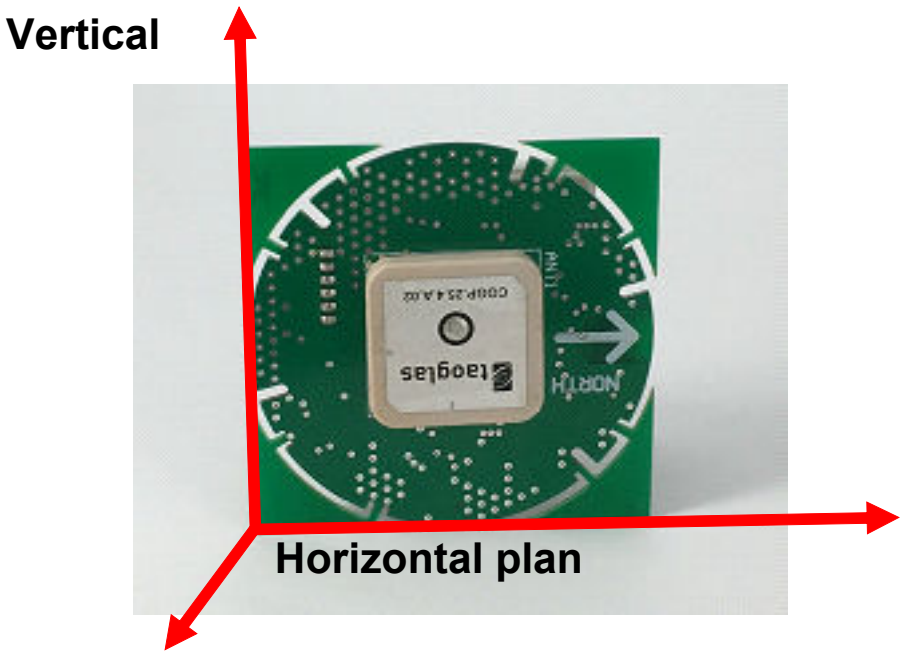
- $PNOVA00,CALIBRATION OK* : the IMU has finished successfully the calibration process

NOTE: *The calibration values are stored into non volatile memory*

$PNOVA83: Runtime user calibration, 90 degrees roll

This message will start the static 90 degrees roll calibration. During the calibration the E-Compass must remain in a fixed 90 degrees roll position so that the IMU captures the zero bias of the accelerometer Z axis and the 1G value of the X axis

Format: $PNOVA83*xx



Acknowledgement:
- $PNOVA83,90 DEGREES ROLL CALIBRATION STARTED* : the IMU is launching the calibration

Information message during the calibration:
- $PNOVA00,JITTER DETECTED* : the IMU is detecting too much jitter thus delaying the calibration

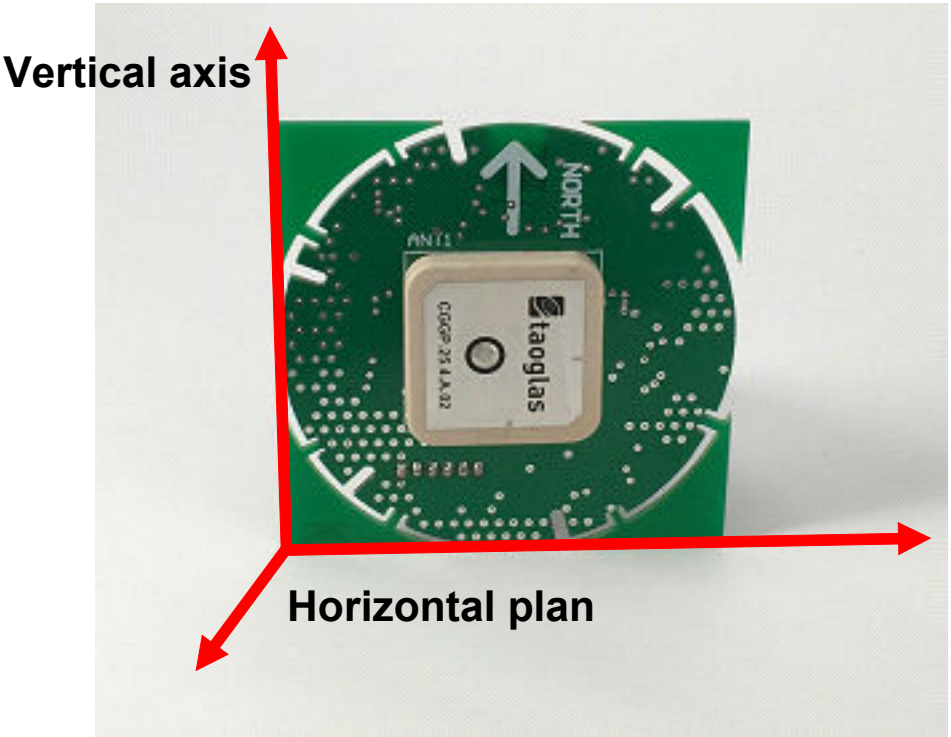
- $PNOVA00,UNIT NOT IN 90 DEGREES ROLL POSITION* : the IMU is detecting that the IMU board is not placed in a 90 degrees roll position

