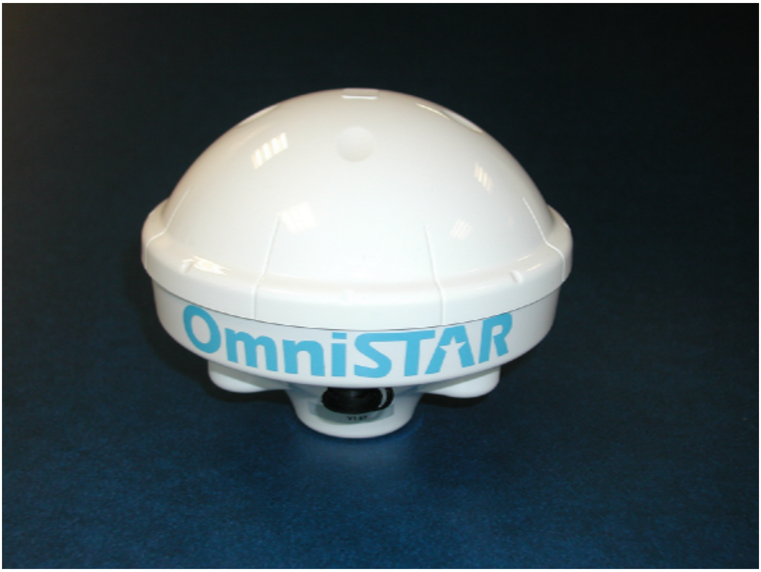
7114LR12

Operator's Manual



OmniSTAR®

The Global Positioning System

Release: May 2004

About this manual

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The information in this manual applies to 7114LR12 receivers with firmware version 1.73

Specifications are subject to change without notice

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Table of contents

List of figures

List of tables

OmniSTAR Limited Warranty

This warranty applies only to normal usage of the product. It does not apply to units or electronic circuit boards, which are defective due to improper installation or handling. Physical damage due to lightning or other electrical discharge and units subjected to fresh or salt-water contamination is not covered. OmniSTAR reserves the right not to warrant the product if, upon request, sufficient proof of recommended installation compliance as laid out in this manual is not provided. No other warranties are expressed or implied. No other warranties exist.

One-Year Limited Hardware Warranty

OmniSTAR reserves the right to repair and/or replace, at its option, any part or parts found to be defective, provided such defects, in their opinion, are due to faulty material or workmanship and are not caused by unauthorised or improper repair or abuse, or normal wear. Purchaser shall be responsible for shipping and insurance of the returned product for repair under this warranty. OmniSTAR will pay shipping and insurance for the product's return to purchaser provided that the product returned proves to be defective under this limited warranty.

OmniSTAR BV and its operating companies world-wide (Fugro NV), warrants this product to be free from defects in workmanship and material for a period of one year from the date of original sale by OmniSTAR or its authorised dealers, to the original purchaser or end user.

OmniSTAR assumes no responsibility for any consequential or incidental losses or damages of any nature with respect to the use of this product.

1. Introduction

The Global Positioning System (GPS) is a reliable, continuous, all-weather navigation system, which is operated by the United States Government. At the time of writing, the space segment of GPS includes a constellation of 28 satellites, which orbit the earth at an altitude of approximately 22.000 km.

These satellites (Space Vehicles or SV's) transmit radio signals containing precise satellite time and position information. By receiving four or more of these signals a 3-dimensional position can be computed.

Although GPS provides an acceptable level of performance for some users, many applications demand a more reliable and precise position than GPS alone can provide. In such cases Differential GPS (DGPS) must be used.

The purpose of DGPS is to minimise the effects of atmospheric and satellite errors on the position determination. In order to achieve this a reference GPS receiver must be installed at a point of known co-ordinates. This receiver uses the radio signals from each of the GPS satellites, which are in view to measure so-called pseudo-ranges to these satellites. Because the exact locations of the satellites and the reference receiver are known, it is then possible to determine the difference between the actual and the expected pseudo-ranges (pseudo-range correction or PRC).

In order to provide compatibility for exchanging this correction data, a standard has been developed by the Radio Technical Commission for Maritime Services Special Committee 104. This standard is commonly known as RTCM SC-104.

When RTCM version 2.0 correction data from the reference receiver is applied to a nearby GPS receiver, the position accuracy will be substantially better than if stand-alone GPS were to be used.

1.1 The OmniSTAR system

The 7114LR12 is one of several DGPS receivers which have been designed to work with the world-wide OmniSTAR service.

The OmniSTAR DGPS system delivers corrections from an array of reference stations, which are located all around the world (see figures 2 and 3 on page 3). The RTCM correction data from these reference stations is provided to OmniSTAR's two Network Control Centres (NCC) , where the corrections are decoded, checked, and repackaged in a highly efficient format for broadcast.

The OmniSTAR data is broadcast over a series of L-band communication satellites. The signal transmitted over each of these satellites contains the corrections from the reference stations in and close to the region in which this satellite can be received.

When a receiver with a valid subscription receives data through one of OmniSTAR's satellite channels it will output a differentially corrected position.

1.2 Subscription

The 7114LR12 supports the following OmniSTAR service:

• Virtual Base Station (VBS), where the data from multiple reference stations is used in the processor software to produce enhanced corrections for the user's location. This service provides optimal position accuracy with a minimum dependence on the user’s location. The VBS service can be obtained on a continental, regional or farm license basis.

