reelektronika

LORADD series

eLoran UTC receiver

Installation and operational manual

Manual version	1.21
LORADD UTC firmware version	UTC 2.46
LERXAnalyser version	7.23
Release date	September 2008

Table of Contents

1   Introduction

reelektronika's LORADD eLoran UTC receiver provides accurate timing and frequency signals throughout the Loran coverage area. This receiver is based on **reelektronika**'s integrated GPS/eLoran receiver, which was released early 2005. The UTC receiver is equipped with a more stable local oscillator to provide the accurate frequency outputs required. Further, the UTC receiver provides accurate 1 pulse per second outputs for various applications, derived from the Loran signal transmissions combined with the Eurofix UTC message information, and the GPS receiver.

Although UTC information can also be derived from Loran using alternative methods, this receiver only operates with Loran-C stations which broadcast Eurofix UTC messages.

The user manual helps the user to install and operate LORADD receivers without problems. Specialised and large-volume users are invited to contact **reelektronika** to set up maintenance contracts.

1.1   Principal description of the timing service

The Loran-C infrastructure provides accurate signals for positioning, frequency and time determination. Within the eLoran system all stations have a fixed (and known) relation with Coordinated Universal Time (UTC). However, recovery of the absolute UTC time through the measurement of the Loran signals in Europe is complex due to the choice of GRI numbers. Time of Coincidence (TOC) between UTC seconds and Loran pulses is rather large.

Within the concept of UTC through Eurofix, a Loran station with a Eurofix installation is capable of broadcasting UTC messages from which a user receiver can instantly retrieve UTC time. The accurately timed Loran pulses provide the time reference in the receiver, the Eurofix data broadcast provides the additional information to calculate UTC year, day of year, time of day and leap seconds information.

The receiver locks its ovenized crystal oscillator to the incoming 100 kHz frequency of the Loran pulses of a selected Loran transmitter. This is the source for the frequency outputs of the receiver. Based on the timing information in the Eurofix message broadcast, the receiver generates a 1 pulse per second (1 PPS) output based on Loran timing.

Since the Loran signals have to propagate from transmitter to user, the generated 1 PPS output will be offset with respect to real UTC by the propagation time. The user may manually adjust this offset or automatically calibrate the UTC receiver by the internal GPS receiver installed.

1.2   Area of operation

Within Europe there are currently 5 transmitters with a Eurofix installation: Anthorn, Sylt, Lessay, Værlandet and Bø. At Anthorn and Sylt, the installation is upgraded with UTC broadcast functionality. The other stations may be upgraded with a UTC service if Europe decides on the long-term operation of Loran services. For now the UTC timing information is available to users within 1,000 km range from the Sylt or Anthorn Loran stations. The service is available on the 7499M rate of Sylt and the 6731Y rate of Anthorn.

Although in principal a UTC timing service through eLoran can be achieved using alternate methods, this receiver only works with UTC services through Eurofix. Upgrades to the receiver to include 9th pulse communication (United States) is anticipated, but not planned yet.

The receiver can derive a PPS signal using any Loran transmitter, regardless of whether the particular signal is modulated or not. For Loran stations without a UTC broadcast facility or with a broadcast means currently not implemented in the receiver, the LORADD-UTC allows a one time automatic synchronisation of the Loran derived 1 PPS with the GPS derived 1 PPS.

1.3 Eurofix message types for broadcasting UTC

The UTC message types will be based on the standard for broadcasting messages over the Loran-C data channel as specified in ITU-R Recommendation M.589-3 [ITU-01]. Currently, 3 message types out of a possible 16 are described by the ITU recommendation. For the UTC service an additional message type is implemented. The message type 6, containing the UTC timing information, will first be labelled "tentative". Current status and description of the Eurofix message types are maintained in [REEL-05].

The basic concept of using the Eurofix broadcast channel to provide precise time to users is very similar to the way radio stations operate by saying "At the next beep the time is …" Instead of using spoken words Eurofix uses one of the 16 message types which actually says "The time of the next pulse after this message is …". Figure 1-1 explains the signal structure of this message. So, the start of the first pulse of the next GRI is the actual moment in time that is defined in the UTC message that just ended.

All GRIs are multiples of 10 µs. Further, the start of all master signals coincide with the 10 µs time ticks of UTC. Therefore, it is sufficient to broadcast only at which 10 µs instant on the UTC scale the master pulse will be broadcast. In contrast with the USA, Russia and Asia, all secondary Loran-C stations in Europe also start the transmission at one of these 10 µs time ticks.

The Eurofix UTC messages will contain UTC time information in 10 µs increments for a range of one hour. In order to broadcast additional information, the UTC messages are divided into subtypes. Subtype 1 contains information to disseminate hour, date and year, Subtype 2 on leap seconds and a possible precise time within the 10 µs intervals. Additional subtypes leave room for broadcasting offsets between Loran and GPS time or other time scales. Tables 1 and 2 show the UTC subtype messages 1 and 2, respectively. The first 35 bits and the CRC of each subtype are common, the remaining
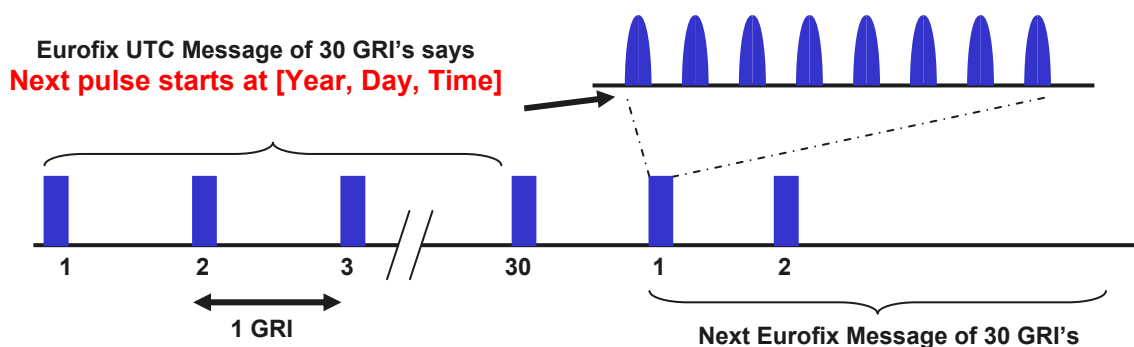
Figure 1-1 – Eurofix Message format for broadcasting UTC

21 bits are subtype specific.

TABLE 1. EUROFIX UTC MESSAGE FORMAT TYPE 6, SUBTYPE 1

Item	Bits	# bits	Unit	Range
Message type (0110)	1-4	4	1	16
Message sub-type (01)	5-6	2	1	4
Time at Master/Secondary in hour *	7-35	29	10 µs	5,368 sec (> 1 hour)
Hour of year	36-49	14	1 hour	16,384 hours (> 1 year)
Year	50-55	6	1	64 years (2000-2063)
Spare	56	1		
Cyclic Redundancy Check	57-70	14		
Total:		70		

* Indicates the UTC time of the standard zero-crossing of the first pulse of the next Eurofix message

TABLE 2. EUROFIX UTC MESSAGE FORMAT TYPE 6, SUBTYPE 2

Item	Bits	# bits	Unit	Range
Message type (0110)	1-4	4	1	16
Message sub-type (10)	5-6	2	1	4
Time at Master/Secondary *	7-35	29	10 µs	5,368 sec (> 1 hour)
Precise Time	36-45	10	10 ns	10.24 µs (> 10 µs)
Leap seconds ** (TAI-UTC)	46-54	9	1 s	-256 – 255 s
Leap second change ***	55-56	2	1 s	-1 – 1 s
Cyclic Redundancy Check	57-70	14		
Total:		70		

* Indicates the UTC time of the standard zero-crossing of the first pulse of the next Eurofix message
** Numbers are in 2's complement
*** Indicates how many leap seconds are to be introduced at the next possible leap-second insertion moment, at the moment UTC would reach 1 Jan 0:0:0 hours or 1 Jul 0:0:0 hours.
Bit pattern 11 means a different change than -1, 0 or +1s at the next change moment. In this case the user should wait for an update of the Loran UTC messages after the change moment before he can use UTC from the Loran system again. Numbers are in two's complement. (00 = 0 seconds, 01 = 1 second, 10 = -1 second, 11 = different)

The grey areas in both tables indicate that the contents of all message subtypes are the same in these fields.

1.4 Specifications

The LORADD Series UTC receiver consists of the following components:
- **reelektronika**'s LORADD OEM eLoran receiver (www.reelektronika.nl)
- Motorola M12+ GPS receiver
  (http://www.synergy-gps.com/images/stories/guides/m12+userguide.pdf)
- Stanford Research Systems 10 MHz Oscillator SC10 (www.thinksrs.com)

Please visit above websites for more information on these components.

Figure 1-2 shows the functional block diagram with all components of the UTC receiver. The LORADD receiver is the heart of the receiver. It receives the Loran signals and decodes the UTC messages. For its frequency source, the receiver runs from the SRS 10 MHz clock. The clock is disciplined using the accurate Loran frequency derived from the received pulses. In the UTC digital platform the eLoran 1 PPS timing output is generated based on the stable 10 MHz clock and the timing information from the UTC messages. The receiver further outputs 10 MHz, 2.048 MHz and 1.544 MHz reference frequencies synthesized from the 10 MHz SRS. The UTC receiver is designed to make use of the short term frequency stability of the SRS oscillator while long term stability is guaranteed through reception of the Loran-C signals. Please visit the SRS website and Loran provider website for more specifics on frequency stability.

The UTC receiver is designed to provide an eLoran derived 1 PPS output within 1 μs from UTC. In order to achieve this, the receiver should be automatically or manually calibrated. Automatic calibration will be done using the on-board GPS receiver. Typically, the output accuracy will be much better than 1 μs after proper calibration. Ultimately the performance depends on Loran-C transmitter timing stability, SNR of the received Loran-C signals, variations in Loran-C ground wave propagation, and antenna and receiver signal delay variations due to temperature variations.
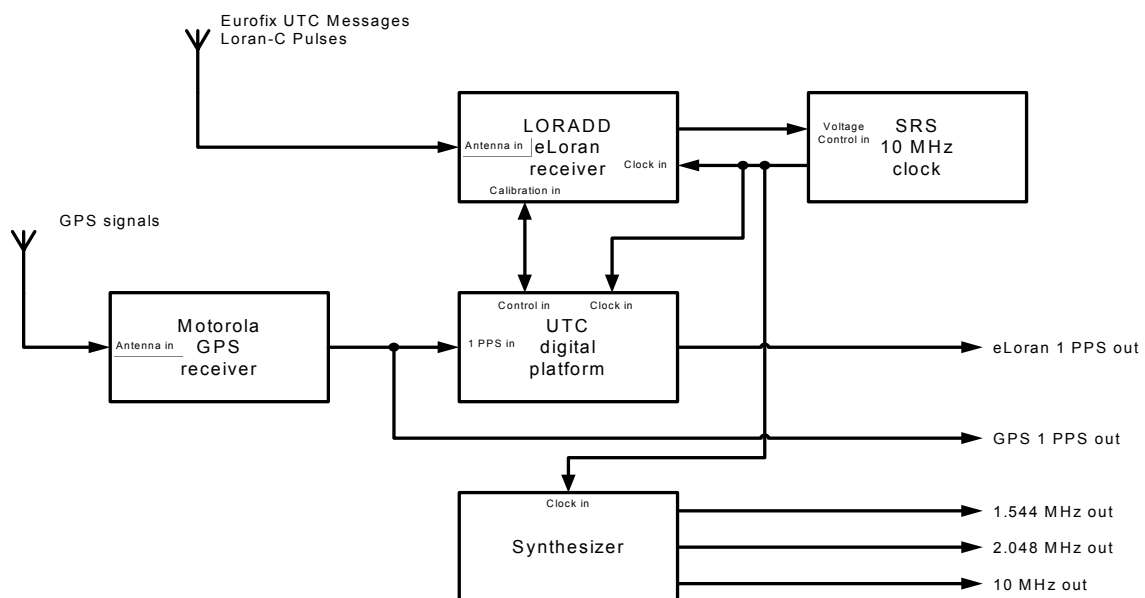
Figure 1-2 – Functional block diagram of the UTC receiver

2   Installation

The LORADD UTC receiver comes in a sturdy 19" housing, with an eLoran H-field antenna. The Loran antenna has a GPS patch antenna included in the housing. The receiver is shipped with a Loran and GPS antenna cable.