- $PNOVA00,CALIBRATION OK* : the IMU has finished successfully the calibration process

NOTE: *The calibration values are stored into non volatile memory*

$PNOVA84: Runtime user calibration, 90 degrees pitch

This message will start the static 90 degrees pitch calibration. During the calibration the E-Compass must remain in a fixed 90 degrees pitch position so that the IMU captures the 1G bias of the accelerometer X/Y axis and the zero bias of the Z axis
Format: $PNOVA84*xx



Acknowledgement:
- $PNOVA84,90 DEGREES PITCH CALIBRATION STARTED* : the IMU is launching the calibration

Information message during the calibration:

- $PNOVA00,JITTER DETECTED* : the IMU is detecting too much jitter delaying the calibration

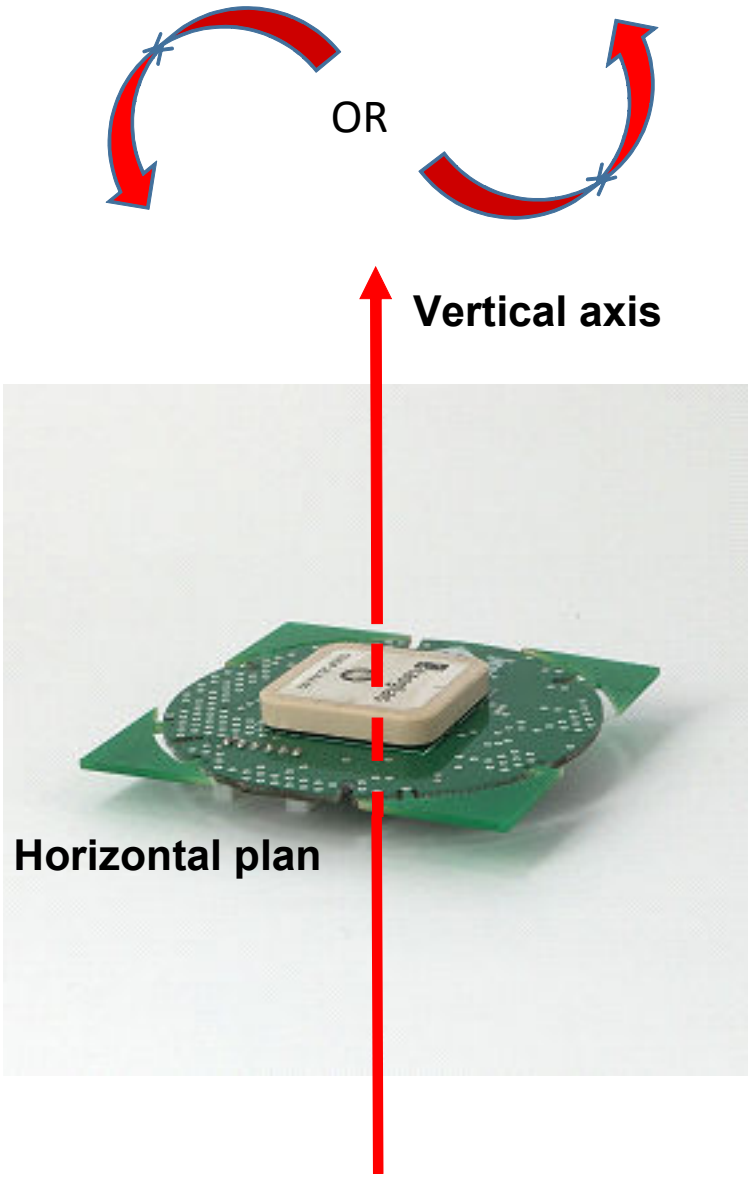
- $PNOVA00,UNIT NOT IN 90 DEGREES PITCH POSITION* : the IMU is detecting that the IMU board is not placed in the horizontal plan

