

# Inertial+

**Inertial  
and GPS  
Measurement  
System**



## **Inertial+ Generic NMEA Integration**

**Confidently. Accurately.**



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## Introduction

This manual explains how to interface an NMEA capable GPS receiver to the Inertial+. NMEA is a very standard interface that is supported by almost all GPS receivers.

The NMEA interface does not provide the best accuracy; if your receiver has another format that is supported by the Inertial+ then you should use this. The NMEA interface does not include a measurement of vertical velocity, which is needed to get the best performance from the Inertial+. Other formats do provide vertical velocity and, therefore, are more accurate.



### Connection Details

The Inertial+ should be connected to the GPS card using an RS232 Serial Port. On the Inertial+ the “External GPS” connector is used. Most GPS receivers have more than one RS232 port and the Inertial+ should be connected to one of these ports.

The Inertial+ does not use hand-shaking; the processor in the Inertial+ is sufficiently fast so that it is always ready to receive data.

The Inertial+ is wired in the same way as a PC serial port. Use a cable that is suitable for connecting the GPS receiver to a standard, 9-way PC serial port.

Power to the GPS receiver and power to the Inertial+ are wired separately to each product. A common ground should be used to avoid ground problems.



## Messages

Table 1 lists the messages that need to be output to the Inertial+ for correct operation.

**Table 1. NMEA Messages**

Message	Data Rate	Description
GPGGA	1Hz	Required for Latitude, Longitude, Altitude, Number of Satellites
GPRMC	5Hz	Required for Horizontal Speed and Track Angle and Date
GPGSA	1Hz	Required for DOP values
GPGSV	1Hz	Optional: required so Inertial+ can output GSV messages

Note: Accuracy will be worse if the RMC message is output at a lower rate than 5Hz. Using a higher rate will not improve the accuracy and should not be used.

The default baud rate is 9600 baud, 8 data bits, 1 stop bit and no parity should be used. The Inertial+ Config software can be used to change the baud rate, but not the other settings.

The Inertial+ will assume that the time in the NMEA messages is UTC time. The GPS system transmits the UTC offset and most GPS receivers compute UTC time using data from the GPS system. However, check that your GPS receiver does this because the Inertial+ will not work if the NMEA messages are output with the incorrect time.

It is essential to only use NMEA standard messages. Do not interleave any binary or other logs.

Do not use faster rates than the ones listed above. This does not result in higher accuracy, though the Inertial+ may report higher accuracy.

### Using VTG for velocity

Some GPS receivers do not output RMC. The Inertial+ can also use VTG messages but these are more difficult to use since they do not include time. The Inertial+ requires the time of the measurement to be known very accurately in order to use the velocity.

The requirements for using VTG are:

- The VTG message must have GGA and ZDA message sent before it has the correct time in it. The VTG message must not be sent before the GGA or ZDA message from the receiver.
- The GGA or ZDA message must have sufficient decimal places to represent the time accurately (some GPS receivers do not output the decimal part of the time).



Typically a higher baud rate will be required when using VTG as there will not be enough bandwidth on the serial port to transmit all the messages at 9600 baud. The Inertial+ will work up to 115200 baud, which will be more than fast enough.

**Table 2. NMEA Messages for VTG**

Message	Data Rate	Description
GPGGA	1Hz or 5Hz	Required for Latitude, Longitude, Altitude, Number of Satellites. The message must have at least one decimal place in the seconds field.
GPZDA	1Hz	Required for the Date
GPVTG	5Hz	Required for Horizontal Speed and Track Angle
GPGSA	1Hz	Required for DOP values
GPGSV	1Hz	Optional: required so Inertial+ can output GSV messages

Note: Accuracy will be worse if the VTG message is output at a lower rate than 5Hz. Using a higher rate will not improve the accuracy and should not be used.



## Fault Diagnosis

The Inertial+ gets different information from the different NMEA messages. Table 3 and Table 4 show the information that is extracted from each message.