2.1   Getting started…

This "Getting started" section will guide you through the typical first time use of the UTC receiver.

- Unpack the receiver, antenna and antenna cables.

- Install the antenna at a location free of interference for GPS and eLoran. The antenna should have a clear view at the sky and should not be close to any large metal objects for best performance.

- Connect the antenna to the receiver using the 8-wire H-field eLoran antenna cable and the coaxial GPS cable.

- Connect the receiver comport COM1 to a PC or laptop comport using a straight serial cable.

- Connect the power to the receiver, the 19" case is equipped with 100-240V AC mains input.

- Install the LERXAnalyser software on the PC or laptop. You can always download the latest version of the LERXAnalyser from www.reelektronika.nl.

- Start the LERXAnalyser software.

- Click on "File" – "Data Source" and select the PC comport you have connected the receiver to. The default settings for communication are: Bitrate: 115200, Parity: None, Databits: 8, Stopbits 1. Press the "Connect" button on the Data Source window.

- Verify that the receiver communicates with the LERXAnalyser software by looking at the "Monitor" window on the screen. You should be able to see logs scrolling by.

- Close the "Data Connect" window and select "Show Default Logs" on the "View" menu.

- Now we will be able to see the logs in a more readable form. The TOAA window gives information on the number of Loran-C stations tracked, the TOA measurements and their quality. Verify that you track stations. If three stations in a chain are tracked and the last character in the "State" column reads 0 for three stations in a chain you should be able to see a calculated eLoran position.

- Select "Eurofix Data" on the "View" menu, to view the incoming Eurofix messages from all tracked stations. If you do not see any messages please make sure that the receiver outputs RMSGA messages. Issue the command LOG COM1 RMSGA ONNEW if necessary.
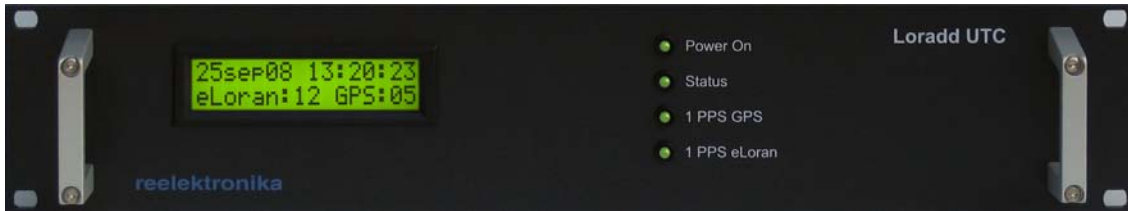
Figure 2-1 UTC receiver front view

- On the Eurofix data screen, select the UTC tab for the station of interest to see that the receiver has received UTC messages.

- Enter the SETTINGS SET UTCSOURCE command in the Serial Commands box to set the UTC Station, e.g. SETTINGS SET UTCSOURCE 7499M.

- Enter the SETTINGS SET TOASOURCE command in the Serial Commands box to set the station which will be used to derive frequency information from, e.g. SETTINGS SET TOASOURCE 6731Y.

- The 1 PPS GPS LED will start blinking as soon as the receiver has acquired enough GPS satellites and the receiver has been able to perform TRAIM timing integrity, to output a 1 PPS signal based on GPS. The 1 PPS eLoran LED will start blinking as soon as the receiver has acquired UTC messages from the selected UTC Station. The STATUS LED will be lit as soon as the receiver has tracks the Loran TOA Source station.

- As soon as the receiver has acquired the necessary UTC information and is capable to calculate UTC time, the display on the front of the receiver will display UTC date and time information and the Loran PPS output will be active.

- Enjoy using your eLoran UTC receiver!

2.2 UTC receiver input/output connections

Figure 2-1 shows the front side of the UTC receiver housing. On the front the following displays are available:
- A 2 row 16 character LCD display showing UTC date and time of day, and the number of tracked Loran signals and GPS satellites.
- A STATUS LED indicating when the receiver tracks the Loran TOA Source station.
- A 1 PPS GPS LED indicating a 1 PPS derived from GPS when the GPS receiver has a sufficient number of GPS satellites and passed the TRAIM integrity criteria.
- A 1 PPS eLoran LED indicating a 1 PPS derived from Loran when the receiver has received UTC messages from the UTC Station or when the receiver is manually synchronised with GPS.
- A Power LED

Figure 2-2 shows the connections at the back of the receiver. The following connectors are available (from left to right):
- 3-pin 100-240 V AC power connector and switch, the receiver is protected by a 2.5 A (slow) fuse in the power connector
- TNC GPS antenna connector
- 8-pin LEMO 1B.308 eLoran H-field antenna connector

Figure 2-2 Picture of the interconnections on the rear of the UTC receiver

- 3 DB-9 Female communication ports (COM1, COM2, COM3)
- 1 DB-9 Male I/O connector for future use
- 12 BNC connectors for output of frequency and 1 PPS pulses

The serial communication ports COM1, COM2 & COM3 allow all standard communication speeds up to 115k2 bps using three-wire interfaces (no flow control signals). The female DB-9 connectors need to be connected with straight-through cables to comports of a PC or laptop. Comport speeds can be selected using the command SETSPEED (see Section 4).

COM1 and COM2 are connected to the LORADD Engine. Commands and logs for the LORADD receiver can be issued using both comports. COM3 is connected to the Motorola M12+ GPS receiver. If needed the M12+ can be queried or configured using the standard Motorola WinOncore Windows program (http://www.synergy-gps.com/images/stories/exe/WinOncore12_1_2.zip).

The UTC receiver is equipped with 12 BNC outputs for frequency and 1 PPS outputs. Currently, 6 provide output and 6 are reserved for future use.

BNC port	Output
1	Reserved
2	10 MHz frequency out (sine wave)
3	Reserved
4	eLoran 1 PPS out (rising flank = UTC mark)
5	GPS 1 PPS out (rising flank = UTC mark)
6	Reserved
7	Reserved
8	Reserved
9	10 MHz frequency out
10	2.048 MHz frequency out
11	1.544 MHz frequency out
12	Reserved

The eLoran 1 PPS output is first generated when the receiver locks on the signal of the UTC Station, and UTC messages are received, or after the manual synchronisation with GPS. The 1 PPS eLoran LED blinks at the same time the 1 PPS BNC output is genrated.
The GPS 1 PPS output is first generated when the Motorola MT12+ receives sufficient GPS signals to provide TRAIM timing integrity.

All frequency outputs are generated using the SRS oscillator, which is governed by the Loran signals from the selected TOA Source. In case the receiver looses lock on the Loran station, or no Loran stations are tracked, the frequency outputs are continued.

The H-field antenna is connected using an 8-wire Tasker C185 cable. On the receiver end, the cable is connected using a LEMO 1B.308 connector. On the antenna end the cable is connected using a CONXall Multi-Con-X282-92G-3XX connector. The cable is connected to the connectors using the following pin information and cable color codes:

CONXall Multi-Con 282-9SG-3XX
cable connector female
solder side
(TASKER C185 colorcode)
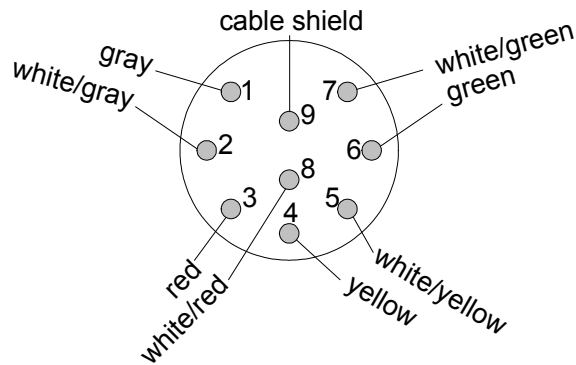
LEMO 1B.308
cable connector male
solder side

Connector @ antenna	Cable color	connector @ receiver
(CONXall Multi-Con-X 282-9SG-3XX)	(TASKER C185)	(LEMO 308: FGG.1B.308.CLCD72)
1 CH 1+	gray	1 CH 1+
2 CH 1-	white/gray	2 CH 1-
4 CH 2+	yellow	4 CH 2+
5 CH 2-	white/yellow	5 CH 2-
3 +5V (200mA)	red	3 +5V (200mA)
8 GND	white/red	8 GND
6 Reserved	green	6 Reserved
7 Reserved	white/green	7 Reserved
9 shield	cable shield	connector shield

The shield of the antenna cable is connected with the LEMO 308 housing and with pin 9 of the CONXall connector

CH1 and CH2 indicate the signals coming from the two separate antenna rods in the H-field antenna.

2.3 H-field eLoran and GPS patch antenna

Every UTC receiver comes with its own H-field eLoran antenna. The receiver and antenna should be considered as one. Changing antennas from one receiver to another is not recommended and may produce sub-optimal results. Please contact **reelektronika** in case you need to change the antenna – LORADD receiver combination.

The eLoran antenna is integrated with a GPS antenna. If the antenna is used in a location where GPS reception is not optimal a separate GPS antenna can be connected. For installation of the antennas the following guidelines have to be taken into account:

- The H-field eLoran antenna needs to be installed in a location free from interference in the 100 kHz frequency range, such as computer monitors, processors, power supplies or other electrical equipment, spark ignition engines or engine alternators. The presence of these noise sources may limit the performance of eLoran in your receiver. Further, antenna installation close to large metal objects might have a negative influence on the accuracy of reception of eLoran signals.

- The GPS antenna needs to be installed with a clear and unobstructed view at the sky, free from any objects which may reflect satellite signals to the antenna. Also, the antenna should not be installed close to equipment which may cause interference in the 1 GHz frequency range, such as TV and radio receiving and broadcasting antennas as well as radar equipment.

