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Technical aspects of Lentus (4.21.1) and use

Summary

1) Introduction

This new mode benefits from the fact that it is nowadays quite easy to synchronize a computer with reference clocks, through an automatic WEB communication. A precision of 50 ms is easy to get with WEB time servers. So if the symbol length is sufficiently large (>2 seconds), the relative precision is quite good.
Consequently, the symbol synchronization is done directly through programmed times, without need to extract synchronization from the signal itself, as it is done in the majority of modes (PSK31 for example). This permits a gain in term of minimum S/N ratio and to increase the robustness of the transmission.

The goal of this mode is to perform VLF to HF communications at a very low S/N ratio (-34 dB with a noise bandwidth of 3 KHz). It is a two-way mode, which means that messages can be transmitted from A to B and from B to A, in a half duplex. Also, it can be used as a beacon and as a repeater.

The way to use it, is similar to the way to use JT65.

Of course, the rate of exchange is very slow (5 times slower than JT65), thus the name of this mode (“lentus” means "slow", but also indolent, nonchalant, quiet… in latin).

2) General description

Below is given a general description of Lentus. For a detailed description, refer to the document "Specifications 1.2 of the Lentus mode" available on my WEB site:
http://f6cte.free.fr/SPECIFICATIONS.ZIP

The baud rate is low: 0.1465 baud (4800/32768), i.e. 6.827 seconds by 5 bits symbol.

A message lasts 293.5 seconds (almost 5 minutes). It begins normally at t=4 sec of the UTC minute 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50 or 55.

The message is normally composed of 43 symbols, each one with a length of 32768 audio samples (i.e. 6.827 seconds by symbol). The 9 first symbols carry a tone allowing the determination of the transmission central frequency. The 31 following "5 bits symbols" carry the message (allowing the Reed-Solomon coding on 75 bits). The last three symbols carry a tone at the central frequency.

Messages can be either plain text (13 characters, preceded by a bit “CQ” and a bit “Beacon”)
Example of plain text:
21:24 01 970 0.0 CQ DE F9XYZ HELLO !

Messages can be formatted text according to different possibilities, listed below:

- A standard CQ call composed of a bit “CQ” + a bit “Beacon” + a complete call (with 3 characters max in the mantissa, as for example “AZ2/FL5XYZ/MM”) + optionally, a 6 characters Locator (accuracy +/-2.31 km in latitude and +/- 4.63 km maximum in longitude).
  Note: without the “CQ”, it is considered as a simple piece of information.
  Example:
  18:14 03 1000 -0.0 CQ DE F9XYZ JN33ET D=636 Km (395 mil.) Az=150°

- A “Station description” type CQ call composed of a bit “CQ” + a bit “Beacon”, a 6 characters call + suffix (as for example “FL5XYZ/MM”), a “6 characters Locator” + Power level + “mW/W” bit + relative gain of HF antenna + directivity of the antenna.
  Note: without the “CQ”, it is considered as a simple piece of information.
  Example:
  18:04 03 1000 -0.0 CQ DE F9XYZ JN33ET Power: 10 W Antenna: Dipole Directivity: E

- A “Meteorological” type CQ call composed of a bit “CQ” + a bit “Beacon”, a 6 characters call (as for example “FL5XYZ”), a “6 characters Locator” + Temperature + Wind force + Type of weather + Humidity.
  Note: without the “CQ”, it is considered as a simple piece of information.
  Example:
  18:09 01 1000 -0.0 CQ DE F9XYZ JN33ET T=20°C Wind: Calm Weather: Sunny Humidity: Normal

- A CQ call with precise geographical position composed of a bit “CQ” + a bit “Beacon”, a 6 characters call + a geographical position (latitude + longitude) in ° ‘ and 2 figures decimal (as for example “48-49.83N 002-22.02E”). The accuracy is equal to 9 m in latitude and in longitude (about 60000 times more precise than a Locator position).
  Note: without the “CQ”, it is considered as a simple piece of information.
  Example:
  18:19 02 1000 -0.0 CQ DE F9XYZ 48°49.86'North 002°22.00'East D=5 Km (3 mil.) Az=29°