$PNOVA00,CALIBRATION OK* : the IMU has finished successfully the calibration process

NOTE: *The calibration values are stored into non volatile memory*

$PNOVA85: Runtime user calibration, dynamic magnetic horizontal plan

This message will start the dynamic horizontal plan calibration. During the calibration the E-Compass must remain in the horizontal plan and must accomplish at least a revolution of 540 degrees (1.5 turn) at a rotation speed of no more than 360 degrees per second. During this calibration the IMU captures the zero bias of the magnetic X/Y axis.
Format: $PNOVA85*xx



Acknowledgement:
- $PNOVA85,MAGNETIC HORIZONTAL PLAN CALIBRATION STARTED* : the IMU is launching the calibration

Information message during the calibration:
- $PNOVA00,JITTER DETECTED* : the IMU is detecting too much jitter delaying the calibration

- $PNOVA00,UNIT NOT IN HORIZONTAL POSITION* : the IMU is detecting that the IMU board is not placed in the horizontal plan

- $PNOVA00,MAG Calibration 0% : the IMU is (re-)starting the calibration process
- $PNOVA00,MAG Calibration 25% : the calibration process is 25% completed
- $PNOVA00,MAG Calibration 50% : the calibration process is 50% completed
- $PNOVA00,MAG Calibration 75% : the calibration process is 75% completed

- $PNOVA00,CALIBRATION OK* : the IMU has finished successfully the calibration process