In case both eLoran and GPS signals are coming from the integrated eLoran/GPS patch antenna the installation has to be performed taking both guidelines into account.

The arrow of the antenna housing need not be pointed in any particular direction in case of static operation. In dynamic applications, the H-field antenna allows determination of real headings even without movement of the vehicle.

For eLoran signal environment analyses the receiver is capable of outputting received spectrum (FFT) plots of both H-field loops, through the FFTA log, which can be made visible through the LERXAnalyser software tool. See Section 4 for more information on this log.

The eLoran antenna and GPS antenna are active antennas. Therefore, the LORADD receiver outputs +5 V DC on pen 6 of the eLoran antenna connector and +3.3 V on the

Figure 2-3 H-field antenna with GPS patch included

GPS SMA connector. Figure 2-3 shows the integrated eLoran/GPS patch antenna.

2.4 The Motorola M12+ GPS receiver

The LORADD-UTC is equipped with a Motorola M12+ GPS receiver providing GPS derived timing signals. The GPS receiver communicates directly to the LORADD receiver, but can also be accessed through comport 3 of the LORADD receiver. By default this comport is configured to communicate at 9600 baud. This communication speed can be changed using the SETSPEED command, however, internally the LORADD receiver continues to communicate at 9600 baud. Please refer to the M12+ user manual for further instructions on the GPS receiver http://www.synergy-gps.com/images/stories/guides/m12+userguide.pdf, the WinOncore windows program can be downloaded at http://www.synergy-gps.com/images/stories/exe/WinOncore12_1_2.zip

The LORADD receiver initiates the following configuration commands to the GPS receiver at start-up. The GPS receiver does not have non-volatile memory to store settings, therefore the receiver reverts to these default settings every time the LORADD receiver is power cycled. Motorola configuration commands are:

@@Hb01 // Output short channel msg once per second
@@Hn01 // Output TRAIM Status message once per second
@@Ge01 // Enable TRAIM
@@Gc03 // Output PPS only if TRAIM valid
@@Bo01 // Request UTC offset, every time it is updated

For proper operation of the GPS components within the LORADD-UTC receiver, the receiver assumes the above configuration is present.

2.5 Firmware updates

All LORADD receivers are designed to accept software updates and **reelektronika** continues to update the firmware for the UTC receivers. New firmware can be downloaded from www.reelektronika.nl. Follow the instructions of the upgrade program or view the readme file to see what changes are incorporated in the new firmware and how to upgrade the receiver.

Further, with every firmware update the LERXAnalyser software and manual are updated accordingly. Please find the latest version of both on the website too.

3   Operation

The UTC receiver is based on **reelektronika**'s LORADD integrated eLoran/GPS receiver. In principal, all functionalities of the integrated navigation receiver are also available on the UTC receiver. However, for UTC operation it is recommended that the receiver remains static. For standard navigation operation of the LORADD series receivers the reader is referred to the manual of the integrated receiver, to be downloaded from the **reelektronika** website.

When all connections are made (eLoran + GPS antenna and power) and the receiver is powered on, the receiver will automatically start searching for Loran stations. The receiver will maintain its latest position prior to the previous power down to facilitate a fast warm acquisition. In case no last position is available the user can force a starting position by entering the SETPOSITION command. The receiver will then search for Loran stations based on the estimated position.

As soon as the receiver has acquired the selected UTC Station, it automatically decodes and uses the UTC timing information. A 1 PPS output is generated as soon as UTC information is retrieved from the UTC Station and the receiver is locked onto the selected TOA Station (indicated by the STATUS LED). The user may select the Loran Station from which UTC information is to be used and the Loran Station by which the clock is governed independently using the SETTINGS command.

For each UTC Station and antenna location the receiver needs to be calibrated manually using the MEASUREPPS STORE command. Only after UTC Offset calibration the eLoran 1 PPS generation is valid. Note that for automatic calibration the GPS receiver needs to receive sufficient satellites and output a 1 PPS signal, indicated by the 1 PPS GPS LED, otherwise the calibration is not valid.

When the receiver has locked onto the UTC Station, received and decoded the UTC messages from the station, and is locked onto the TOA Source station, the Loran derived 1 PPS output is generated and the LCD display outputs date and time information. As soon as the receiver is able to output a 1 PPS signal based on eLoran, the 1 PPS eLoran LED will also indicate the 1 PPS pulses. From this time on the receiver will continue to output a 1 PPS signal, even if lock on the UTC or TOA Source station is lost. This hold-over using the frequency stability of the SRS clock is indicated by the STATUS LED being off.

As soon as the receiver has locked its internal clock to the incoming signals of the TOA Station (TOALOCK) the frequency outputs are disciplined by the TOA Station signals.

The GPS receiver will autonomously search for satellites, perform a TRAIM calculation and generate a 1 PPS output. As soon as the 1 PPS output is available the 1 PPS GPS LED starts blinking in the 1 PPS tempo.

Note that the eLoran 1 PPS output is only valid when the receiver tracks the TOA Station (indicated by the STATUS LED) and the receiver has a valid UTC Offset.

Note that it still may take some time before the receiver has steered the SRS clock towards the reference TOA of the TOA Source and the 1 PPS is at the correct position in time, even though the receiver indicates TOALOCK through the STATUS LED. Every time a new calibration is performed, the user sets a new UTCOFFSET or the receiver reacquires the "lost" TOA Source station, the receiver will need a settling time before the 1 PPS output reflects the new

settings. Indication for the receiver to have settled can be given by viewing the TOA output using the LERXAnalyser. The receiver will steer towards the set UTC Offset with a maximum of approximately 1.5 microseconds per second.

Note that the UTC Offset calibration is only valid when the 1 PPS eLoran LED is blinking, and the 1 PPS GPS LED is blinking and the STATUS LED is lit during the whole calibration sequence of 100 seconds.

Note that the UTC Offset needs to be changed with every change of UTC Station source or eLoran receiving antenna location.

4   Command and log interface

As mentioned before, the UTC receiver is based on the LORADD Series integrated eLoran/GPS receiver, and takes all commands and logs from the standard receiver. For completeness the commands and logs are included in this section. However, first the UTC specific commands are presented.

4.1   UTC Receiver specific commands

Commands are entered as space separated commands terminated by a Carriage Return <CR>. Commands can be entered on all serial ports. Commands are not case sensitive.

The command 'SETTINGS' is used to list and/or change various parameters in the receiver that influence its operation. In order to control the generation of a proper 1 PPS eLoran output, the following parameters are available:

UTCOFFSET	The offset, in microseconds, that is applied to compensate for the internal receiver delays and propagation between the selected Loran transmitter and the receiver.
UTCSOURCE	Sets the UTC Station source for UTC message reception and 1 PPS generation.
TOASOURCE	Sets the station that is used as a frequency reference.

Command SETTINGS, parameter UTCOFFSET

Syntax: SETTINGS SHOW

Response: …
            UTCOFFSET: 1339.23
            …

Shows the current value of the UTC offset. The value is in microseconds.

Syntax: SETTINGS SET UTCOFFSET <value>

Response: Parameter set

Use this command to manually enter the UTC Offset. The UTC Offset is immediately used. To permanently store this (and other) parameters in non-volatile memory, issue a SAVECONFIG command.

In order to line up the Loran generated PPS with a GPS-derived PPS, the MEASUREPPS STORE command can be used.

Command SETTINGS, parameter UTCSOURCE

Syntax: SETTINGS SHOW

Response: …
       UTCSOURCE: 7499M
       …

Shows the current value of the UTC Station, which is used as source for Eurofix UTC messages and frequency reference. The best UTCSOURCE station is typically the closest Loran transmitter that broadcasts Eurofix UTC messages.

Syntax: SETTINGS SET UTCSOURCE <StationID>

Response: Parameter set

Use this command to set the UTC Station source. To permanently store this (and other) parameters in non-volatile memory, issue a SAVECONFIG command.

Command SETTINGS, parameter TOASOURCE

Syntax: SETTINGS SHOW

Response: …
       TOASOURCE: 6371Y
       …

Shows the current value of the TOASOURCE, which is the station that is used to steer the internal oscillator of the receiver. The TOASOURCE may differ from the UTCSOURCE station, or can be the same. Typically, the best TOASOURCE station to use will be the Loran-C transmitter closest to you. The TOASOURCE station can be any Loran station, regardless of whether it broadcasts UTC messages.

Syntax: SETTINGS SET TOASOURCE <StationID>

Response: Parameter set

Use this command to set the TOASOURCE station. To permanently store this (and other) parameters in non-volatile memory, issue a SAVECONFIG command.

Command MEASUREPPS

Syntax: MEASUREPPS

Response: PPS Offset measurement started
       …
       $PRLK,PPSOFFSET,1.0,2046.63,0.087891*5F
       Measured offset: 0.087891 microseconds

This command starts a calibration sequence to measure the difference between the 1 PPS generated by GPS and the 1 PPS generated by the Loran receiver. If both PPSs are close together the measurement will be close to 0 microseconds. After 100 seconds the receiver has determined the measured offset which is reported to the user. The calibration is only valid if the 1 PPS eLoran, the 1 PPS GPS and the Status LEDs are active during the whole period of calibration.

The loglines reported back contains the PPS Offset in microseconds. The result is displayed both in a standard logline-format, as well as in a human-readable line. A positive value indicates that the generated Loran-C PPS occurs later in time than the GPS PPS.

Syntax: MEASUREPPS STORE

Response: PPS Offset measurement started

> …
> $PRLK,PPSOFFSET,1.0,2046.63,0.087891*5F
> Measured offset: 0.087891 microseconds
> UTC Offset stored

Use this command to automatically calibrate and store the UTC Offset for the Loran 1 PPS with respect to the GPS 1 PPS. After the measurement the new UTC Offset is calculated and stored in the settings. To permanently store this (and other) parameters in non-volatile memory, issue a SAVECONFIG command.

Note that each UTC Station and each different location need a different UTC Offset. Therefore, it is recommended to do calibration or manual UTC offset every time the receiver is relocated or the UTC Station is changed. In order to actually adjust the timing of the produced Loran PPS signal, the UTCOFFSET parameter should be manually changed using the SETTINGS SET UTCOFFSET command. In order to calculate the new UTCOFFSET, the measured PPSOFFSET value should be added to the old UTCOFFSET.

Note that the UTC Offset contains every delay between time of transmission of the signal at the station and processing of the received signals in the receiver. This includes Loran Primary Factor, Secondary Factor, Additional Secondary Factor, antenna, cable and processing delays.

Command SYNCUTCFROMGPS

Syntax: SYNCUTCFROMGPS

Response: UTC will be synchronized at next GPS PPS

Use this command to synchronise the Loran 1 PPS output and UTC time display to GPS in case there is no Eurofix enabled Loran transmitter with UTC broadcast in the vicinity. After synchronisation, the Loran 1 PPS output will be enabled and the display will show UTC time as derived from GPS. From the calibration moment on, the Loran 1 PPS output and UTC time display will be governed using the Loran disciplined ovenized clock. So even after GPS has become unavailable the receiver continues to output Loran 1 PPS and UTC time.

You may use UTCOFFSET or MEASUREPPS STORE to refine the Loran UTC Offset calibration to compensate for GPS PPS jitter or other error sources.