- An answer to a CQ with Locator 4 characters composed of a 6 characters Call 1 (as for example “FL5XYZ”) + a 6 characters Call 2 (as for example “FL5XYZ”) + Locator 4 characters (accuracy +/-55 km in latitude and +/- 111 km maximum in longitude), in answer of Call 1 to a CQ done by Call 2,
  Example:
  18:24 01 1000 -0.0 F6CTE DE F9XYZ JN33 D=690 Km (428 mil.) Az=147°

- An answer to a CQ with S/N ratio and drift composed of a 6 characters Call1 (as for example “FL5XYZ”) + a 6 characters Call 2 + Suffix (as for example “FL5XYZ/MM”) + S/N ratio (12 to -37 dB) + drift (-4 to 4 by step of 0.1 Hz/mn), in answer of Call 1 to a CQ done by Call 2,
  Example:
  18:29 14 1000 -0.0 F6CTE DE F9XYZ 0 dB 0.0 Hz/mn

- An answer to finish a QSO composed of a 6 characters Call 1 (as for example “FL5XYZ”) + 6 characters Call 2 + Suffix (as for example “FL5XYZ/MM”) + “73 GB SK”.
  Example:
  18:34 02 1000 -0.0 F6CTE DE F9XYZ 73 GB SK

Lentus can be used to do QSO (two way communication) or as a beacon. In that last case, no answer is required:

- a beacon transmission could be done at minutes 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, or 55.

- for a QSO, by mutual agreement , the Ham calling CQ will transmit at minutes 0, 10, 20, 30, 40, 50 and the Ham answering to the CQ call will transmit at minutes 5, 15, 25, 35, 45, 55.

Lentus can also be used, for very specific use, as a repeater. As a repeater, it simply transmits what it is received so as to forward the message to other stations or to broadcast a message (through several repeaters).

In plain text, the speed is equal to 0.43 wpm (13 characters maximum by 5 minutes period).

The modulation used is a MFSK 32 tones (for 5 bits) with a shift between tones of 0.7325 Hz (5 x baud rate).

The synchronization tone transmitted during the 9 first symbols corresponds to the central frequency of the transmission bandwidth. It allows the determination of the central frequency (with a precision of about +/- 0.1 Hz) and the drift speed (up to 3 Hz/mn). The 32 possible 10^{th} symbol (first data) frequencies will be estimated from these two pieces of information. The synchronization frequency search bandwidth tolerance is variable from +/- 20 Hz to +/-80 Hz, counted from the frequency clicked, by the user, on the waterfall.

It must be selected USB on the transceiver.

Regarding time accuracy, each transmitting or receive period of 300 sec must start at t=4 sec of the UTC minute 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, or 55 with a maximum tolerance of +/-0.1 sec of the PC clock. It must be used a very accurate time from an Internet Time Service as the NSIT, through a SNTP or NTP protocol (but not through the RFC-868 Time Protocol) so to have an accuracy widely better than 50 ms.

It is possible to introduce an advance (from 0 to 990 msec by 10 msec steps) to compensate from a possible transmission delay (due to a big distance to the zone to target or a delay due to a Wifi link or due to a SdR TX buffer, for example). Symmetrically, in reception, it is possible to introduce a delay (from 0 to 990 msec by 10 msec steps) to start decoding, for the same reasons as for the advance in transmission (transmission delay, Wifi link, SdR RX buffer…).

The time to switch the transceiver is supposed to be very short (definitely less than 100 ms).

The character set (46 characters) is compsosed of:
ABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789 <SPACE> / + - . ? ! @ % $

The bandwidth is equal to 23 Hz.

The coding used is a Reed Solomon (31, 15) one: 31 symbols of 5 bits for 15 symbols of 5 information bits (so a yield of 0.48).

A scrambling is used for the 31 Reed-Solomon symbols to avoid that a carrier produces a suite of same symbols (suite which could be interpretable by the Reed Solomon coding as a correct code).

The mean power to peak power is maximum and equal to 1.

The drift tolerance is about 2 Hz/mn.

The lowest S/N is equal to -34 dB (without any drift, for more than 90 % of the frames), however some frames are decoded from -36.5 dB. At -37 dB and below, none frames are decoded.

3) About Recommended frequencies and drift

Recommended frequencies

The recommended frequencies (dialed on the transceiver) are the following (for an AF frequency of 1000 Hz, in USB): 136.3, 1837.0, 3589.0, 7037.5, 10138.7, 14074.0, **14095.6** KHz. In all cases, the frequencies chosen (HF+AF) must coincide with a 100 Hz division (900, **1000**, 1100 Hz…on the waterfall)..