Figure 1: Artist impression of the OmniSTAR system

Figure 2: World coverage map for the OmniSTAR service

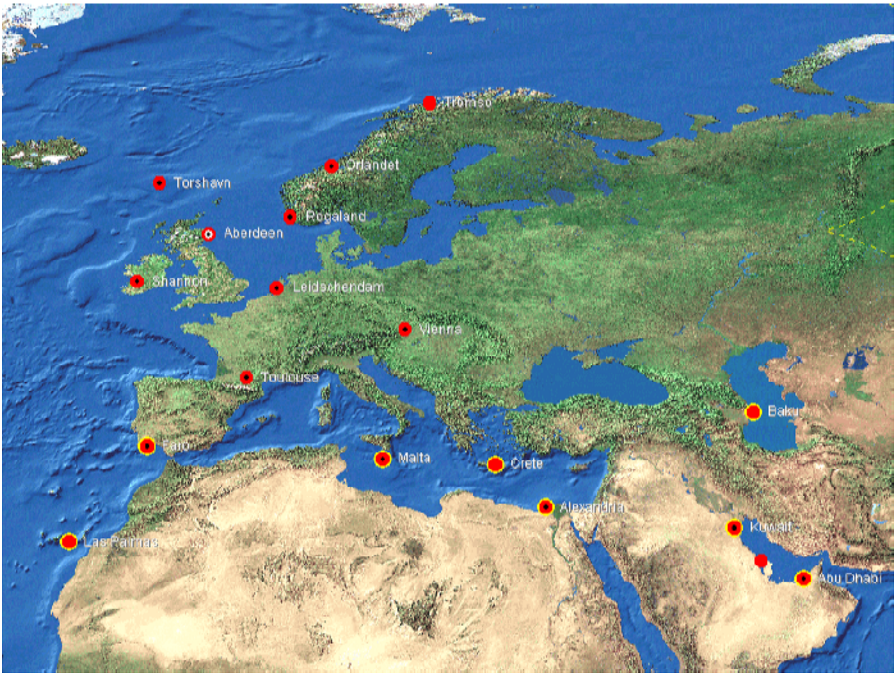


Figure 3: EA-SAT coverage area and reference stations

2. Factors affecting system performance

The 7114LR12 has proven to be a high-quality, sub-meter positioning device. The accuracy that the user can obtain depends on several factors, including:

- Number of visible satellites
- Multipath
- Dilution of Precision (DOP)
- Satellite elevations
- GPS mode
- Differential correction
- DGPS mode

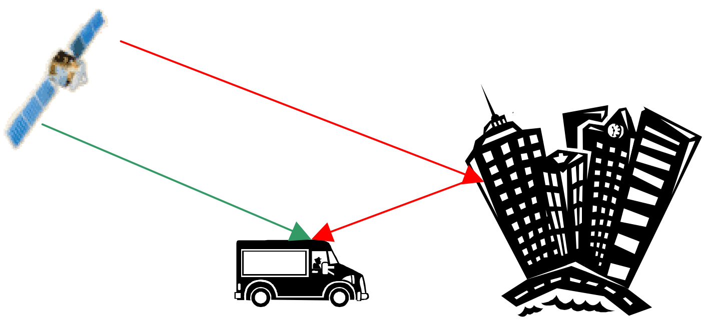
2.1 Number of visible satellites

A minimum of four satellites is required to calculate a 3-dimensional position. In general it can be said that every increase in the number of visible satellites will result in an increase in the system's accuracy. As the GPS satellites orbit around the earth the number of visible satellites will change in time. The GPS constellation has been designed so as to provide a minimum of 4 visible satellites at any location at all times. The number of visible satellites can decrease due to blockage by objects such as trees and buildings.

2.2 Multipath

It is possible for satellite signals to reflect off large nearby objects such as buildings, cars or even the ground, thereby resulting in an erroneous distance measurement. This phenomenon is known as multipath. Multipath can cause significant errors in the position determination and it is therefore important to place the receiver in an environment, which is free of large reflective surfaces. It is also recommended to mount the receiver directly onto a surface, while maintaining a clear view of the sky in all directions.

Figure 4: Multipath



2.3 Position Dilution of Precision (DOP)

The Position Dilution of Precision (PDOP) is a measure of the satellite geometry. The lower the PDOP value, the more accurate the GPS position will be. By default the 7114LR12 is configured to output position data as long as the Position Dilution of Precision does not exceed 6.

2.4 Satellite elevations

The signal from a satellite, which is low on the horizon, will travel a greater distance through the atmosphere. This results in lower signal strength and a delayed reception, thereby causing erroneous and noisy data. By default the 7114LR12 is configured to ignore any satellites that have an elevation angle lower than 5°.

2.5 GPS mode

The default GPS position mode is Auto 2D/3D. Three-dimensional positions are more accurate than two-dimensional positions, so changing the receiver to Manual 3D prevents 2D positions from being computed.

2.6 Differential corrections

For accurate positioning it is essential that the differential corrections are being received. In order to ensure reception of the OmniSTAR satellite signal it must be prevented that the line of sight towards the satellite is blocked by objects such as trees and buildings.

Multipath reflections can cause destructive interference, thereby significantly decreasing the signal strength. It is therefore recommended to mount the 7114LR12 directly onto a surface in a reflection free environment.

Although the 7114LR12 has been designed to provide optimal system performance under most circumstances, it is possible, due to the nature of radio communications, that system performance degrades due to local interference sources.

2.7 DGPS mode

The DGPS mode default setting is DGPS Auto/On/Off. Selecting DGPS Only, restricting the receiver to only output differential GPS positions, prevents autonomous (non-differential) positions from being computed.

3. Installation

This chapter contains instructions and recommendations for the installation of the 7114LR12.

3.1 System parts list

A shipment usually consists of:

- 7114LR12 receiver (part nr: REC-7114LR12)
- Combined data/power cable
- This manual
- Magnetic mount
- Configuration software

3.2 Installing the 7114LR12

In order to provide for a smooth and successful installation, please observe the following instructions and recommendations.

3.2.1 Receiver placement

The 7114LR12 may be mounted using the three M5 threaded inserts in the receiver's base plate, or the 5/8 threaded insert in the centre of the receiver's base plate with a pole or the magnetic mount.

When selecting a location for installation make sure that:

- The receiver is within reach of power and data cable connections
- The cable can not be bent or damaged by external components
- The receiver has a clear line of sight towards the L-band communication satellite. Since these satellites are located above the equator, they are to the South of Europe at an elevation angle of 20° (Oslo) to 45° (Athens).

3.2.2 Power considerations

Power can be supplied to the 7114LR12 by connecting 9-32 VDC on the red power wire. The other power wire should be connected to ground.

Only supply power after the cable has been connected to the 7114LR12.
Never attach or detach a powered cable to/from the unit.

The power consumption of the 7114LR12 is 250 mA at 12 V.

3.3 Receiver connections

Figure 5 shows the bottom of the 7114LR12 receiver and its connection port.