4.2 General LORADD Series Commands

The following commands can be entered to control the receiver:

HELP	Prints help for all supported commands
VERSION	Prints version information
SHOWSEARCH	Shows the current searchlist
RESET	Performs a software reset
LOG	Command to start logs
UNLOG	Command to stop logs
SETSPEED	Sets the speed of a serial port
READCONFIG	Restores configuration from Non-Volatile Memory
SAVECONFIG	Stores current configuration into Non-Volatile Memory
RESETCONFIG	Restores the current configuration to factory defaults
SETPOSITION	Sets an approximate position
ADDDASFA	Adds a Differential ASF datapoint in the ASF table
RESETDASFA	Resets the internal Differential ASF table
SETTINGS	Controls various settings of the receiver
AUTH	Enters an authentication code into the receiver

Command HELP

Syntax: HELP

Response: List of available commands

Syntax: HELP <COMMAND>
              Where <COMMAND> is any valid command

Response: Detailed help on the command

Command VERSION

Syntax: VERSION

Response: Version information on firmware

This information is necessary if an error report is sent back to **reelektronika**.

Command SHOWSEARCH

Syntax: SHOWSEARCH

Response: Shows the searchlist of the receiver

Example: Current SearchList:

      1: 7499 (4, 32)
      2: 6731 (4, 32)
      3: 9007 (8, 64)

Where each line shows the search information for one GRI. The numbers in brackets are the minimum and maximum number of GRIs the receiver looks for stations in the chain.

Command RESET

Syntax: RESET

Response: Start of Program!

Resets the firmware of the Loran engine. The receiver starts with the configuration of comport speeds, enabled logs etc. as stored in the non-volatile memory of the receiver.

Command LOG

Syntax: LOG <port> <logtype> <trigger>
        Where
        <port> is the destination port of the receiver, e.g. COM1, COM2, COM3
        <logtype> is one of the logtypes as described in Section 3 and 4, always without $ sign
        <trigger> is the trigger for generating a new log, e.g. ONTIME <time> or ONNEW, with <time> is the update interval in seconds that the log should be output

Response: Output of logs

The following table summarizes the possible logs and the possible triggers:

NMEA logs			
Log	Description	Triggers	
GPGGA	Global Positioning System Fix Data		ONNEW
GPGLL	GPS Geographic position, Latitude and Longitude		ONNEW
GPGSA	GPS DOP and active satellites		ONNEW
GPGST	GNSS Pseudorange noise statistics		ONNEW
GPVTG	Course over ground/speed		ONNEW
GPZDA	UTC and local date/time data		ONNEW
GPGSV	GNSS Satellites in view		ONNEW
LCGLC	Loran-C Geographic position, Time differences		ONNEW
LCHDT	Loran-C Heading		ONNEW
LCGLL	Loran-C Geographic position, Latitude and Longitude	ONTIME	

reelektronika proprietary logs			
Log	Description	Triggers	
GPPOSA	GPS calculated position	ONTIME	
LCPOSA	Loran-C calculated position	ONTIME	
INPOSA	Integrated position fix using GPS and/or Loran-C	ONTIME	
LCRSDA	Loran-C range residuals	ONTIME	
TOAA	Loran-C Time of Arrival measurements		ONNEW
SMDA	Loran-C Station measurement data	ONTIME	
SSDA	Loran-C dual loop signal measurements	ONTIME	
HDGA	Heading measurement		ONNEW
DASFA	Differential ASF measurements	ONTIME	
RMSGA	Eurofix decoded messages		ONNEW
RTCMB	Binary output of RTCM SC104 DGPS data received through Eurofix		ONNEW
FFTA	Frequency spectrum data		ONNEW

Command UNLOG

Syntax: UNLOG <port> <logtype>
            Where
            <port> is the destination port of the receiver, e.g. COM1, COM2, COM3

<logtype> is one of the logtypes as described in Section 3 and 4, always without $ sign

Response: SerialX >
Where X is the number of serial port the command is entered

Terminates the output of the specified log on the port.

Syntax: UNLOG <port> ALL
Where <port> is the destination port of the receiver, e.g. COM1, COM2, COM3

Response: SerialX >
Where X is the number of serial port the command is entered

Terminates the all output on the port.

Command SETSPEED

Syntax: SETSPEED <port> <speed>

Response: Speed of port <port> now set to <speed>

Sets the speed of a port. Common speeds are:
 2400
 4800
 9600
 19200
 38400
 57600
 115200 (default)
 400000

Please make sure the communications port on the receiving end is configured at the same speed. Other settings should be 8 databits, No parity, 1 stopbit, no handshaking.

Command READCONFIG

Syntax: READCONFIG

Response: Configuration read OK

Reads the configuration stored in non-volatile RAM previously stored by SAVECONFIG.

Command SAVECONFIG

Syntax: SAVECONFIG

Response: Configuration saved

Saves the configuration in non-volatile RAM. Settings that are saved are port speeds and enabled logs. The last position is saved automatically to enable a fast start-up when the receiver is used in approximately the same location.

Command RESETCONFIG

Syntax: RESETCONFIG

Response: None

Resets the current configuration to the factory defaults. All communication port speeds are set at 115200 and default logs are enabled on ports 1 and 2.

Command SETPOSITION

Syntax: SETPOSITION <latitude> <longitude>

Response: SetPosition: Position set

Sets the approximate position on <latitude> <longitude>. This approximate position is needed to generate a searchlist for chains and have a start position for calculating the Loran positions. If a GPS position is available, this position will be used as a start position to search for Loran chains. If no GPS is available the SETPOSITION command will trigger the generation of a searchlist.

Command ADDDASFA

Syntax: ADDDASFA <$PRLK,DASFA,…*CC>

Response: DASFA succesfully added

Adds a DASFA datapoint to the internal differential ASF table. This way a user can build up his own ASF database through ASF measurement storage using DASFA logs. The format for the DASFA logline is the same as described in the log formats.

Command RESETDASFA

Syntax: RESETDASFA

Response: DASFA table reset

Resets the internal differential ASF table.

Command AUTH

Syntax: AUTH <1> <2> <3> <4>

Response: Auth code accepted

Enters an authentication code into the receiver. The authentication code enables the firmware that came with the receiver or that has been uploaded by the user. Each firmware and/or upgrade may have its own authentication code. Each receiver has its own unique authentication code. The parameters <1> <2> <3> and <4> are hexadigital numbers to be entered. The authentication code will be provided to the user together with the receiver. In case an authentication code is lost, please contact **reelektronika**.

Command NOTCH

Syntax: `NOTCH AUTO [ON|OFF]`

Response: `Automatic placement of notches is now enabled/disabled`

Enables or disables automatic notch setting
If automatic notch placement is turned OFF, the receiver retains the last notch settings. Use `NOTCH CLEAR ALL` after this command to effectively clear all notches.

Syntax: `NOTCH LIST`

Response: `Automatic notch placement: ON`
`        Notches:`
`        Notch 0: Active Freq: 128.9 kHz; BW = 336.0 Hz`
`        Notch 1: Active Freq: 77.5 kHz; BW = 568.5 Hz`
`        ...`
`        Notch 28: Inactive`
`        Notch 29: Inactive`

Lists all currently activated notches

Syntax: `NOTCH SET <r> <freq> <bw>`

Response: `Notch <r> activated: f = <freq> kHz; BW =  bw Hz`

Sets notch number `<r>` to frequency `<freq>` (kHz) with bandwidth `<bw>` (Hz)
Note that this command is only effective if the `NOTCH AUTO` is `OFF`.

Example: `NOTCH SET 0 77.5 500` (sets notch 0 to 77.5 kHz, width 500 Hz)

Valid values for `<r>` range from 0 to 29

Syntax: NOTCH CLEAR <r>|ALL

Response: Notch <r> deactivated
          All notches deactivated

Clears the setting of notch <r>, or all notches.
Note that this command is only effective if the NOTCH AUTO is OFF.

Example: NOTCH CLEAR 5 (to disable notch number 5)
           NOTCH CLEAR ALL (to clear all notches)

Valid values for <r> range from 0 to 29

Command SETTINGS

Syntax: SETTINGS SHOW

Response: Current settings:
          ANT_UPSIDEDOWN   : OFF
          AUTONOTCHES   : ON
          EFDGPS   : ON

Shows current settings

Syntax: SETTINGS SET ANT_UPSIDEDOWN [ON|OFF]

Response: Antenna setting is now upside down/normal
          WARNING: The receiver will reset shortly to apply the
          new setting
          SETTINGS: Setting applied

Specifies whether the antenna is mounted upside down or not.
NOTE: After changing the setting, the receiver will restart automatically!

Syntax: SETTINGS SET AUTONOTCHES [ON|OFF]

Response: SETTINGS: Setting applied

Turns autonotches ON or OFF. Command does the same as NOTCH AUTO [ON|OFF].

Syntax: SETTINGS SET EFDGPS [ON|OFF]

Response: SETTINGS: Setting applied

Turns the passthrough of RTCM SC104 data to the internal GPS receiver ON or OFF. If
EFDGPS is ON, decoded DGPS messages as received from the closest Eurofix station

are passed on to the internal GPS receiver. If `EFDGPS` is `OFF` the GPS receiver will use WAAS or EGNOS data if available.

Syntax: `SETTINGS RESET`

Response: `Settings reset to defaults`

Resets the settings to the default values. Note that the `ANT_UPSIDEDOWN` setting is left untouched. Use `SETTINGS SET ANT_UPSIDEDOWN [ON|OFF]` to change this setting.

4.3 General log interface description

This Section describes the data interface format. All command and log communication is done using one (or more) of the available comports of the UTC receiver. Comports can be set at speeds up to 400 000 baud.

The command and log interface as described in this document adheres to the NMEA 0183 standards for communication between instrumentation aboard maritime vessels. The general format of this interface is:

$aaaaa,…,…,…*CC[CR][LF]

where $aaaaa is the header, identifying the log or command, and CC is an optional checksum. The **reelektronika** receivers will output the checksum. The checksum is the 8-bit exclusive OR (no start or stop bits) of all characters in the sentence, including the "," delimiters, between - but not including - the "$" and "*" delimiters.

The fields in the logs are separated by commas. In contrast to NMEA 0183, most fields are variable in size and can be left blank if data is unavailable. Also, the length of the loglines is in principal unlimited.

Besides NMEA 0183 defined log formats, the receivers also output proprietary **reelektronika** logs, which all start with $PRLK. Commands are entered as space separated strings, not in NMEA 0183 format. In response to a command the receiver outputs status information or a prompt on the comport the command is issued. More information on the commands will be given below.