Drift and maximum HF frequency

There is a risk of slow drift. This one is supposed inferior or equal to 2 Hz/minute. Consequently, for common transceivers, it is encouraged:

- to make work the transceiver (in reception) at least one half an hour, for temperature stabilization before beginning Lentus,
- to use frequencies inferior to 14.35 MHz, to limit drift (this one being proportional to the frequency).

The transceiver HF frequency is, thus, supposed to be quite stable.
The sound card is not supposed to be of bad quality (to avoid introducing a drift at AF level).

4) About the Lentus repeater

The principle is to forward a received message towards other stations or to broadcast a message (through several repeaters). It is to be considered as useful only for very specific cases.

A message possibly received at minute 0, 10, 20, 30, 40 or 50 will be repeated 5 minutes after (so at minute 5, 15, 25, 35, 45 or 55) or, reversely, a message possibly received at minute 5, 15, 25, 35, 45 or 55 will be repeated 5 minutes after (so at minute 10, 20, 30, 40 or 50 or 0) .

Utilization examples:

- this function could permit for a QRP (weak power) beacon station to transmit his LENTUS frames through a close powerful (QRO) station which will repeat the QRP frames: QRP ---->QRO ---> DX station,
- to broadcast a message (without need of an answer), through several repeaters,
- this function could also be used for QSO, in case of very big attenuation (underground communications, for example).
  In that case, the repeater could, advantageously, use two different frequencies (one for each direction).

5) Using Lentus

Below, it will be found several snapshots of Multipsk screen with indications to the « how to operate », which shows the basic functions of the LENTUS mode.

For questions about Lentus, ask them on the Multipsk Yahoo group (http://groups.yahoo.com/group/multipsk/).
There is a Yahoo group only dedicated to Lentus: (http://groups.yahoo.com/group/MULTIPSK-LENTUS/).

For Lentus skeds, there is a good address: http://www.obriensweb.com/sked

It is reminded that Lentus use is not very different from JT65 use (on Multipsk).

Note: due to some bugs existing in the Multipsk 4.21 version (first release of this mode), this version must not be used for Lentus QSO. Instead, it must be used Multipsk version 4.21.1 or following ones.

About the help in Multipsk:

* for the contextual help, click on the right button of the mouse, with the focus over the mode button ("LENTUS", in this case).
* use also the button hints (wait a fraction of second over a button).

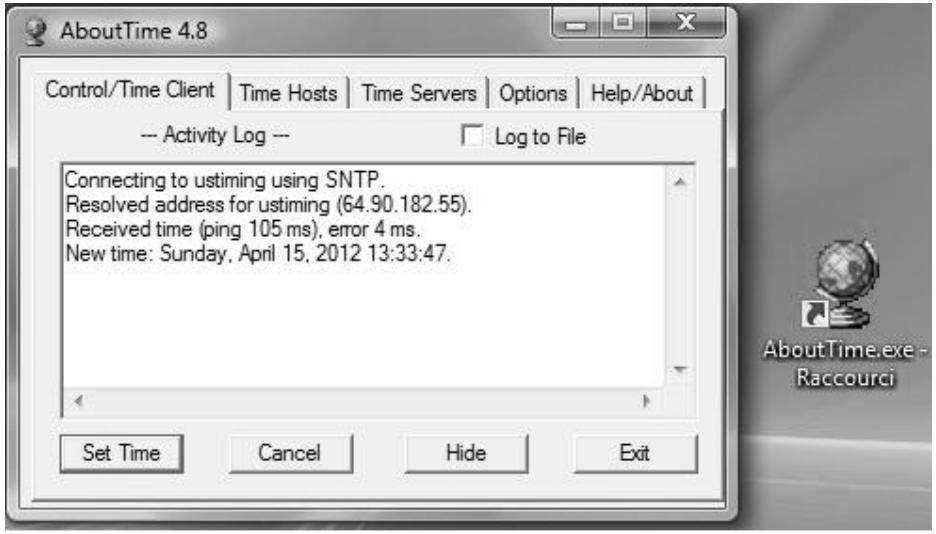
List of the forms

PC time adjustment
Other adjustments
Personal data useful for Lentus
Lentus reception
Lentus transmission in beacon mode
Lentus transmission in QSO mode
Using the Lentus traffic window
Test on a Lentus recording

Note: on the "**LENTUS EASY WITH MULTIPSK"** DOC file available on my WEB site: http://f6cte.free.fr/LENTUS_easy_with_Multipsk.doc, it will be found the necessary Lentus.WAV file (for the "Test on a Lentus recording" form).