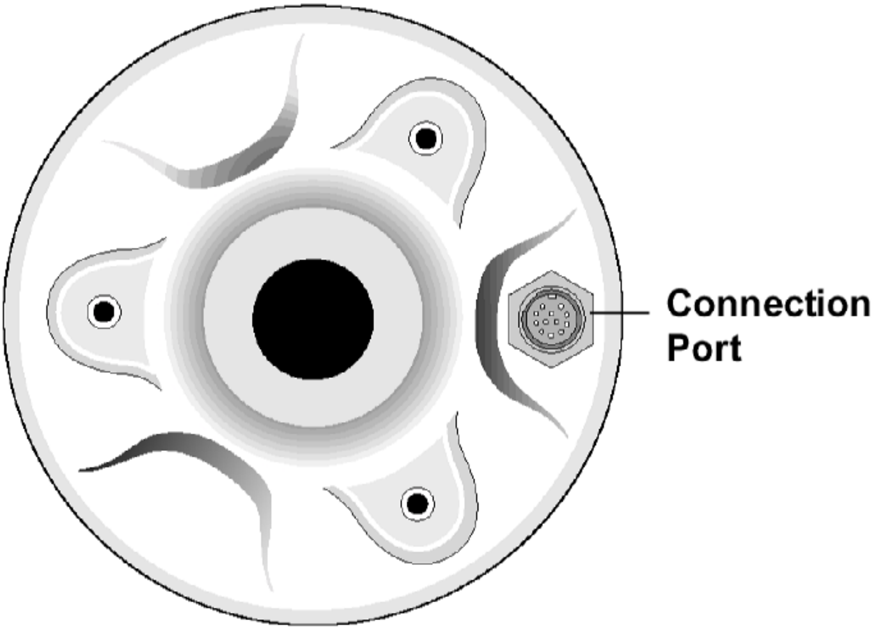


Figure 5: 7114LR12 Receiver Bottom View

The connection port can accept power. The 7114LR12 standard power/data cable supplies power and features a data connector for interfacing to an external device. For more information, see Cables and Connectors, page 10.

3.3.1 ASCII and TSIP Input

The connection port can be used to input ASCII, TSIP and CAN data from an external device. ASCII data can be received from an external sensor, converted into a NMEA message, and exported to another device. TSIP command packets are used to set and monitor GPS and Satellite DGPS parameters using the included configuration software program.

3.3.2 RTCM, TSIP and NMEA Output

The connection port is used to output RTCM, TSIP, NMEA 0183 or CAN messages to an interface device. TSIP is output when communicating with the included configuration software. NMEA is output when exporting GPS position information to an external device, such as a Pocket PC with mapping software.

CAN is used when communicating over a Can bus system to other connected external devices.

3.3.3 1 PPS Output

The connection port can output a 1 PPS (pulse per second) strobe signal to synchronise the external instruments to the receiver's internal clock.

3.4 Startup procedure

Consider the following guidelines before starting to work with the system:

- Normally the receiver software is already set to the user's specific requirements
- Make sure that the 7114LR12 has a clear line of sight to the communication satellite
- Connect the 9 pin sub-D connector to a PC (or other logging device), which has been set to communicate using 9600,8,N,1
- Connect the power cable to an appropriate power supply (9 to 32 VDC) which has been turned off
- Turn on the power supply

*When the unit is used for the first time, has not been used for a long period of time, or has been moved a long distance it may take up to **12.5** minutes to start outputting NMEA messages. The outputting of differentially corrected NMEA may take up to **45** minutes under these circumstances.*

3.5 Subscription (re) activation

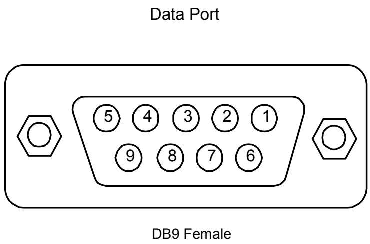
If the OmniSTAR subscription on your 7114LR12 has not been activated yet, will expire soon or has been expired already, a new subscription can be sent over the satellite link.

The procedure for obtaining a new subscription is:

- Fill in the *OmniSTAR subscription agreement* form (see Appendix E)
- Fax the form to OmniSTAR BV at +31-70-3170919
- At the agreed time of activation make sure your receiver is outside and in a place where it will be able to receive signals from the communication satellite
- Have the receiver switched on at the time of activation

At the time of activation a series of commands containing the new expiry date and other subscription information will be sent over the satellite link to your 7114LR12 receiver. If your receiver does not start outputting differential position data within 45 minutes after the activation time, please contact OmniSTAR by phone at +31-70-3170900.

4. Cable and Connectors



Pin#	Signal
1	N/A
2	RXD
3	TXD
4	EVE
5	GND
6	N/A
7	N/A
8	N/A
9	N/A

Figure 6: Pinning of the 9 pin sub-D connector on the power/data cable

Figure 7: Pins of the 12-pin male (left) and 12-pin female (right) connectors

P1 Conn 12-Pin (F)		7 Conn Cable	P2 Conn DB-9 (F)		P3 Conn 12-Pin (M)		Red/ Black
Pin	**Signal**	**Color**	**Pin**	**Signal**	**Pin**	**Signal**	**Wires**
1	EVENT IN	Brown	4	EVENT			
2	TX	Yellow	2	RXD			
3	RX	Orange	3	TXD			
4							
5	SIG GND				5	GND	
6	TX	Green			2	RX	
7							
8	RX	Blue			3	TX	
9							
10	V+	Red			10	V+	Red V+
11	V-	Black	5	GND	11	V-	Black V-
12							

Table 1: 7114LR12 Power/Data cable pin connections

4.1 Routing and connecting the 7114LR12 data/power cable

A 5-meter (16.5-foot) data/power cable is included with your 7114LR12 receiver (see Figure 8). One end of the cable features a 90-degree connector. The opposite end features a 9-pin connector (Port A) and a straight round 12-pin connector (Port B). Connect the 90-degree connector to the bare of the receiver, then route the cable to the external device.

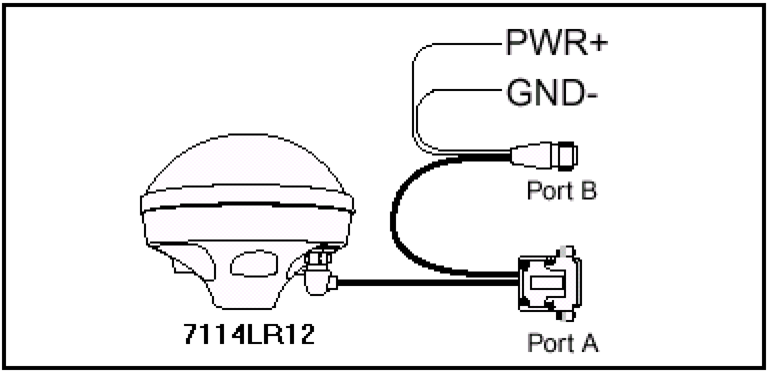


Figure 8: 7114LR12 Standard data/power cable

When routing the data cable, avoid the following hazards:

- sharp ends or kinks in the cable
- hot surfaces (exhaust manifolds or stacks)
- rotating or moving machinery parts
- sharp or abrasive surfaces
- door and window jams
- corrosive fluids or gases

4.2 Connecting to external equipment

The 7114LR12 uses the RS232 protocol to communicate with external equipment.