4.4 NMEA 0183 supported logs

The integrated GPS/eLoran sensor supports general GPS and eLoran position and data logs as defined within the NMEA 0183 standard. These are:

Log	Description
GPGGA	Global Positioning System Fix Data
GPGLL	GPS Geographic position, Latitude and Longitude
GPGSA	GPS DOP and active satellites
GPGST	GNSS Pseudorange noise statistics
GPVTG	Course over ground/speed
GPZDA	UTC and local date/time data
GPGSV	GNSS Satellites in view
LCGLC	Loran-C Geographic position, Time differences
LCHDT	Loran-C Heading
LCGLL	Loran-C Geographic position, Latitude and Longitude

The logs above are all described in NMEA 0183 documentation. For more information on the formats, definitions of numbers and conventions, the reader is referred to NMEA documentation. The following information on the logs has been extracted from there:

$GPGGA - Global Positioning System Fix Data

```
                  UTC time of fix
                                                   GPS Quality
                                                      Num satellites used
                                                                 Height above MSL
                                                                         Geoidal separation
                                                                                    Age of DGPS data
                                                                                          DGPS reference ID
   Header              Latitude   Longitude   E/W           HDOP    Meters     Meters         Checksum
                                N/S                                                       
```

```
$GPGGA,hhmmss.ss,ddmm.mm,a,dddmm.mm,a,x,xx,x.x,x.x,M,x.x,M,x.x,xxxx*CC
```

Sample log:
$GPGGA,104545.00,5052.3562,N,00437.5650,E,2,06,2.5,61.3,M,47.4,M,5.7,0548*7F

$GPGLL - GPS Geographic position, Latitude and Longitude

```
                                          UTC time of fix
                                                    Status 1
                                                      Mode Indicator 2
   Header   Latitude    Longitude   E/W                Checksum
                    N/S
```

```
$GPGLL,ddmm.mm,a,dddmm.mm,a,hhmmss.ss,a,a*CC
```

1 Status is A for normal operation, V for invalid position
2 Mode Indicator is:
    A = Autonomous
    D = Differential
    E = Estimated
    M = Manual mode
    S = Simulator mode
    N = No fix data

Sample log:
$GPGLL,5052.35,N,00437.56,E,104835.00,A,D*60

$GPGSA - GPS DOP and active satellites

```
                                   12 Satellite IDs
   Header                                               PDOP   HDOP   VDOP   Checksum
       Mode 1
        Mode 2
```

```
$GPGSA,a,x,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,x.x,x.x,x.x*CC
```

1 Mode is M for manual forced 2D/3D, A for automatic
2 Mode is:
    1 = fix not available

2 = 2D
3 = 3D

Sample log:
$GPGSA,A,3,03,22,11,18,15,19,,,,,,,3.3,2.5,2.0*31

$GPGST - GNSS Pseudorange noise statistics

```
                               n
                              o
                              i
                    n         t
                    o         a
                    i         t
                    t         n
              n     a         e
              o     i         i
              i     v         r
              t     e         o
              a     d                                    r     r
              i           r     r     r                  o     o
              v     r     o     o     j                  r     r
              e     o     j     n     a                  r     r     r
              d     j     i     i     m           e      e     e     o
                    a     m     m     -     e     m      m           r
        e     S     m     -     i     i     i     i      i     e     r
        m     M     -     i     m     m     t     t      t     d     e
        i     R     i     m     e     e     i     i      u     u     m
        T     n     m     e     S     S     L     L      t     t     u
              o     e                                    i           s
  r     C     i     S     S     S     e     e     e      g     i     k
  e     T     t     S     S     S     d     d     d      n     t     c
  d     U     a     M     M     M     u     u     u      o     l     e
  a           i     R     R     R     t     t     t      L     A     h
  e           t                                                      C
  H           a
  Header,UTC Time,RMS Deviation,Semi-major deviation,Semi-minor deviation,Semi-major orientation,Latitude error,Longitude error,Altitude error,Checksum
$GPGST,hhmmss.ss,x.x,x.x,x.x,x.x,x.x,x.x,x.x*CC
```

Sample log:
$GPGST,104815.00,2.4,3.2,2.1,0.0,3.2,2.1,3.9*52

$GPVTG – Course over ground/speed

```
        Header,Course in degrees,True heading,Course in degrees,Magnetic heading,Speed,Knots,Speed,km/h,Checksum
$GPVTG,x.x,T,x.x,M,x.x,N,x.x,K*CC
```

Sample log:
$GPVTG,352.39,T,,M,0.005,N,0.010,K,D*32

$GPZDA - UTC and local date/time data

```
        Header,UTC time,UTC Day,UTC Month,UTC Year,Local Zone Hours,Local Zone Minutes,Checksum
$GPZDA,hhmmss.ss,xx,xx,xxxx,xx,xx*CC
```

Sample log:
$GPZDA,104728.00,24,03,2005,00,00*6C

$GPGSV – GNSS Satellites in view

```
                       Number of Satellites
              Total messages
                  Message number
                          Satellite ID
                             Elevation
                               Azimuth
   Header                        SNR    Checksum 1

$GPGSV,x,x,xx,xx,xx,xxx,xx,...*CC
```

[1] Logs come in groups of three satellites each

Sample log:
$GPGSV,3,1,12,20,85,302,39,11,49,142,42,24,55,297,41,31,43,251,39*76
$GPGSV,3,2,12,01,39,055,41,23,39,188,40,25,24,077,36,04,12,301,*7A
$GPGSV,3,3,12,13,11,201,,14,04,037,30,33,29,205,34,05,0,354,*70

$LCGLC - Loran-C Geographic position, Time differences

```
                  Signal Quality M 1
                        Signal Quality 1 1
                              Signal Quality 2 1
                                    Signal Quality 3 1
                                          Signal Quality 4 1
                                                Signal Quality 5 1
         Master TOA
   Header      TD1   TD2   TD3   TD4   TD5
        GRI                                      Checksum

$LCGLC,xxxx,x.x,a,x.x,a,x.x,a,x.x,a,x.x,a,x.x,a*CC
```

[1] Signal status is:
   B = Blink warning
   C = Cycle warning
   S = SNR warning
   A = Valid

Sample log:
$LCGLC,7499,7238.9700,A,14021.7721,A,31696.1800,A*00
$LCGLC,6731,6750.7446,A,14450.7611,A,42178.2373,A*0A

$LCHDT - Loran-C Heading

```
            Header  Heading  True heading  Checksum
$LCHDT,x.x,T*CC
```

Sample log:
$LCHDT,65.9,T*17

$LCGLL – Loran-C

```
      Header  Latitude  N/S  Longitude  E/W  UTC time of fix  Status 1  Mode Indicator 2  Checksum
$LCGLL,ddmm.mm,a,dddmm.mm,a,hhmmss.ss,a,a*CC
```

1 Status is A for normal operation, V for invalid position
2 Mode Indicator is:
   A = Autonomous
   D = Differential
   E = Estimated
   M = Manual mode
   S = Simulator mode
   N = No fix data

Sample log:
$LCGLL,5052.77062,N,00437.01017,E,,A,A*5E

4.5 reelektronika Proprietary logs

Besides the supported NMEA logs for GPS and Loran-C the integrated navigation sensor also outputs **reelektronika** proprietary logs. These logs are necessary if the user wants to use the sensor at its most accurate and sophisticated level. The NMEA 0183 logs are then not sufficient to communicate all available and relevant data to other equipment. These logs all begin with the header $PRLK.

The following logs are currently supported:

Log	Description
GPPOSA	GPS calculated position
LCPOSA	Loran-C calculated position
INPOSA	Integrated position fix using GPS and/or Loran-C
LCRSDA	Loran-C range residuals
TOAA	Loran-C Time of Arrival measurements
HDGA	Heading measurement
DASFA	Differential ASF measurements
RMSGA	Eurofix decoded messages
RTCMB	Binary output of RTCM SC104 DGPS data received through Eurofix
FFTA	Frequency spectrum data
NOTCHA	Notch frequency and bandwidth information
SYNCA	Loran-C to UTC Synchronisation information

GPPOSA - GPS calculated position

```
$PRLK,GPPOSA,c--c,hhmmss.ss,ddmmyy,a,a,x.x,x.x,x.x,x.x,x.x,x.x,x.x,x,x.x,x.x,x.x,x.x*CC
```

Fields: Header, Logheader, Interface version, UTC time of fix [1], UTC Date, UTC Mode [2], GPS Mode [3], Latitude, Longitude, Height above MSL, Undulation [4], Velocity (m/s), Heading, Compass heading [5], Num Satellites, HDOP, VDOP, PDOP, Quality [6], Checksum

[1] If UTC time is not available, the internal receiver time since boot is reported

[2] UTC Mode is:
     G = GPS derived UTC
     L = Loran-C derived UTC
     N = No UTC synchronisation

[3] GPS Mode is:
     A = Autonomous, only GPS
     W = Differential WAAS/EGNOS
     R = Differential RTCM Radiobeacon
     E = Differential Eurofix
     N = No fix data

[4] Undulation is difference between Mean Sea Level (MSL) and geoid height, "-" = mean sea level is below WGS-84 geoid.

[5] Compass heading currently not available in this log, use HDGA instead

[6]   Quality indicator TBD

Sample log:
$PRLK,GPPOSA,1.0,145836.00,110405,G,E,50.8727658,4.6261289,69.9,47.4,0.0,331
.2,,7,1.36,1.51,2.03,*0B

LCPOSA - Loran-C calculated position

Header	Logheader	Interface version	UTC time of fix [1]	UTC Date	UTC Mode [2]	LC Mode [3]	Latitude	Longitude	Velocity (m/s)	Heading	Compass heading [4]	Num Loran-C	HDOP	Quality [5]	Checksum

$PRLK,LCPOSA,c--c,hhmmss.ss,ddmmyy,a,a,x.x,x.x,x.x,x.x,x.x,x,x.x,x.x*CC

[1]   If UTC time is not available, the internal receiver time since boot is reported
[2]   UTC Mode is:
        G = GPS derived UTC
        L = Loran-C derived UTC
        N = No UTC synchronisation
[3]   LC Mode is:
        C = Coarse position (no cycle identification necessary)
        A = Uncorrected Loran-C
        D = Differential Loran-C
        G = GPS Calibrated Loran-C
        S = ASF Corrected Loran-C
        N = No position fix
[4]   Compass heading currently not available in this log, use HDGA instead
[5]   Quality indicator TBD

Sample log:
$PRLK,LCPOSA,1.0,1934.00,,N,G,50.8727050,4.6262118,0.2,161.2,,5,2.0,*29

INPOSA - Integrated position fix using GPS and/or Loran-C

Header	Logheader	Interface version	UTC time of fix [1]	UTC Date	UTC Mode [2]	Position Mode [3]	Latitude	Longitude	Height above MSL	Undulation [4]	Velocity (m/s)	Heading	Compass heading [5]

$PRLK,INPOSA,c--c,hhmmss.ss,ddmmyy,a,aa,x.x,x.x,x.x,x.x,x.x,x.x,x.x,

```
Num Satellites
  Num Loran-C
    HDOP
      Quality 6
        Checksum

x,x,x.x,x.x*CC
```