PC time adjustment

The transmission of a LENTUS frame must begin theoritically at the fourth second of the minutes 0, 5, 10,...,50, 55 with a tolerance of +/-0.1 sec on the PC clock. So it will be necessary before beginning to do LENTUS, to set your PC clock to the right time through Internet.
For this, it must be used the very accurate time from an Internet Time Service as the NSIT, through a SNTP or NTP protocol (but not through the RFC-868 Time Protocol) so to have an accuracy widely better than 50 ms. The use of the "AboutTime" freeware (http://www.arachnoid.com/abouttime/) is widely encouraged as the PC time error is determined by this soft, simply by setting time twice, the second time (and the followings) will give the PC time error (4 ms below).



The time service "**nist1-ny.ustiming.org**" works well (to add in the page "Time Hosts", function "Add"). Also see http://tf.nist.gov/tf-cgi/servers.cgi.
It is recommended to, automatically, set time each 30 minutes (page "Options", check "Set time at" 30 minutes intervals).

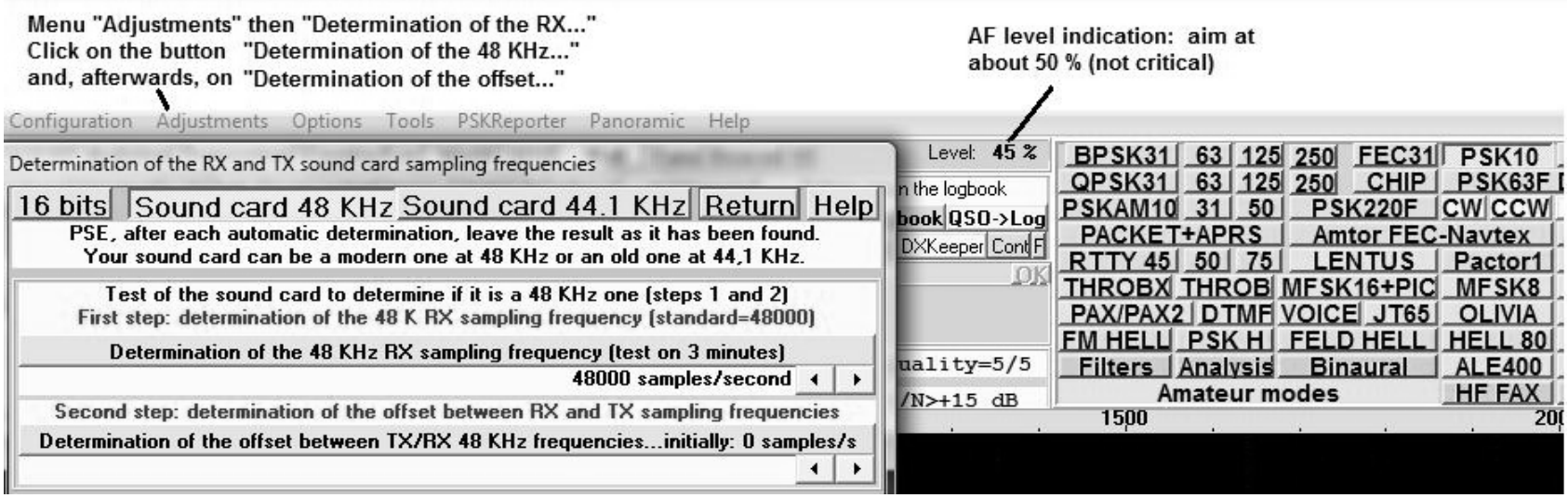
Attention: it must not be used GPS time because the accuracy by these means is not sufficient (+/- 1 sec for +/- 0.1 sec required).
Clock (the companion of Multipsk) can, possibly, be used only if the PC is powerful and if the time station is very well received (as Allouis in France for example).