**Table 3. NMEA Message Information using RMC**

Message	Data Rate	Description
GPGGA	1Hz	Required for Latitude, Longitude, Altitude
GPRMC	5Hz	Required for North and East Velocity and Date
GPGSA	1Hz	Required for DOP information and Number of Satellites
GPGSV	1Hz	Optional, this information is just passed through the Inertial+

**Table 4. NMEA Message Information using VTG**

Message	Data Rate	Description
GPGGA	5Hz	Required for Latitude, Longitude, Altitude
GPVTG	5Hz	Required for North and East Velocity
GPZDA	1Hz	Required for Date
GPGSA	1Hz	Required for DOP information and Number of Satellites
GPGSV	1Hz	Optional, this information is just passed through the Inertial+

In addition, the internal GPS *must* have found time and position so that it can accurately synchronise the IMU to the external GPS. An antenna must be fitted to the Primary GPS port in order to get the Inertial+ to work.



**Table 5. Troubleshooting**

Problem	Description
The system appears to work even though the External GPS is not connected	The Inertial+ is configured to use the Internal GPS, which is not as accurate.
The GPS LED is off	There is no data being received from the external GPS. (If corrupt data was being sent then the LED would be flashing red).
The “External GPS Skipped Chars” field is increasing	Check that the baud rate is correct. Check that only NMEA messages are being output on this port.
The software shows that there are some skipped chars from the External GPS	This is normal. As long as the number is not increasing then there is nothing to worry about.
The Position Mode is “None”	The GPGGA message is not being sent by the external GPS or the ZDA message is not being output (VTG only)
The Velocity Mode is “None”	The GPRMC or GPVTG message is not being sent by the external GPS.
The Number of Satellites is not being displayed	The GPGGA message is not being sent by the external GPS.
The Inertial+ does not initialise when driving forwards	If all the data is being received from the external GPS then the Internal GPS is not working correctly. Check the antenna that is connected to the primary port of the Inertial+.
Erratic performance or failure to initialise	Check the external GPS is outputting UTC time in the NMEA messages.
GPGSV output blank	The GPGSV message output by the Inertial+ will only have data in it if the GPS receiver is transmitting GPGSV information. GLONASS information is not fully supported.



## Accuracy Specification

**Table 6. Typical Performance Specification for Inertial+ using NMEA GPS cards**

Parameter	2cm L1/L2 GPS	20cm L1 Float GPS	DGPS	SPS
Positioning	RT2	RT20 OmniStar HP	Differential GPS OmniStar VBS	SPS
Position Accuracy	2cm 1 $\sigma$	20cm (10cm for HP)	0.4m CEP	1.8m CEP L1
Velocity Accuracy	0.1 km/h RMS	0.1 km/h RMS	0.12 km/h RMS	0.15 km/h RMS
Acceleration				
– Bias	10 mm/s <sup>2</sup> 1 $\sigma$	10 mm/s <sup>2</sup> 1 $\sigma$	10 mm/s <sup>2</sup> 1 $\sigma$	10 mm/s <sup>2</sup> 1 $\sigma$
– Linearity	0.01%	0.01%	0.01%	0.01%
– Scale Factor	0.1% 1 $\sigma$	0.1% 1 $\sigma$	0.1% 1 $\sigma$	0.1% 1 $\sigma$
– Range	100 m/s <sup>2</sup>	100 m/s <sup>2</sup>	100 m/s <sup>2</sup>	100 m/s <sup>2</sup>
Roll/Pitch	0.05° 1 $\sigma$	0.06° 1 $\sigma$	0.08° 1 $\sigma$	0.1° 1 $\sigma$
Heading	0.1° 1 $\sigma$	0.1° 1 $\sigma$	0.1° 1 $\sigma$	0.1° 1 $\sigma$
Angular Rate				
– Bias	0.01°/s 1 $\sigma$	0.01°/s 1 $\sigma$	0.01°/s 1 $\sigma$	0.01°/s 1 $\sigma$
– Scale Factor	0.1% 1 $\sigma$	0.1% 1 $\sigma$	0.1% 1 $\sigma$	0.1% 1 $\sigma$
– Range	100°/s	100°/s	100°/s	100°/s
Track (at 50km/h)	0.15° RMS	0.15° RMS	0.15° RMS	0.18° RMS
Update Rate	100 Hz			
Calculation Latency	3.9 ms			

The specification achieved by the Inertial+ will be dependent on the specification of the external GPS receiver. These are the best specifications that are likely to be achieved.



## Revision History

**Table 7. Revision History**

Revision	Comments
080317	Initial version.
090320	Added VTG option.
100716	Added GSV option.