The 7114LR12 is normally shipped for communicating with the following settings:

9600 BPS
8 bits
No parity
1 stop bit

The 7114LR12 is normally configured to output the following NMEA sentences:

GGA
GLL
GSA
VTG

Other NMEA sentences are available (see Appendix D). The software program View 3200 can be used to select different NMEA sentences (see View 3200 manual).

Figure 9 shows the standard data/power cable connection to a laptop computer.

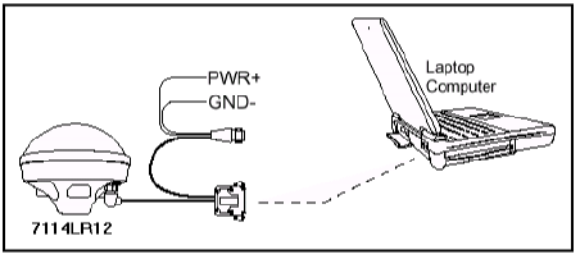


Figure 9: 7114LR12 receiver to a laptop computer

Figure 10 shows the standard data/power cable connection to a Pocket PC.

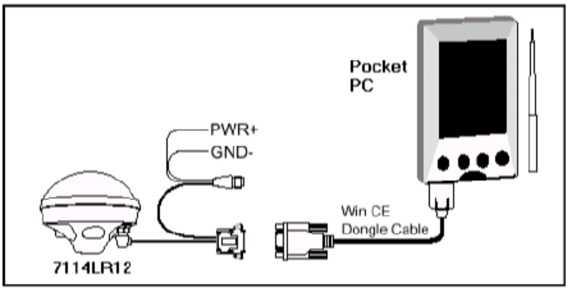


Figure 10: 7114LR12 receiver to a Pocket PC

5 Troubleshooting

This chapter covers frequently asked questions and troubleshooting techniques for the 7114LR12 receiver. OmniSTAR recommends you to read through this chapter before calling technical support.

5.1 Increasing GPS accuracy

The 7114LR12 receiver always gives the most accurate position under the current GPS, satellite differential operating conditions. By manipulating various GPS masks, some satellite configurations are locked out, preventing less accurate positions from being computed. However, these changes can prevent positions from being output. If your GPS application can tolerate occasional outages, then more accuracy is possible by changing the various GPS receiver parameters from their default values. There are many GPS receiver parameters that affect accuracy. For more information see page 4, Factors affecting system performance.

5.2 Intermittent GPS loss

When GPS lock is intermittent, the power/data cable may have a loose connection. Check that all connections are secured properly. Water may enter the cable connection and cause intermittent loss of GPS. Disconnect the cable and let the connection dry. Reconnect the cable. If the receiver is connected properly, make sure that it is mounted on the highest point of the vehicle, so that no GPS signals are blocked. Depending on the orientation of the vehicle, the satellites and the possible obstruction, one or more satellites may be blocked. Sometimes blocking shows up when traveling one direction, but not while traveling other directions. If the receiver seems fine, check the configuration masks. If the PDOP or SNR Masks are set to extreme levels, the receiver could possibly ignore valid satellite data. The default SNR Mask is 6. The default PDOP Mask is 6.

5.3 Power lines and strong magnetic fields

In Europe, the energy from power lines is 50 Hz. The harmonic energy falls off rapidly as the frequency increases. Thus, power lines have very little effect on the GPS & Satellite Differential Signals.

Strong magnetic fields have no effect on GPS & Satellite Differential signals. Some computers and other electric equipment radiate electromagnetic energy that can interfere with a GPS receiver. If you suspect interference from a local magnetic field, move the receiver away from, or turn off the suspect electronics while observing the GPS receiver's number of satellites being tracked or satellite's signal-to-noise ratio.

5.4 Choosing an mounting location

The receiver must be mounted so that it has a clear view of the sky, on the center line of the vehicle, away from any sources of interference like electric motors. See Installation, page 6.

5.5 Checking for cable failure

To check a cable for a short, use an ohmmeter. The resistance of a good cable between connector pins at each end of the cable, is zero. If the cable checks out fine, but you are confident it is the cable causing the errors, swap out the cable with another known working cable (if possible). If the cable is defective, contact OmniSTAR for a replacement.

5.6 Reducing engine noise

An unshielded ignition system can radiate enough noise to block reception of the OmniSTAR signal. To solve this problem, use resistor spark plug wires. Sometimes an alternator generates noise that interferes with the signal. Use bypass capacitors, commonly available in automotive stores for cleaning up interference to CB and other radios. If the problem persists, engine components can be shielded with aluminum foil. Before purchasing new engine parts, make sure that there is not a PC computer or power source near the 7114LR12 receiver. Some PCs and their power sources generate noise that is disruptive to the GPS & satellite DGPS signals.

5.7 Why satellite DGPS works in some places but not others

Local canopy cover in the direction of the differential satellite can reduce the correction signal strength to unusable levels. Wet canopy reduces signals even more. The same local environmental factors that affect GPS signals, such as radar sets, microwave transmitters, and the like can interfere with the differential satellite signals.

5.8 Verifying the unit is outputting NMEA messages

Connect the 7114LR12 receiver to a PC with the Standard Data/Power Cable and use Windows 95/98’s HyperTerminal or any other terminal program to view the NMEA messages input through the computer’s serial port. The default NMEA parameters are 9600-N-8-1.

5.9 Losing configuration settings when the receiver is powered off

The 7114LR12 receiver configuration parameter settings are stored in battery-backed RAM (random access memory). The Lithium battery has a 10-year life span. You can assume the Lithium battery has failed when the receiver no longer retains configuration parameter setting changes.

Note – The receiver can continue to use the default configuration parameters, but does not retain any custom changes to the default settings after it is powered off. Contact OmniSTAR Technical Support Service at +31-70-3170900 to arrange for replacement of Lithium batteries.

5.10 Troubleshooting guide

Use the following diagram to identify and solve problems in the event that the 7114LR12 does not output a differentially corrected position.