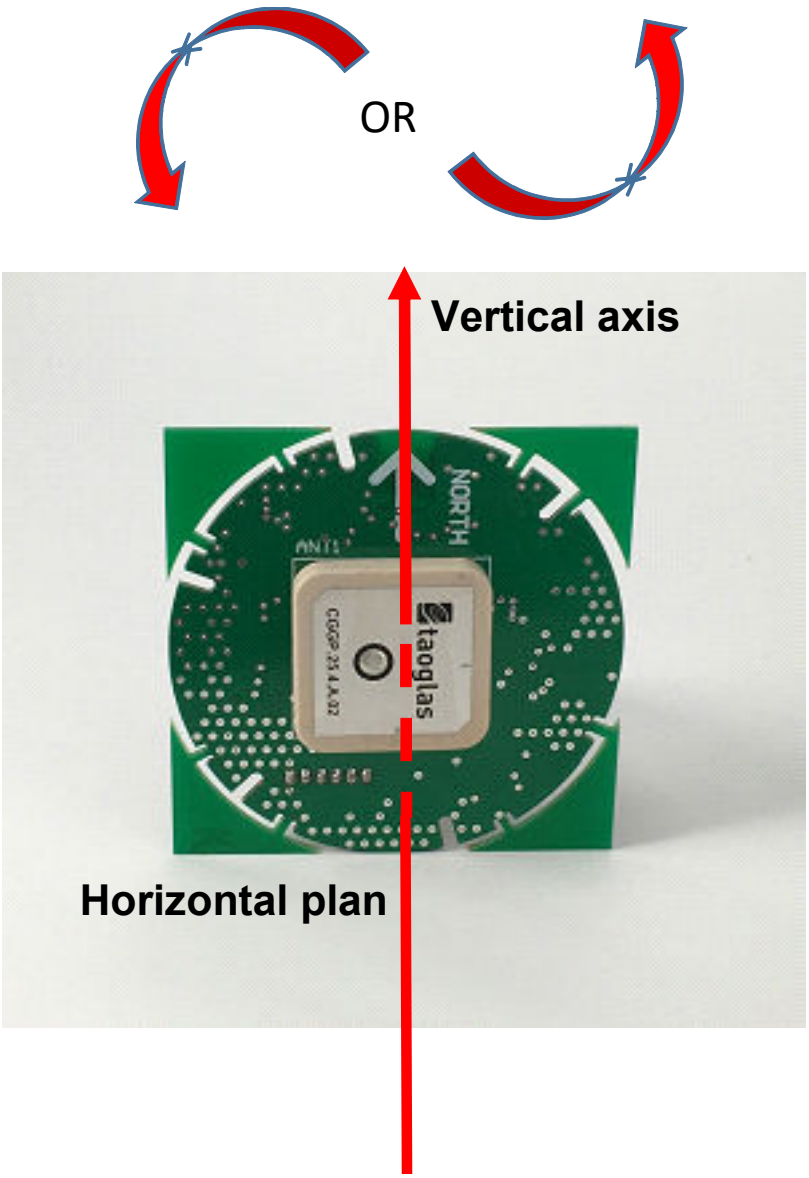
NOTE: *The calibration values are stored into non volatile memory*

$PNOVA86: Runtime user calibration, dynamic magnetic 90 degrees pitch

This message will start the dynamic 90 degrees pitch calibration. During the calibration the E-Compass must remain in the 90 degrees pitch plan and must accomplish at least a revolution of 540 degrees (1.5 turn) at a rotation speed of no more than 360 degrees per second. During this calibration the IMU captures the zero bias of the magnetic Z axis.

Format: $PNOVA86*xx

Proprietary NMEA commands



Acknowledgement:
- $PNOVA86,MAGNETIC 90 DEGREES PITCH CALIBRATION STARTED* : the IMU is launching the calibration

Information message during the calibration:
- $PNOVA00,JITTER DETECTED* : the IMU is detecting too much jitter thus delaying the calibration

- $PNOVA00,UNIT NOT IN 90 DEGREES PITCH POSITION* : the IMU is detecting that the IMU board is not placed in the 90 degrees pitch plan position

- $PNOVA00,MAG Calibration 0% : the IMU is (re-)starting the calibration process
- $PNOVA00,MAG Calibration 25% : the calibration process is 25% completed
- $PNOVA00,MAG Calibration 50% : the calibration process is 50% completed
- $PNOVA00,MAG Calibration 75% : tthe calibration process is 75% completed

-$PNOVA00,CALIBRATION OK* : the IMU has finished successfully the calibration process

NOTE: *The calibration values are stored into non volatile memory*

$PNOVA87: Abort current calibration process

Abort the current ongoing calibration process.

Format: $PNOVA87*xx
xx: checksum

Acknowledgement $PNOVA87,CALIBRATION ABORTED*xx

$PNOVA88: Get the calibration configuration

Get the calibration configuration of the IMU, user or factory values are used to compute the AHRS fusion algorithm.