Other adjustments

- **HF frequency accuracy**
  Due to the very low S/N ratio, it is possible neither to hear the Lentus signal nor to see it on the waterfall. So the transceiver must be very precisely tuned, to be sure to be on the right frequency. For this:
  - first make work the transceiver (in reception) at least one half an hour, for temperature stabilization,
  - if not residual (<10 Hz), determine the offset of the transceiver for a given HF frequency using a fixed WWV carrier (see help for details).
- **Sampling frequency and AF level**

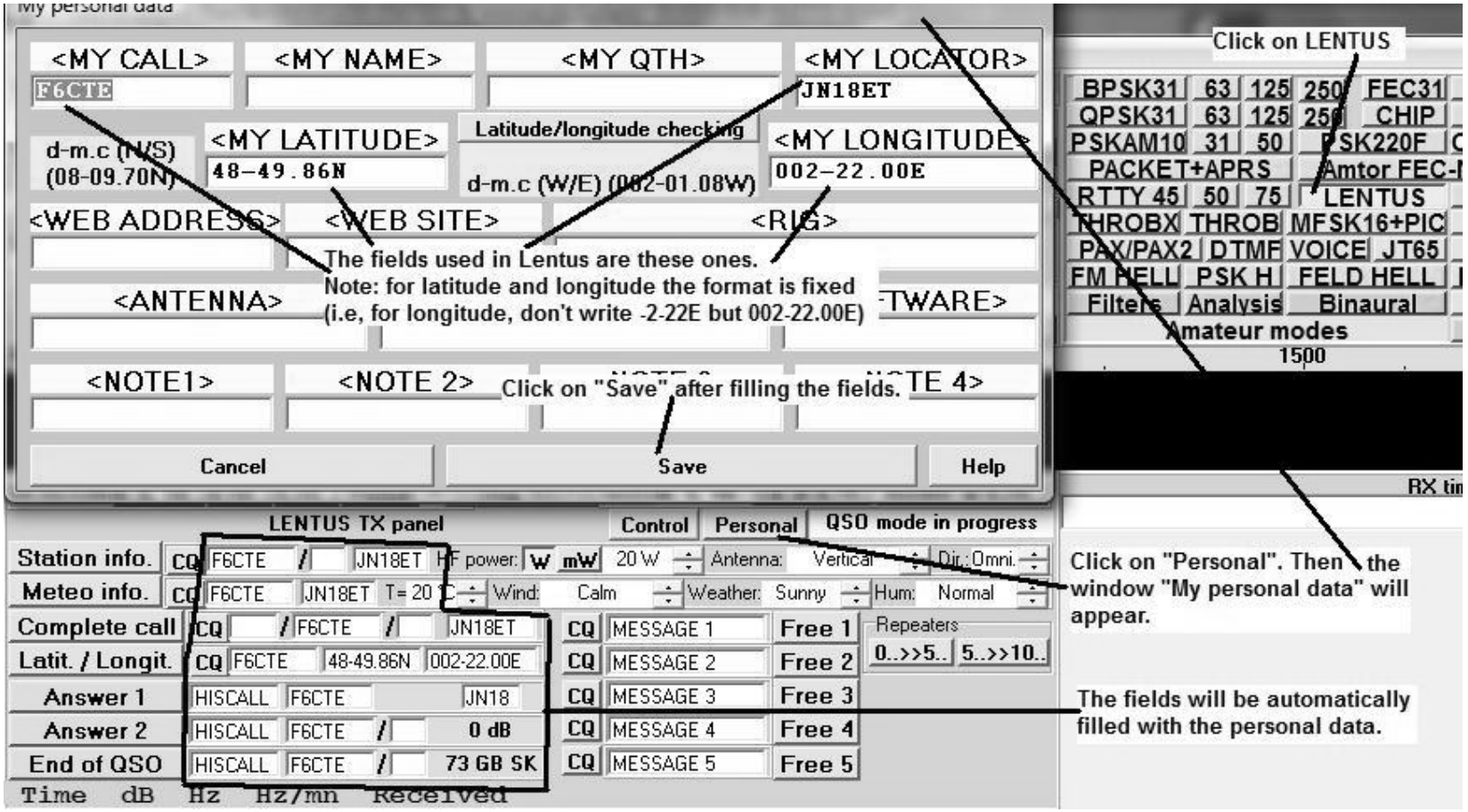
  It is strongly recommended to calibrate the sound-card: click on the "Adjustments" menu button, then select the "Determination of the RX/TX sound-card sampling frequencies" option.