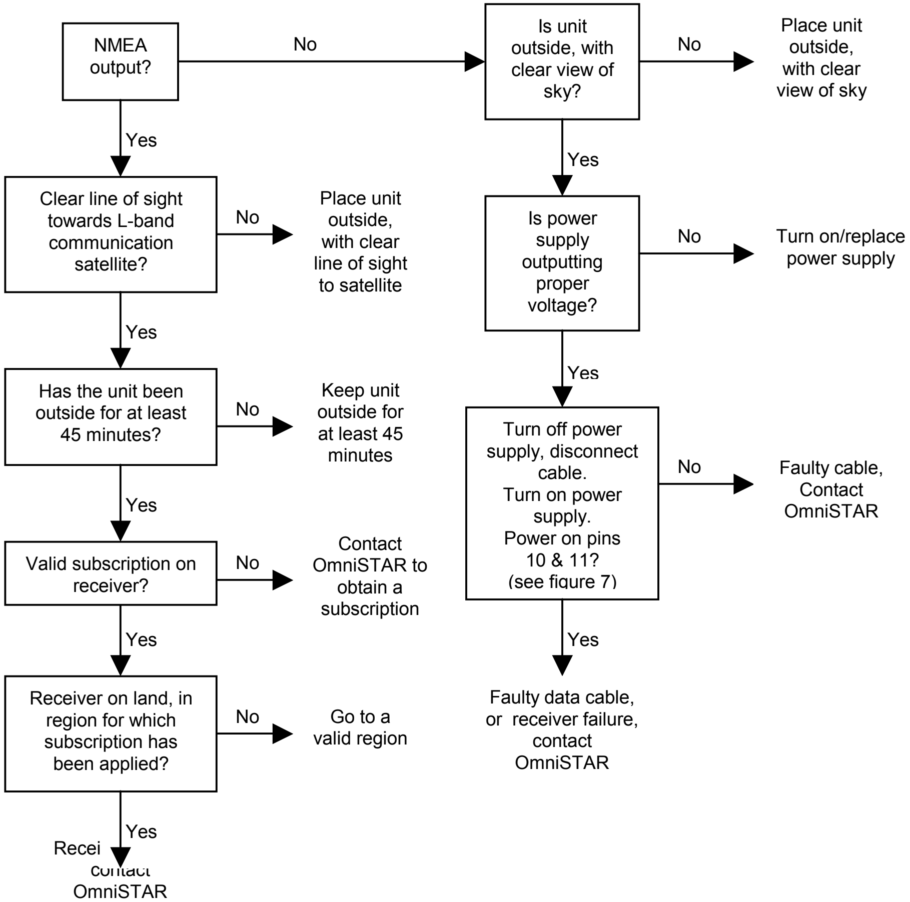


Figure 11: Troubleshooting

5.11 Contacting OmniSTAR

If you encounter a technical problem during installation or system operation, please contact OmniSTAR at +31-70-3170900.

Appendix A - Specifications

This chapter provides the 7114LR12's specifications.

Table 2: 7114LR12 specifications

OmniSTAR Engine	
Frequency Range	1525 – 1560 MHz

GPS Engine	
General	12 channel, parallel tracking L1 C/A code and carrier phase filtered measurements and multi-bit digitizer
Update rate	1 Hz standard; 2, 5, 10 Hz optional
Frequency	1575.42 MHz

Serial Interface	
Serial Protocol	RS-232
Serial Bus	CANBUS Hi & Lo
Baud rate	300, 600, 1200, 2400, 4800, 9600, 19200, 38400 default = 9600,8,N,1
Data output	NMEA (RTCM optional)
Data rate	1 Hz (2, 5, 10 Hz optional)

Power Specifications	
Power supply	9 – 32 VDC
Power consumption	250 mA at 12 V

Physical Characteristics	
Weight	0.52 kg
Dimensions	Circular housing diameter: 152 mm height: 127 mm
Casing	UV resistant plastic, dust-proof, waterproof, shock resistant

Environmental Specifications	
Operating Temperature	-30°C to 60°C
Storage Temperature	-40°C to 80°C
Humidity	100% condensing, unit fully sealed

Approvals	
Compliance	FCC Class B, CE, EP 455

Appendix B – List of communication satellites

The following table presents a list of L-band communication satellites, which will enable you to use your 7114LR12 over the entire world (depending on your subscription type you might only be entitled to a restricted area).

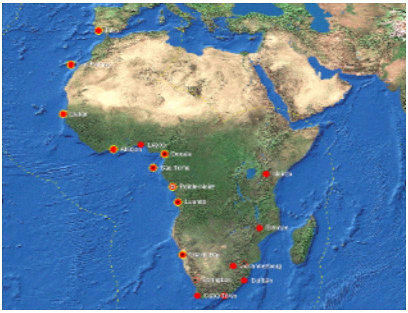
Table 3: World-wide satellite frequencies and symbol rates

Satellite Channel	Frequency (MHz)	Baud Rate
AF-SAT	1535.1400	600
EA-SAT	1535.1525	1200
AP-SAT	1535.1375	1200
AM-SAT	1535.1375	1200

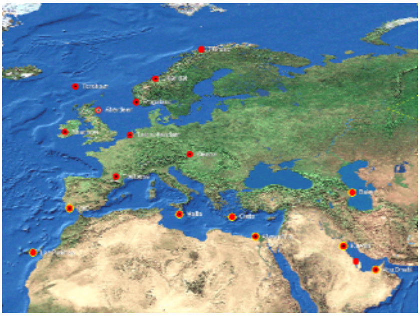
The coverage-area of each satellite and its reference stations are displayed in the following figures.

Figure 12: Reference stations and coverage area per satellite

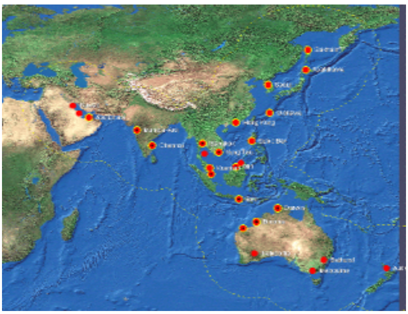
AF-SAT



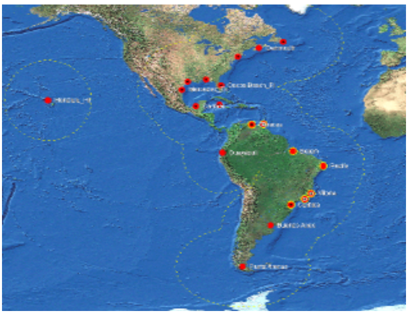
EA-SAT



AP-SAT



AM-SAT



APPENDIX C

List of reference stations

The following tables present the current list of reference stations, which are broadcast over the different satellites. Check www.surveyplanner.com for the latest updates of these lists.