Format: $PNOVA88*xx
xx: checksum

Acknowledgement : $PNOVA88,a,b,c,d,e*xx\r\n
a: ‘0’ factory, ‘1’ user
- zero bias for the accelerometer X/Y axis, +1G bias for the accelerometer Z axis, zero bias for the gyroscope X/Y/Z axis

b: ‘0’ factory, ‘1’ user
- zero bias for the accelerometer Z axis, +1G bias for the accelerometer X axis

c: ‘0’ factory, ‘1’ user

- +1G bias for the accelerometer Y axis

d: ‘0’ factory, ‘1’ user
- zero bias for the magnetometer X/Y axis

e: ‘0’ factory, ‘1’ user
- zero bias for the magnetometer Z axis

Example: $PNOVA88,0,1,1,0,1*xx

The IMU is using the **factory** calibration of:
- zero bias accelerometer X/Y axis, +1G bias accelerometer Z axis, zero bias gyroscope X/Y/Z axis
- magnetometer X/Y axis

And the IMU is using the **user** calibration of:
- zero bias for the accelerometer Z axis, +1G bias for the accelerometer X axis, +1G bias for the accelerometer Y axis, zero bias for the magnetometer Z axis

$PNOVA89: Set the calibration configuration

Set the calibration configuration of the IMU, user or factory values are used to compute the AHRS fusion algorithm.

Format: $PNOVA89,a,b,c,d,e*xx
xx: checksum

a: ‘0’ factory, ‘1’ user
- use factory or user calibration of zero bias for the accelerometer X/Y axis, +1G bias for the accelerometer Z axis, zero bias for the gyroscope X/Y/Z axis

b: ‘0’ factory, ‘1’ user
- use factory or user calibration of zero bias for the accelerometer Z axis, +1G bias for the accelerometer X axis

c: ‘0’ factory, ‘1’ user
- use factory or user calibration of +1G bias for the accelerometer Y axis

d: ‘0’ factory, ‘1’ user
- use factory or user calibration of zero bias for the magnetometer X/Y axis

e: ‘0’ factory, ‘1’ user
- use factory or user calibration of zero bias for the magnetometer Z axis

NOTE: *The calibration status is stored into non volatile memory*

Acknowledgement: $PNOVA89,OK*xx\n

$PNOVA98: Compute CRC

Compute and compare the internal flash program memory checksum prior to the embedded firmware upgrade process.

Format: $PNOVA98,aaaaaaaa*xx
aaaaaaaa: CRC 32 in hex format
xx: checksum

Example: $PNOVA98,F608F559*01

Acknowledgement:
- $PNOVA98,CRC OK, RESETING NOW FOR UPGRADE*xx when the CRC32 is matching
- $PNOVA98,CRC FAULT*xx when the CRC32 is not matching

NOTE: *when the CRC is matching, the IMU will be reset and the upgrade of the embedded flash memory will be launched*

$PNOVA99: Flash sector

Program the data into flash program memory for further firmware upgrade.

Format: $PNOVA99,aaaa,bbbbbbbbbbbbbbbbbbbbbbbbbbbbbb*xx

aaaa: sector number, 1 to 1984
bbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbb: program data, 32 bytes
xx: checksum

Example: $PNOVA99,41,84BB4CD6D632E393D59020EC01C45789*12
Flash sector 41with “84BB4CD6D632E393D59020EC01C45789” 32 bytes data

Acknowledgement:
- $PNOVA99,aaaa,OK*xx when the flash operation of the sector aaaa is successful
- $PNOVA99,xxx,FAULT*xx when the flash operation of sector aaaa has failed

The E-Compass IMU is compatible with the full SIRF or UBLOX NMEA command protocol. Please refer to the NMEA command protocol document to configure the embedded GPS/GLONASS module.

Example: Query/Rate control of standard SIRF NMEA message $PSRF103
- $PSRF103,00,00,01,01*xx set the GGA NMEA message output every second

Acknowledgement:
- $PSRF,OK*xx
xx: checksum

NOTE: *the NMEA rates are saved into non volatile memory*

3.4 Query/Rate Control: $PSRF103

This message controls the output of only standard NMEA messages GGA, GLL, GSA, GSV, RMC and VTG. It also controls the ZDA message in software that supports it. Using this command message, standard NMEA messages may be polled once, or setup for periodic output. Checksums may also be enabled or disabled depending on the needs of the receiving program. NMEA message settings are saved in battery-backed memory for each entry when the message is accepted.