1. If UTC time is not available, the internal receiver time since boot is reported
2. UTC Mode is:
   G = GPS derived UTC
   L = Loran-C derived UTC
   N = No UTC synchronisation
3. Position Mode has two characters, first indicating the GPS mode:
   A = Uncorrected GPS
   W = Differential WAAS/EGNOS
   R = Differential RTCM Radiobeacons
   E = Differential Eurofix
   N = No GPS included
   The second character indicates the Loran-C mode:
   A = Uncorrected Loran-C
   D = Differential Loran-C
   G = GPS Calibrated Loran-C
   S = ASF Corrected Loran-C
   N = No Loran-C included
4. Undulation is difference between Mean Sea Level (MSL) and geoid height, "-" = mean sea level is below WGS-84 geoid. If height is not available the field will be left blank
5. Compass heading currently not available in this log, use HDGA instead
6. Quality indicator TBD

Sample log:
$PRLK,INPOSA,1.0,141646.00,110405,G,EG,50.8727703,4.6260831,69.3,47.4,1.4,331.5,,6,5,0.00,*46

LCRSDA - Loran-C range residuals

```
Header
  Logheader
    Interface version
      UTC time of fix 1
        UTC Date
          UTC Mode 2
            LC Mode 3
              Num Loran-C
                Loran-C Station ID 1
                  Residual LC 1 (m)
                    Weight factor LC 1
                      Loran-C Station ID n
                        Residual LC n (m)
                          Weight factor LC n
                            Checksum

$PRLK,LCRSDA,c--c,hhmmss.ss,ddmmyy,a,a,x,xa,x.x,x.x,.....,xa,x.x,x.x*CC
```

1. If UTC time is not available, the internal receiver time since boot is reported
2. UTC Mode is:
   G = GPS derived UTC
   L = Loran-C derived UTC
   N = No UTC synchronization
3. LC Mode is:
   A = Uncorrected Loran-C

D = Differential Loran-C
G = GPS Calibrated Loran-C
S = ASF Corrected Loran-C
N = No position fix

Sample log:
$PRLK,LCRSDA,1.0,1274.00,,N,S,5,6731M,-0.4,1.00,6731X,0.0,0.14,6731Z,
-1.0,0.49,7499M,0.9,0.49,7499X,0.3,0.99*75

TOAA – Loran-C Time of Arrival measurements

Column headers (vertical, first block):
Header, Logheader, Interface version, Receiver time [1], Update interval, Integration time, Clock steering, Clock error (s/s), Noise Loop 1 (dB), Noise Loop 2 (dB), Num Stations, Loran-C Station ID 1, Signal Strength (dB), SNR (dB), Batch Quality [2], ECD (µs), Cycle Ident Quality [2], Status [3], Time of Arrival (µs), Doppler (s/s), Locktime (s)

$PRLK,TOAA,c--c,x.x,x,x,c--c,x.x,x.x,x.x,x,xa,x.x,x.x,x.x,x.x,x.x,x.x,XXXX,x.x,x.x,x.x,...

Column headers (vertical, second block):
Loran-C Station ID n, Signal Strength (dB), SNR (dB), Batch Quality [2], ECD (µs), Cycle Ident Quality [2], Status [3], Time of Arrival (µs), Doppler (s/s), Locktime (s), Checksum

xa,x.x,x.x,x.x,x.x,x.x,XXXX,x.x,x.x,x.x,*CC

[1] The internal receiver time since boot is reported
[2] Quality indicator between 0 and 1, 1 is highest quality
[3] Status is a hexadecimal number which indicates the tracking of the station. Each bit in the number corresponds to a signal flag:

0x0001	Cycle Ident not valid
0x0002	Reserved
0x0004	Reserved
0x0008	Reserved
0x0010	Reserved
0x0020	Reserved
0x0040	TOA invalid (TOA set to -1)
0x0080	Doppler invalid
0x0100	Reserved
0x0200	Reserved
0x0400	Reserved
0x0800	Reserved
0x1000	Reserved
0x2000	Data modulation detected
0x4000	Reserved
0x8000	Reserved

Sample log:
$PRLK,TOAA,1.0,1129.00,5,5,FINESTEERING,7.86e-07,,,6,
6731M,50.98,16.66,0.777,-0.369,0.780,0000,6750.6586,1.8025e-09,1063.97,
6731X,38.94,-0.58,0.377,-0.003,0.351,0000,21201.4204,4.0613e-10,1064.98,
6731Z,50.14,10.28,0.860,-0.895,0.653,0000,48928.8892,1.3639e-09,1064.98,
7499M,50.32,10.45,0.816,-0.817,0.682,0000,7238.8968,-1.4135e-09,1064.03,
7499X,51.01,16.68,0.866,-0.421,0.774,0000,21260.6690,1.479e-09,1063.96,
7499Y,34.07,-6.82,0.312,-0.858,0.346,0000,38935.0639,3.7997e-09,1063.96*79

HDGA – Heading measurement

```
                       Interface version
                       Receiver time 1
                       Update time
                       Mode 2
       Header
       Logheader                          Heading
                                          Heading Std
                                          Quality
                                          Checksum
```

$PRLK,HDGA,c--c,x.x,x,a,x.x,x.x,x.x*CC

[1] The internal receiver time since boot is reported
[2] Mode is:
   G = GPS derived heading
   L = Loran-C derived heading
   I = Inertial derived heading

Sample log:
$PRLK,HDGA,1.0,1216.00,1,L,65.47,0.0,1.0*58

DASFA – Differential ASF measurements

```
                       Interface version
                       UTC time of fix
                       UTC Date
                       UTC Mode1
                       GPS Pos Lat
                       GPS Pos Lon
                       Num stations
       Header          Loran-C Station ID 1
       Logheader       Differential ASF
                       Quality
                       Loran-C Station ID n
                       Differential ASF
                       Quality
                       Checksum
```

$PRLK,DASF,c--c,hhmmss.ss,ddmmyy,a,x.x,x.x,x,xa,x.x,x.x,...,xa,x.x,x.x*CC

[1] UTC Mode is:
   G = GPS derived UTC
   L = Loran-C derived UTC
   N = No UTC synchronisation

Sample log:
$PRLK,DASFA,1.0,1464.00,,N,50.8726202,4.6260773,6,6731M,0.000,0.0001,
6731X,2.084,0.0043,6731Z,-0.068,0.0030,7499M,-0.069,0.0030,
7499X,0.002,0.0024,7499Y,-0.710,0.0053*32

RMSGA – Eurofix decoded messages

```
                                                    Eurofix message ²
                                   Interface version
                                          Receiver time ¹
                                                 Loran-C Station ID
              Header
                  Logheader
                                                             Num GRI Errors
                                                             Num GRI Erasures
                                                                  Checksum

$PRLK,RMSG,c--c,x.x,xa,X--X,x,x*CC
```

[1] The internal receiver time since boot is reported
[2] The Eurofix message of 10 7-bit words is represented as 10 hexadecimal numbers of two characters, description of the message content can be found in "Eurofix Message Format, Reel-EMF"

Sample log:
$PRLK,RMSGA,1.0,1605.66,7499Y,61574307711F000C2A63,0,12*78

RTCMB – Binary output of RTCM SC104 DGPS data

RTCMB data is binary RTCM SC 104 Version 2.2 data that can be fed to any standard GPS receiver. It is recommended that this log is activated on a separate comport than ASCII logs. The RTCM data is extracted from the received Eurofix messages from the closest Loran Station outputting Eurofix.

Sample log:
fQFIA^AAB{w~oTS@tO@kYnYvH^aHBO@   cV@ZF@zYnyv~an{}vw|Ome Gy nY nYvH^Q

FFTA – Frequency spectrum data

```
                                                     Number of FFT channels
                                   Interface version
                                          FFT points
                                              Start bin ¹
                                                  Num bins ¹
                                                     Integration count
                                                         Profile count ²
                                                             Gain setting
              Header
                  Logheader
                                                                  FFT value
                                                                      Next FFT value
                                                                          Checksum

$PRLK,FFTA,c--c,x,x,x,x,x,x,x,x.x,...*CC
```

[1] Bins are counted in units of 400 kHz/(FFT Points)
[2] Profile count is TBD

Sample log:
$PRLK,FFTA,1.1,4096,615,820,24,0,127,1,20.9,13.5,-2.0,...*29

Trigger: ONNEW

NOTCHA– Notch frequency and bandwidth information

```
                                                      log
                                       in notches
                                   Interface version
                                                     notches
                                                              (kHz)      (kHz)
                                   Receiver time¹
                                                     active
                                            of notches
                                            of
                                                     Frequency Notch 0
                                                              Bandwidth Notch 0
              Header
                     Logheader
                                            Number
                                            Number
                                                                        Next notch
                                                                                Checksum

$PRLK,NOTCHA,c--c,x.x,x,x,x.x,x.x...*CC
```

¹ The internal receiver time since boot is reported

Sample log:
$PRLK,NOTCHA,1.0,171130.81,30,13,128.92,0.6867,77.47,0.6338,75.03,0.6457,77.4
7,0.6338,127.27,0.5483,80.99,0.5649,80.99,0.5649,118.28,0.5122,128.92,0.6867,9
4.67,0.2946,75.03,0.6457,70.92,0.3092,-1,-1,82.74,0.6709,-1,-1,-1,-1,-1,-1,-1,-1,-1,-
1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1*07

Trigger: ONNEW

SYNCA– Loran-C to UTC Synchronisation information

```
                                        source²
                                                                       Samplecount³
                                   Interface version
                                                                                      Leapseconds⁵
                                   Synchronisation
                                                                                             Offset⁶
                                   Receiver time¹
                                                                                                        Station ID⁷
                                                                       Receiver
                                                                              UTC Flag⁴
                                                                                      Applied
                                                                                             Applied
                                                                                                        UTC
              Header
                     Logheader
                                        Year
                                            Month
                                                Day
                                                    Hours
                                                        Minutes
                                                            Seconds
                                                                                                        Loran
                                                                                                           Checksum

$PRLK,SYNCA,c--c,x.x,c—c,x ,x ,x .x ,x ,x ,x.x,x,x ,x.x,xa*CC
```

¹ The internal receiver time since boot is reported
² Synchronisation source can be
  LORANUTC = sync information derived from received Eurofix UTC message
  (depending if the service is available in the area of operation)
  GPSPPS = sync information is derived from an external GPS 1 PPS signal fed into
  the receiver (only available on UTC and ASF measurement equipment)
³ Receiver samplecount (with fraction) in units of 2.5 µs of the exact UTC second
⁴ Indicates of the date and time are represented in UTC time (1=UTC, 0=No UTC)
⁵ Number of leap seconds between the UTC source and UTC time. At the moment of
  printing of this manual GPS is 14 seconds ahead of UTC, Loran is 23 seconds
  ahead of UTC. Note that the leap seconds are already applied in the UTC date and
  time presented
⁶ Applied offset to compensate for propagation time from transmitter to user, also
  already used in the reported UTC time.
⁷ Loran station ID of the station of which the UTC information is derived

Sample log:
$PRLK,SYNCA,1.0,1676.97,LORANUTC,2006,06,01,08,57,24,671653990.473579,1,
23,0.0,7499M*30

Trigger: ONNEW

$PRLK,SYNCA,1.0,1676.97,LORANUTC,2006,06,01,08,57,24,671653990.473579,1,
23,0.0,7499M*30

5 LERXAnalyser user interface

The LORADD receiver comes with a Windows software program to view and monitor the output of the receiver, LERXAnalyser. The software allows communicating to the receiver via serial communications or replaying of recorded logs from file.