Table 4: Reference stations on EA-SAT

Nr	Station	ID	VBS	HP
1	Abu Dhabi, UAE	016	YES	YES
2	Kuwait	290	YES	YES
3	Bahrain	260	YES	NO
4	Aberdeen, Scotland	571	YES	YES
5	Alexandria, Egypt	310	YES	NO
6	Astrakhan, Russia	462	YES	NO
7	Baku, Azerbaijan	400	YES	NO
8	Bodo, Norway	122	YES	NO
9	Crete, Greece	340	YES	NO
10	Faro, Portugal	371	YES	YES
11	Istanbul, Turkey	410	YES	NO
12	Leidschendam, The Netherlands	521	YES	YES
13	Malta	351	YES	NO
14	Ny Alesund, Spitsbergen	101	YES	NO
15	Orlandet, Norway	630	YES	YES
16	Rogaland, Norway	580	YES	YES
17	Shannon, Ireland	530	YES	NO
18	Torshavn, Faroes	620	YES	NO
19	Toulouse, France	431	YES	NO
20	Tromso, Norway	690	YES	NO
21	Vardo, Norway	114	YES	NO
22	Visby, Sweden	229	YES	NO
23	Vienna, Austria	480	YES	NO

Table 5: Reference stations on AF-SAT

Nr	Station	ID	VBS	HP
1	Abidjan, Ivory Coast	050	YES	NO
2	Blantyre, Malawi	155	YES	NO
3	Cape Town, South Africa	335	YES	NO
4	Dakar, Senegal	144	YES	NO

5	Douala, Cameroon	043	YES	YES
6	Durban, South Africa	305	YES	NO
7	Faro, Portugal	371	YES	NO
8	Lagos, Nigeria	060	YES	NO
9	Las Palmas, Canaries	280	YES	NO
10	Luanda, Angola	095	YES	YES
11	Nairobi, Kenya	015	YES	NO
13	Pointe-Noire, Congo	045	YES	YES
14	Port Elizabeth, South Africa	337	YES	NO
15	Rogaland, Norway	580	YES	YES
16	Sao Tome, Sao Tome	011	YES	YES
17	Walvis Bay, Namibia	235	YES	NO

Table 6: Reference stations on AP-Sat

Nr	Station	ID	VBS	HP
1	Auckland, NZ	022	YES	NO
2	Karratha, Australia	215	YES	NO
3	Darwin, Australia	125	YES	NO
4	Broome, Australia	185	YES	NO
9	Asahikawa, Japan	261	YES	NO
10	Singapore	010	YES	YES
11	Miri, Malaysia	042	YES	YES
12	Vung Tua, Vietnam	012	YES	YES
13	Hong Kong	220	YES	NO
14	Seoul, S. Korea	370	YES	NO
15	Kota Kinabalu, Malaysia	061	YES	NO
16	Bali, Indonesia	096	YES	YES
17	Mumbai-Arvi, India	191	YES	YES
19	Subic Bay, Phillipines	151	YES	NO
20	Kuwait	290	YES	NO
21	Abu Dhabi, UAE	016	YES	NO
23	Kuantan, Malaysia	041	YES	NO
25	Bangkok, Thailand	141	YES	YES
26	Chennai, India	131	YES	NO
27	Bathurst, Australia	336	YES	NO
28	Kalgoorlie, Australia	315	YES	NO
31	Melbourne, Australia	385	YES	NO

32	Okinawa, Japan	261	YES	NO
33	Platong, Thailand	018	YES	NO
34	Sakhalin, Russia	510	YES	NO
35	Bahrain, Bahrain	260	YES	NO

Table 7: Reference stations on AM-Sat

Nr	Station	ID	VBS	HP
1	Houston, Texas	100	YES	YES
2	Cocoa Beach, Florida	120	YES	YES
3	Long Island, New York	333	YES	YES
4	Carmen, Mexico	110	YES	YES
5	Punta Arenas, Chile	210	YES	NO
6	Guayaquil, Ecuador	202	YES	NO
7	Rio de Janeiro, Brazil	225	YES	YES
8	St. Johns, Newfoundland	470	YES	YES
9	Dartmouth, Nova Scotia	440	YES	NO
10	Recife, Brazil	075	YES	NO
11	Port Of Spain, Trinidad	111	YES	YES
12	Caracas, Venezuela	112	YES	YES
13	Belem, Brazil	017	YES	NO
14	Caymen, Grand Cayman	192	YES	YES
15	Honolulu, USA	210	YES	NO
16	Curtiba, Brazil	257	YES	YES
17	Pensacola, USA	301	YES	YES
18	Vitoria, Brazil	205	YES	YES
19	Mercedes, USA	263	YES	YES
20	Buenos Aires, Argentina	345	YES	NO

Appendix D - NMEA 0183

D.1 NMEA introduction

NMEA 0183 is an interface protocol created by the National Marine Electronics Association. The latest release of NMEA 0183 is Version 2.2. This protocol was originally established to allow marine navigation equipment to share information. NMEA 0183 is a simple, yet comprehensive ASCII protocol, which defines both the communication interface and the data format.

D.2 NMEA 0183 message options

The OmniSTAR 7114LR12 is normally configured to output the GGA, GLL, GSA and VTG NMEA 0183 sentences. Sentences can be added or removed at the customer's request. The output rate is normally configured at a 1-second interval.

Table 8: NMEA 0183 message options

Standard	Message Sentence	Description
	ALM	GPS Almanac Data
	GBS	GNSS Satellite Fault Detection
*	GGA	GPS Fix Data
*	GLL	Geographic Position – Latitude/Longitude
	GRS	GPS Range Residuals
*	GSA	GPS DOP and Active Satellites
	GST	GPS Pseudorange Noise Statistics
	GSV	GPS Satellites in View
	RMC	Recommended Minimum Specific GPS Data
*	VTG	Track Made Good and Ground Speed
	ZDA	Time and Date
	PTNLDG	DGPS Receiver Status
	PTNL, GGK	Time, Position, Position Type and DOP Values
	PTNLID	Receiver Identity
	PTNLSM	RTCM Special Message

D.3 NMEA 0183 message format

NMEA 0183 allows a single source (talker) to transmit serial data over a single twisted wire pair to one or more receivers (listeners). The NMEA 0183 protocol covers a broad array of navigational data. This is separated into discrete messages, which convey a specific set of information. The NMEA 0183 message structure is outlined below.

$IDMSG,D1,D2,D3,D4,……..,Dn*CS[CR][LF]

"$"	The "$" signifies the start of message.
ID	The Talker identification is a two-letter mnemonic, which describes the source of the navigation information. The GP identification signifies a GPS source.
MSG	The message identification is a three letter mnemonic which describes the message content and the number and order of the data fields.
","	Commas serve as eliminators for the data fields.
Dn	Each message contains multiple data fields (Dn) which are delimited by commas.
"*"	The asterisk serves as a checksum delimiter.
CS	The checksum field contains two ASCII characters, which indicate the hexadecimal value of the checksum.
[CR][LF]	The carriage return [CR] and line feed [LF] combination terminates the message.