This message is supported in SiRFstarIV B03 and and partially supported in SiRFstarV. See Table 3.7 for details.

Table 3.7 lists the input values for the following example:

Query the GGA message with checksum enabled.

```
$PSRF103,00,01,00,01*25<CR><LF>
```

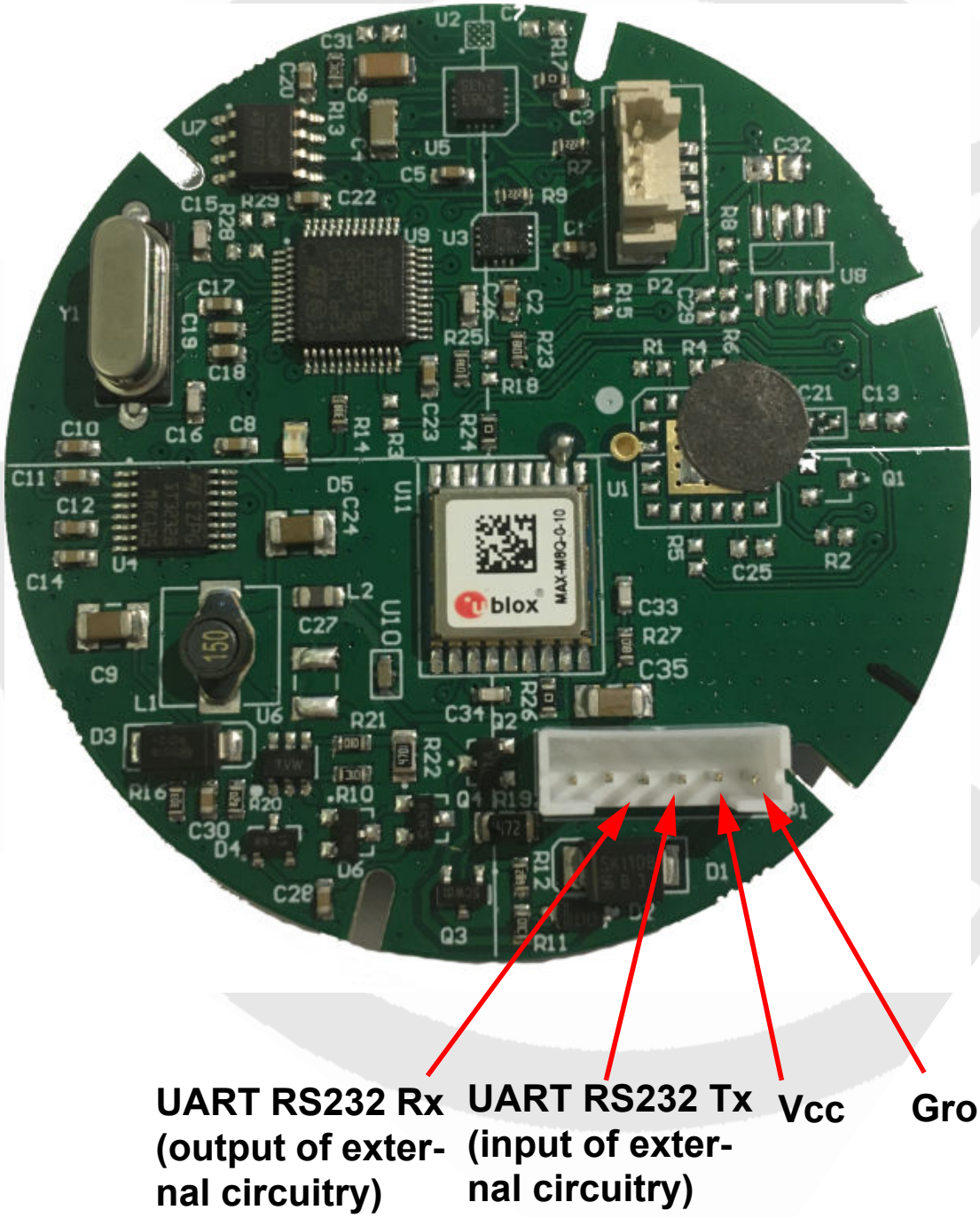
Value	Description
0	GGA
1	GLL
2	GSA
3	GSV
4	RMC
5	VTG
6	MSS (If internal beacon is supported)
7	EPE
8	ZDA (if 1PPS output is supported)
9	GNS