Before the LERXAnalyser is able to display information, the user should select a data source from a comport, TCP/IP connection or file, using the "Data source" menu under "File". Once a connection to the receiver is made, a command script (for instance to upload a previously stored DASFA database) can be uploaded. Also, a file can be opened in which the incoming data is stored.

Views of different logs can be opened or closed using the menu "View". By selecting the "Serial Monitor" view the user may enter commands. The two windows show the incoming data. The left window shows all data passing by, the right window all data which have the Select string included or excluded. If for instance the Select string is "$" and the radiobutton "Exclude" is selected, the right window will show responses on commands only. The data views display the different logs in a tabulated structure for easy viewing. The Loran-C derived heading information is displayed as an arrow. Offsets can be entered to calibrate the true north heading, which may be biased during to antenna installation. The user has a number of tools at his disposal; most of which are self-explanatory. Figure 5-1 shows a screen capture of the main window.

Besides data views the LERXAnalyser has more sophisticated screens available. The software allows monitoring of eLoran TOA measurements for a longer period in a graphical representation, Figure 5-2. To reduce the effects of receiver clock error, the
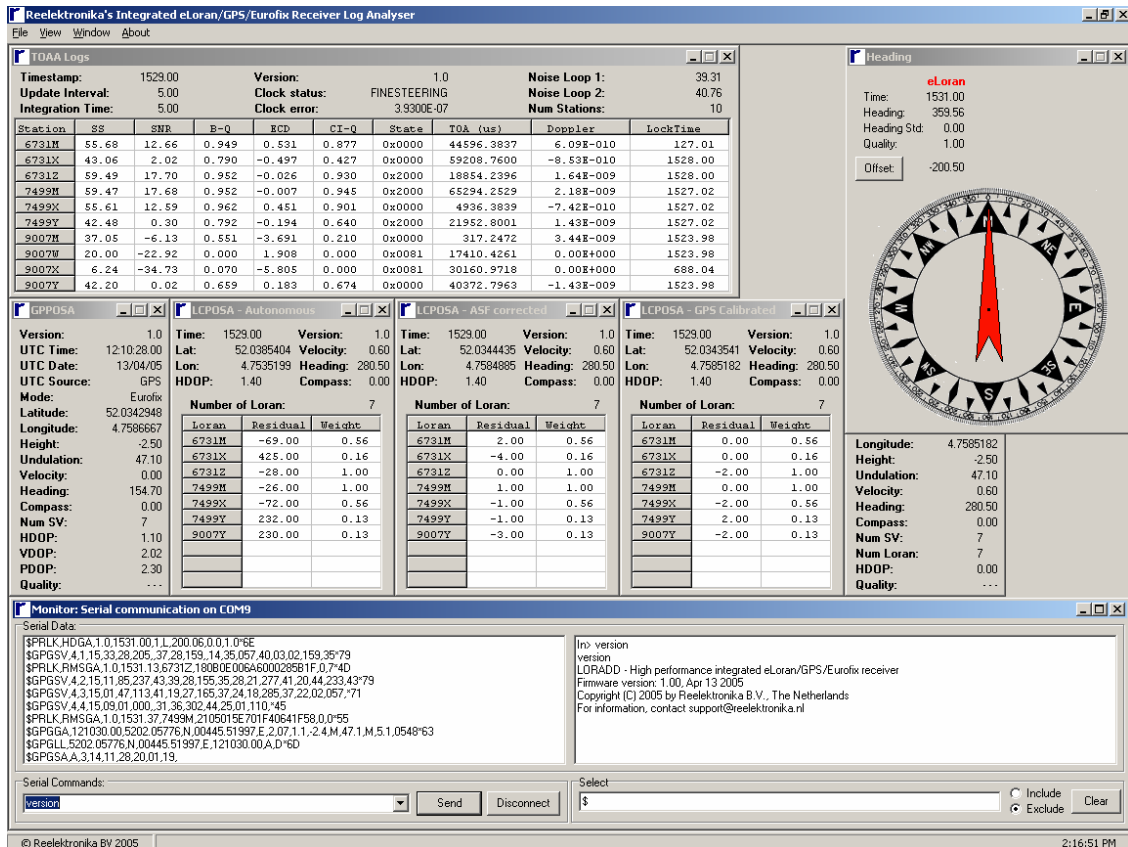

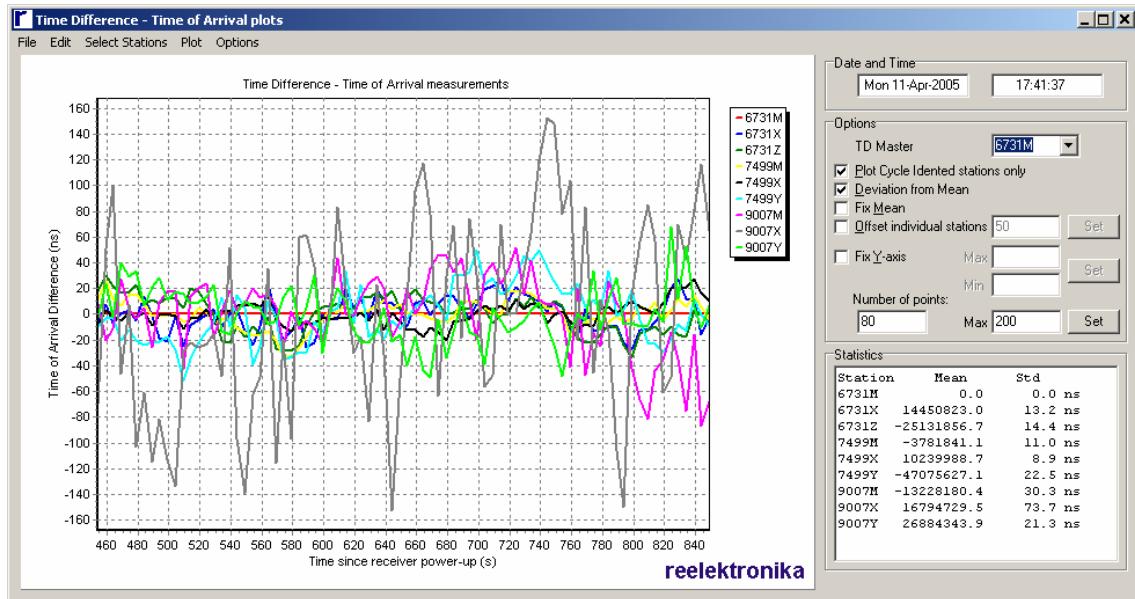*Figure 5-1 Screen capture of the main view of the LERXAnalyser software*

Figure 5-2 Screen capture of the TOA monitoring plots

user may select any station to be a "master". However, with the SRS oscillator being governed by the UTC Station the TOA measurements should be stable after settling time of the receiver (approximately 10 minutes). All TOAs will be plotted with respect to the timing of the "master" station. This window also allows displaying of SMDA or DASFA data, use "File" – "Source". Individual stations or whole chains can be selected and deselected using the "Select Stations" menu. On the right side, different settings can be chosen to display the data. Also, statistical data for all stations displayed is presented.

The reception of Eurofix messages can be monitored using the Eurofix Data screen, Figure 5-3, which will be shown through "View" – "Eurofix Data". Select the tab "UTC" to view the reception of UTC messages from the stations.

The LERXAnalyser further allows monitoring position outputs of the different modes of operation in a scatterplot, Figure 5-4. Positions can be selected to be displayed using
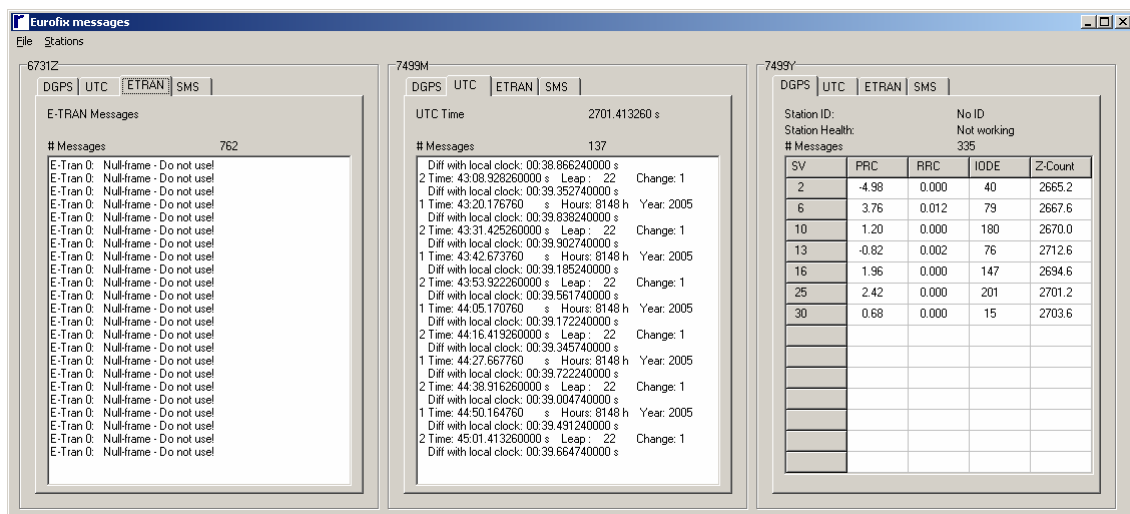

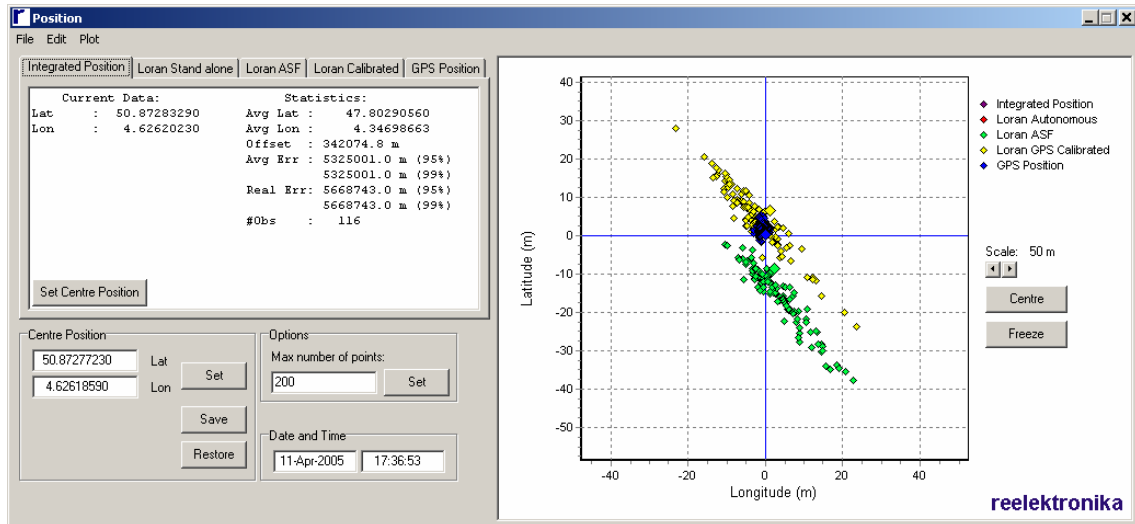
Figure 5-3 Screen capture of the Eurofix message decoding

Figure 5-4 Screen capture of the position scatter plots

the "Plot" menu. Further, statistical information on the performance is displayed for 5 position outputs. This will only make sense for static measurements.