NMEA messages vary in length, but each message is limited to 79 characters or less. This length limitation excludes the "$" and the [CR] [LF]. The data field block, including delimiters, is limited to 74 characters or less.

D.4 NMEA 0183 Message Formats

In this section each message is described in more detail.

ALM – GPS Almanac Data

The ALM message identifies the GPS week, SV health and contains the almanac for one satellite. One sentence per satellite, up to a maximum of 32.

$GPALM,1,1,03,698,00,6ae6,1d,779f,fdef,a10d68,6469a6,7c1f62,5f583
9,*43

Field Number	Description
1	Total number of ALM sentences for this cycle
2	Sentence sequence number
3	SV PRN number, 01 to 32
4	GPS week number
5	SV health status
6	Eccentricity
7	Almanac reference time
8	Inclination angle
9	Rate of right ascension
10	Root of semi-major axis
11	Argument of perigee
12	Longitude of ascension node
13	Mean anomaly
14	A f0, clock parameter
15	A f1, clock parameter

Table 9: Description of the ALM message.

GBS – GNSS Satellite Fault Detection

The GBS sentence is used to support Receiver Autonomous Integrity Monitoring (RAIM).

$GBS,183059.30,0.0,0.0,0.0,0.0,0.0,0.0*6F

Field Number	Description
1	UTC time of the GGA or GNS fix associated with this sentence.
2	Expected error in latitude.
3	Expected error in longitude.
4	Expected error in altitude.
5	ID number of most likely failed satellite.
6	Probability of missed detection for most likely failed satellite.
7	Estimate of bias, in meters, on most likely failed satellite.
8	Standard deviation of bias estimate.

Table 10: Description of the GBS message.

NOTE:
* Because the contents of this NMEA message do not change significantly during a 1-second interval, the receiver outputs this message at a maximum rate of 1 Hz.

GGA – GPS Fix Data

The GGA message includes time, position and fix related data for the GPS receiver.

$GPGGA,hhmmss.s,llll.llll,a,yyyyy.yyyy,a,x,xx,x.x,x.x,M,x.x,M,x.x,xxxx

Field Number	Description
1	UTC of Position
2,3	Latitude, N (North) or S (South). *
4,5	Longitude, E(East) or W (West). *
6	GPS Quality Indicator: 0=No GPS, 1=GPS, 2=DGPS.
7	Number of Satellites in Use.
8	Horizontal Dilution of Precision (HDOP).
9,10	Height above Mean Sea level in Meters, M = Meters.
11,12	Geodial Separation in Meters, M = Meters. **
13	Age of Differential GPS Data. ***
14	Differential Reference Station ID (0000 – 1023)

Table 11: Description of the GGA message.

NOTES:
* The GGA message provides 4 decimal points of precision in non-differential mode, and 5 decimal points of accuracy in differential mode.

** Geodial Separation is the difference between the WGS-84 earth ellipsoid and mean-sea-level (MSL).

*** Time in seconds since the last RTCM SC-104 message type 1 or type 9 update.

GLL – Geographic Position – Latitude/Longitude

The GLL message contains the latitude and longitude of the present position, the time of the position fix and the status.

$GPGLL,llll.lll,a,yyyyy.yyy,a,hhmmss.s,A

Field Number	Description
1,2	Latitude, N (North) or S (South).
3,4	Longitude, E (East) or W (West).
5	UTC of Position.
6	Status: A = Valid, V = Invalid.

Table 12: Description of the GLL message.

GRS – GPS Range Residuals

The GRS sentence is used to support the Receiver Autonomous Integrity Monitoring (RAIM).

$GPGRS,220320.0,0,-0.8,-0.2,-0.1,-0.2,0.8,0.6,,,,,,*55

Field Number	Description
1	UTC time of GGA position fix
2	Residuals 0: Residuals used to calculate position given in the matching GGA line 1: Residuals recomputed after the GGA position was computed
3 to 14	Range residuals for satellites used in the navigation solution, in meters

Table 13: Description of the GRS message.

NOTE:
* Because the contents of this NMEA message do not change significantly during a 1-second interval, the receiver outputs this message at a maximum rate of 1 Hz.

GSA – GPS DOP and Active Satellites

The GSA message indicates the GPS receivers operating mode and lists the satellites used for navigation and the DOP values of the position solution.

$GPGSA,a,x,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,x.x,x.x,x.x

Field Number	Description
1	Mode: M = Manual, A = Automatic.
2	Current Mode 1 = Fix not available, 2 = 2D fix, 3 = 3D fix.
3 to 14	PRN numbers of the satellites used in the position solution. *
15	Position Dilution of Precision (PDOP).
16	Horizontal Dilution of Precision (HDOP).
17	Vertical Dilution of Precision (VDOP)

Table 14: Description of the GSA message.

NOTE:
* When less than 12 satellites are used, the unused fields are null.

GST – GPS Pseudorange Noise Statistics

The GST sentence is used to support Receiver Autonomous Integrity Monitoring (RAIM).

$GPGST,220320.0,1.3,0.8,0.5,166.1,0.8,0.5,1.6,*4F

Field Number	Description
1	UTC time of GGA fix
2	RMS value of the standard deviation of the range inputs to the navigation process (range inputs include pseudoranges and DGPS corrections)
3	Standard deviation of semi-major axis of error ellipse, in meters
4	Standard deviation of semi-minor axis of error ellipse, in meters
5	Orientation of semi-major axis of error ellipse, in degrees from true north
6	Standard deviation of latitude error, in meters
7	Standard deviation of longitude error, in meters
8	Standard deviation of altitude error, in meters

Table 15: Description of the GST message.

NOTE:
* Because the contents of this NMEA message do not change significantly during a 1-second interval, the receiver outputs this message at a maximum rate of 1 Hz.

GSV – GPS Satellites in View

The GSV sentence identifies the number of SVs in view, the PRN numbers, elevation, azimuth and SNR values.

$GPGSV,4,1,13,02,02,213,,03,-3,000,,11,00,121,,14,13,172,05*67

Field Number	Description
1	Total number of sentences of this type in this cycle
2	Sentence number
3	Total number of SVs visible
4	SV PRN number
5	Elevation in degrees, 90 ½ maximum
6	Azimuth, degrees from true north, 000 ½ to 359 ½
7	SNR, 00-99 dB (null when not tracking)
8-11	Information about second SV, same format as fields 4-7
12-15	Information about third SV, same format as fields 4-7
16-19	Information about fourth SV, same format as fields 4-7

Table 16: Description of the GSV message.