  If the AF level is not sufficient, modify the adjustments on the mixer (sound card input).

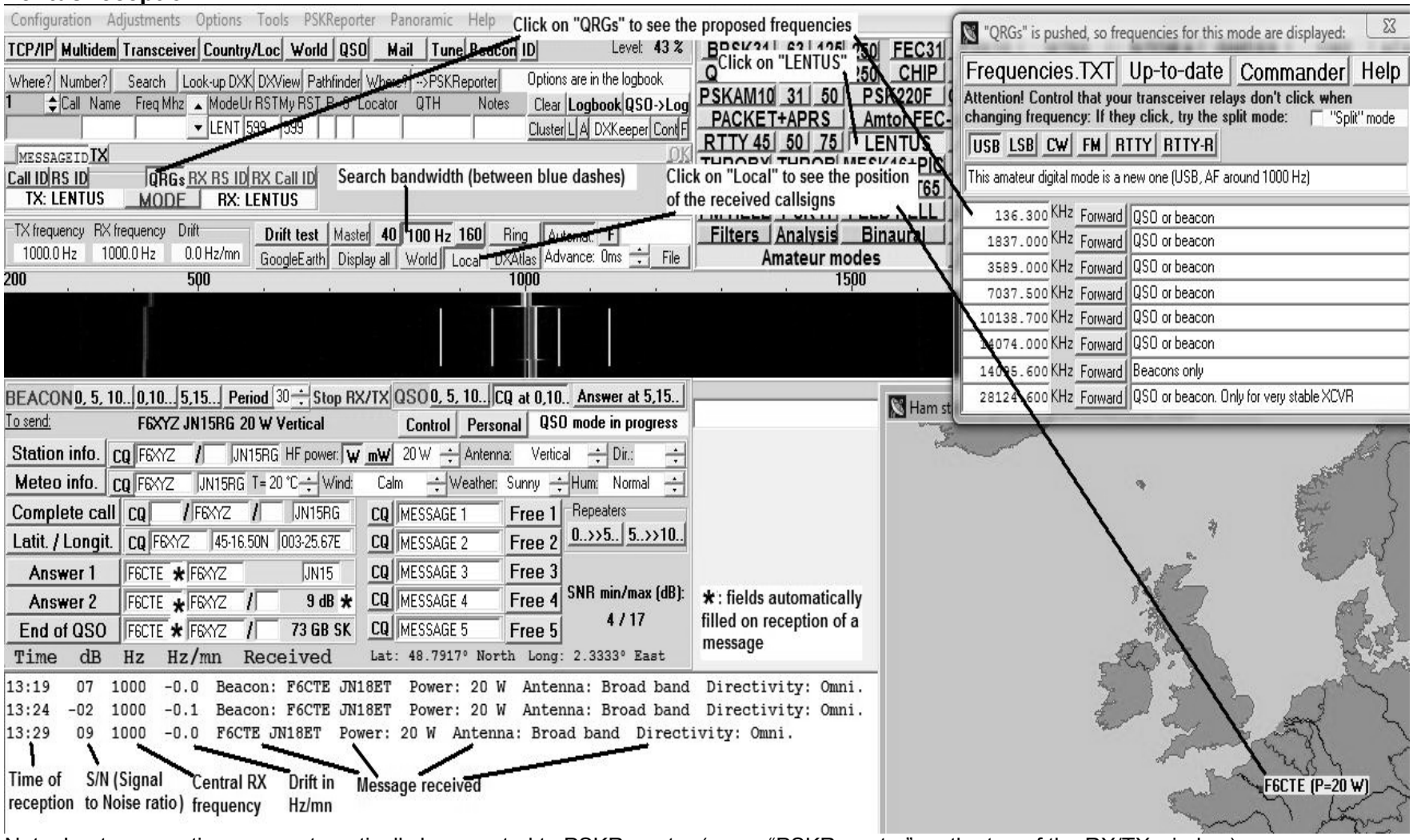


Personal data useful for Lentus

Click on LENTUS then on the Personal button.



Lentus reception



Note: Lentus receptions can automatically be reported to PSKReporter (menu “PSKReporter” on the top of the RX/TX window).