The last screen shows a spectrum plot of the received Loran and in-band/out –of-band interferers, Figure 5-5. The mouse pointer will show frequency and relative strength of the interferer pointed at. Make sure you enabled the FFTA log by sending the command "LOG COM1 FFTA ONNEW" (if your PC is connected to LORADD com1).
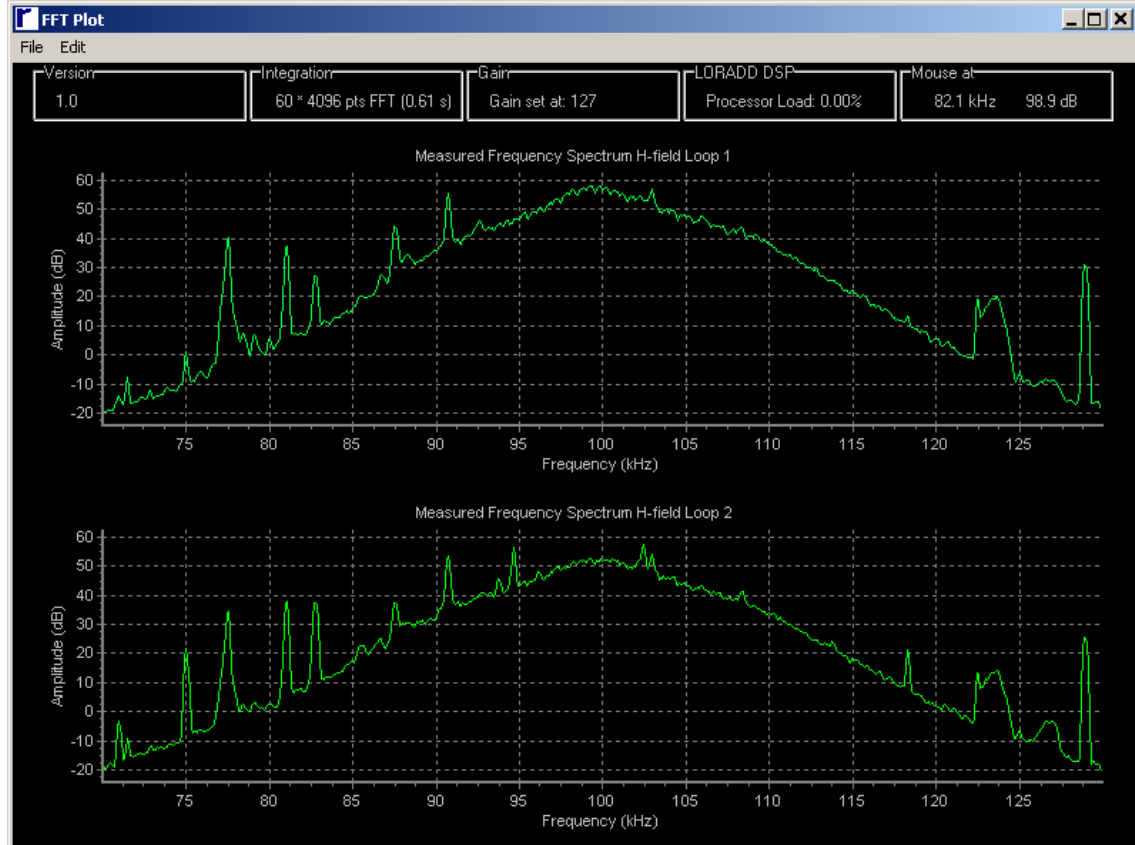
Figure 5-5 Screen capture of FFT screen

6   Troubleshooting

This section will give a quick overview of the most common problems with the UTC receiver in the form of a "frequently asked questions" guide.

In order to do the troubleshooting, make sure all connections are made properly and the UTC receiver COM1 is connected using a straight through cable to a PC or Laptop running the LERXAnalyser software (Section 2.1).

Questions regarding the operation of the UTC receiver

Q1:   The receiver does not light any LEDs.

A1:   - Check if the power cord is properly connected, input is 100-240 V 50/60 Hz mains.
- Check if the fuse at the back of the power connecter is broken, replace with 1 A (slow) only.
- If the power is connected and the switch is turned on, the power LED should be lit.

Q2:   The receiver is turned on, and the power LED is lit. However, the display continues to report 0 Loran stations for a long time.

A2:   - Check if the eloran H-field antenna is properly connected.
- Check if the antenna is installed according to Section 2.3.
- If this is OK, connect the receiver COM1 to a Windows PC or Laptop and run the LERXAnalyser software (Section 2.1).
- Enable the TOA output by entering the command "LOG COM1 TOAA ONNEW" after establishing communication to the receiver. The TOAA menu under View shows the TOA output of the receiver. Here the receiver should show tracking of stations and a noise indication of both loops. Both loops should indicate noise levels above 20 dB and normally below 50 dB.
- Verify that the receiver tracks a number of stations with good SNR (> 0 dB) including the UTC station.
- If the receiver does not track any stations, issue the command SETPOSITION to tell the receiver its approximate position. A Google Earth file with all Loran transmitters can be downloaded from the **reelektronika** website. Verify that the receiver is searching for Loran stations in your area using the SHOWSEARCH command.
- If the "clock status" shows FINESTEERING or TOALOCK, the receiver and antenna are connected fine and the "1PPS eloran" LED should blink .

Q3:   The receiver is turned on, and the power LED is lit. However, the "1PPS GPS" LED remains off.

A3:   - Check if the GPS antenna is properly connected.
- Check if the antenna installed according to Section 2.3.
- If this is OK, connect the receiver COM3 to a Windows PC or Laptop and run the Motorola WinOncore software. Connect to the receiver using 9600 baud (default). Change the comport speed of COM3 using the SETSPEED command on COM1 (using LERXAnalyser) if needed.
- Use the WinOncore software and Motorola receiver manual to troubleshoot the GPS receiver.

Q4:   The receiver is turned on, the power LED is lit, but the "Status" LED remains off.

A4:   - Connect the receiver COM1 to a Windows PC or Laptop and run the
      LERXAnalyser software (Section 2.1).
      - Enable the TOA output by entering the command "LOG COM1 TOAA ONNEW"
      after establishing communication to the receiver. The TOAA menu under View
      shows the TOA output of the receiver. Here the receiver should show tracking of
      stations and a noise indication of both loops. Both loops should indicate noise
      levels above 20 dB and normally below 50 dB.
      - If the "clock status" shows FINESTEERING but not TOALOCK, make sure to
      set the TOA source using the commands "SETTINGS SHOW" and "SETTINGS
      SET TOASOURCE 7499M". Replace 7499M with the station identifier of the UTC
      station you want to select.

Q5:   The receiver is turned on, the power LED is lit. The display does not show UTC
      time after 5 minutes of operation and the eLoran LED is not blinking.

A5:   - Connect the receiver COM1 to a Windows PC or Laptop and run the
      LERXAnalyser software (Section 2.1).
      - Enter the command "SETTINGS SHOW" to view the current setting of the
      receiver after establishing communication to the receiver. If you want to view the
      response of the receiver, make sure the right panel of the Serial Monitor window
      filters on "excluding" the '$' sign.
      - Verify that the UTCSOURCE is set to a station which broadcasts UTC
      messages. If not, enter the command "SETTINGS SET UTCSOURCE 7499M".
      Replace 7499M with the station identifier of the UTC station you want to select.
      - Enable the RMSGA output by entering the command "LOG COM1 RMSGA
      ONNEW". If the UTC Source is correct verify that the receiver receives Eurofix
      messages from that station by selecting "Eurofix Data" under the View menu. The
      window should show a panel with the station you selected as UTC Source,
      showing decoded Eurofix messages.
      - Verify that the message counter increases every 3 seconds (or less). Choose
      the UTC tab and verify that UTC messages are received.
      - If they are not received, verify if any Eurofix messages are received on the other
      tabs.
      - If no Eurofix messages are received or no UTC messages are received the
      reception of Eurofix may be hampered.
      - Check the quality of reception using A2.
      - Select a different UTC Source with UTC messages available in the "Eurofix
      Data" menu.
      - If no Eurofix broadcasts are available issue the command
      "SYNCUTCFROMGPS" to synchronise Loran UTC with GPS UTC.

Q6:   The receiver is turned on and all LEDs are indicating proper operation. The
      display shows UTC time (which may be offset to your local time). The 1 PPS
      sources output 1 pulse per second pulses (GPS and eloran). However the 1 PPS
      from Loran and GPS do not coincide.

A6:   Note that the rising flanks of both 1 PPS sources are the accurate time
      information of the UTC second.
      - Connect the receiver COM1 to a Windows PC or Laptop and run the
      LERXAnalyser software (Section 2.1).
      - Enter the command "SETTINGS SHOW" to view the current setting of the
      receiver after establishing communication to the receiver. If you want to view the
      response of the receiver, make sure the right panel of the Serial Monitor window

filters on "excluding" the '$' sign.
- If the UTC Offset is 0, perform a calibration of the "eloran 1 PPS" using the "GPS 1 PPS" by entering the command "MEASUREPPS STORE".
- If the UTC Offset is not 0, verify that the UTC Offset corresponds to your location and the selected UTC Station. Each UTC Station and change of position needs a new UTC Offset, either manually or automatically.

Questions regarding the LERXAnalyser

Q7: The receiver is working properly, but the LERXAnalyser is not able to communicate with the receiver.

A7: - Make sure you connect the receiver COM1 using a straight through cable to a free comport on the PC or Laptop.
- Default the receiver communicates on 115200 baud, but these settings can be changed and saved in non-volatile RAM. Choose No Parity, 8 bits, 1 stop bit in the Data Source window.
- Try to connect at different speeds. Verify if you get a response using the "VERSION" command.
- Once communication is established, you can set the communication speed to your desired value using the "SETSPEED COM1 115200" command. Replace 115200 with your preferred value. After issuing this command, press the disconnect button in the LERXAnalyser and reconnect at the selected speed in the Data Source window.
- If despite the efforts you are not able to communicate, try communicating to COM2 instead. Once communication with COM2 is established the speed of COM1 can be set using the above command.
- Make sure to save the setting if you want to make the change permanently using the "SAVECONFIG" command.

References

[ITU-01] Recommendation ITU-R M.589-3, "Technical characteristics of methods of data transmission and interference protection for radionavigation services in the frequency bands between 70 and 130 kHz", International Telecommunication Union, August, 2001.

[RTCM-01] "RTCM Recommended Standards for Differential GPS (Global Navigation Satellite Systems) Service", Version 2.3, RTCM Special Committee no. 104, Alexandria, VA, USA, 2001.

[REEL-05] "Eurofix Message Format", Reel-EMF, version 2.11, 23 August 2005.