NOTE:
* Because the contents of this NMEA message do not change significantly during a 1-second interval, the receiver outputs this message at a maximum rate of 1 Hz.

RMC – Recommended Minimum Specific GPS Data

The RMC sentence identifies the UTC time, status, latitude, longitude, speed over ground (SOG), date and magnetic variation of the position fix.

$GPRMC,184804.00,A,3723.476543,N12202.239745,W,000.0,0.0,051196,15.6,E*7C

Field Number	Description
1	Time: UTC time of the position fix in hhmmss.ss format
2	Status A: Valid V: Navigation Receiver Warning (V is output whenever the receiver suspects something is wrong)
3	Latitude coordinate
4	Latitude direction: N = North, S = South
5	Longitude coordinate
6	Longitude direction: W = West, E = East
7	Speed Over Ground (SOG) in knots (0-3 decimal places)
8	Track Made Good, True, in degrees
9	Date in dd/mm/yy format
10	Magnetic Variation in degrees
11	Direction of magnetic variation E: Easterly variation from True course (subtracts from True course) W: Westerly variation from True course (adds to True course)
12	Mode Indication A: Autonomous D: Differential N: Data not valid

Table 17: Description of the RMC message.

VTG – Course Over Ground and Ground Speed

The VTG sentence identifies the actual track made good and speed over ground.

$GPVTG,0,T,,,0.00,N,0.00,K*33

Field Number	Description
1	Track made good
2	Fixed text 'T' shows that track made good is relative to true north
3	Not used
4	Not used
5	Speed over ground in knots (0-3 decimal places)
6	Fixed text 'N' shows that speed over ground is in knots
7	Speed over ground in kilometers/hour (0-3 decimal places)
8	Fixed text 'K' shows that speed over ground is in kilometers/hour

Table 18: Description of the VTG message.

NOTE:
* Because the contents of this NMEA message do not change significantly during a 1-second interval, the receiver outputs this message at a maximum rate of 1 Hz.

ZDA – Time and Date

The ZDA message contains UTC, the day, the month and the year of the local time zone.

$GPZDA,hhmmss.s,xx,xx,xxxx,xx,xx

Field Number	Description
1	UTC.
2	Day (0 – 31).
3	Month (0 – 12).
4	Year.
5	Local Zone Description Hours (± 13 Hours). *
6	Local Zone Description Minutes.

Table 19: Description of the ZDA message.

NOTES:
* Local zone description is the number of whole hours added to local time to obtain UTC. The zone description is always negative for eastern longitudes. Fields 5 and 6 are Null fields in the “Trimble BD132”. A GPS receiver cannot independently identify the local time zone offsets.
* Because the contents of this NMEA message do not change significantly during a 1-second interval, the receiver outputs this message at a maximum rate of 1 Hz.

PTNLDG –DGPS Receiver Status

The PTNLDG sentence is a sentence for identifying the DGPS receiver channel strength, channel SNR, channel frequency, channel bit rate, channel number, channel tracking status, RTCM source and channel performance indicator for satellite DGPS.

$PTNLDG,xxx.x,xx.x,xxxxxxx.x,xxxxx,xx,x,x,x,xx*xx

The PTNLDG sentence fields are defined in free format with the maximum number of characters in the field indicated in above (i.e. 25 bps displayed as xxx,25,xxx instead of xxx,00025,xxx). Additionally, if a channel is disabled, the channel fields may be null fields (commas only). If more then one channel is available, the sentence should be repeated for each channel.

Field Number	Description
1	Channel signal strength, in 1 dBµV/m. This is the ADC input voltage level.
2	Channel signal to noise (SNR) level, in dB
3	Channel frequency, in kHz
4	Channel bit rate, in bits per second (bps)
5	Channel number, 0-99
6	Channel tracking status 0: Channel idle 1: Wideband FFT search 2: Searching for signal 3: Channel has acquired signal 4: Channel has locked on signal 5: Channel disabled
7	Specified channel is used as RTCM source 0: Not used 1: Used
8	Channel tracking performance indicator. This is the time since the last sync, in tenths of seconds ranging from 0-255

Table 20: Description of the PTNLDG message.

NOTE:
* Because the contents of this NMEA message do not change significantly during a 1-second interval, the receiver outputs this message at a maximum of 1 Hz.

PTNL,GGK – Time, Position, Position Type and DOP Values

$PTNL,GGK,172814.00,071296,3723.46587704,N,12202.26957864,W,
3,06,1.7,EHT-6.777,M*48

Field Number	Description
1	UTC of position fix, in hhmmss.ss format
2	UTC Date of position, in mmddyy format
3	Latitude, in degrees and decimal minutes (for example, dddmm.mmmmmmm)
4	Direction of latitude: N: North S: South
5	Longitude, in degrees and decimal minutes (for example, dddmm.mmmmmmm)
6	Direction of Longitude: E: East W: West
7	GPS Quality indicator: 0: Fix not available or invalid 1: Autonomous GPS fix 4: Differential, code phase only solution (DGPS)
8	Number of satellites used in GPS solution
9	DOP of fix
10	Ellipsoidal height of fix (antenna height above ellipsoid)
11	M: Ellipsoidal height is measured in meters

Table 21: Description of the PTNL,GGK message.

PTNLID –Receiver Identity

The PTNLID sentence is a sentence for identifying the receiver's machine ID, product ID, major and minor release numbers and firmware release date.

$PTNLID,097,01,xxx,xxx,DD/MM/YY*XX

Field Number	Description
1	Machine ID
2	Product ID
3	Major firmware release number
4	Minor firmware release number
5	Firmware release date, in DD/MM/YY format

Table 22: Description of the PTNLID message.

NOTE:
* The PTNLID sentence is, if enabled, output every 30 seconds.

PTNLSM – RTCM special message

The PTNLSM sentence is a sentence for identifying the Reference Station ID and the ASCII Text message included in a RTCM Type 16 Special Message. The PTNLSM message is generated anytime a RTCM stream receives a valid Type 16 Special Message.

$PTNLSM,0022,This is a message,*.XX

Field Number	Description
1	Reference Station ID number, ranging from 0 to 1023. Leading zeros must be added to fill 4-digit field.
2	ASCII text message sentence contained within the Type 16 RTCM message.

Table 23: Description of the PTNLSM message.

Appendix E – OmniSTAR subscription agreement form

The form is necessary to apply for a new OmniSTAR subscription for your 7114LR12 receiver. And can be found on our website: www.omnistar.nl