SIRF/UBLOX NMEA commands

Name	Unit	Description
$PSRF103	-	PSRF103 protocol header
Msg	-	Message to control. See Table 3.8 (1)
Mode	-	0: Set rate 1: Query one time 2: ABP on 3: ABP off 4: Reverse EE on 5: Reverse EE off 6: 5Hz Navigation on 7: 5Hz Navigation off 8: SBAS Ranging on 9: SBAS Ranging off 10: FTS (Fast Time Sync) Mode on 11: FTS Mode off 12: SW Tracking Loop on (SiRFstarIV B03 only) 13: SW Tracking Loop off (SiRFstarIV B03 only) 18: SSB Debug (SiRFstarIV B03 only)
Rate	Seconds	Output Rate, 0: off 1 to 255: Seconds between messages(2) If the Mode field is set to 18 (SSB Debug), this field means message level control. Bit mask of Rate wcontrol output of each message. Bit 0 (SiRFstarIV B03 only): SIRF_MSG_SSB_MEASURED_NAVIGATION (MID 2) SIRF_MSG_SSB_MEASURED_TRACKER (MID 4) SIRF_MSG_SSB_OK_TO_SEND (MID 18) Bit 1 (SiRFstarIV B03 only): SIRF_MSG_SSB_NL_MEAS_DATA (MID 28) SIRF_MSG_SSB_NL_DGPS_DATA (MID 29) SIRF_MSG_SSB_NL_SV_STATE_DATA (MID 30) SIRF_MSG_SSB_NL_INIT_DATA (MID 31) SIRF_MSG_SSB_NL_AUX_INIT_DATA (MID 64, SID 1) SIRF_MSG_SSB_NL_AUX_MEAS_DATA (MID 64, SID 2) SIRF_MSG_SSB_NL_AUX_AID_DATA (MID 64, SID 3) SIRF_MSG_SSB_NL_DEBUG_GNSS (MID 64, SID 4) SIRF_MSG_SSB_BEP_SET_TIME_INFO (MID 64,SID 10) Bit 2 (SiRFstarIV B03 only): SIRF_MSG_SSB_GEODETIC_NAVIGATION (MID 41) Bit 3 (SiRFstarIV B03 only): SIRF_MSG_SSB_AGC_GAIN_OUTPUT (MID 91,3) SIRF_MSG_SSB_CW_DATA (MID 92, SID 1) SIRF_MSG_SSB_CW_FILTER (MID 92, SID 2)
CksumEnable	-	0: Disable checksum 1: Enable checksum

A standard 6 pins socket* is used for connecting the external system to the board. Only 4 wires are required: Ground, VCC, RS232 TX, RS232 RX

*(*example of socket: JST (JAPAN SOLDERLESS TERMINALS) B6B-PH-K-S(LF)(SN) Wire-To-Board Connector, PH Series, 6 Contacts, Header, 2 mm, Crimp, 1 Rows)*



Document history

Version 1.0: First version

Version 1.1:
Changed proprietary NMEA header to $PNOVA
Added PSRF Sirf NMEA acknowledgement
Added non volatile memory storage comment for standard NMEA message rates
Added pictures for calibration chapters

Version 1.2:
Added baud rate stored into non volatile memory

Version 1.3:
Modified $PNOVA10 & $PNOVA11 chapters for magnetic declination fixed/ automatic setup and computation

Version 1.4:
Modified $PNOVA01 message, removed 2400, 57600, 115200 baud rates
Added $PNOVA05 and PNOVA06 messages

Modified electrical characteristics section:
- updated voltage input for version 2 HW revision
- added UBLOX chipset support

Version 1.5:
Added electrical connections diagram