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## Technical aspects of Lentus (4.21.1) and use

### Summary

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### 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<sup>th</sup> 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 composed 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

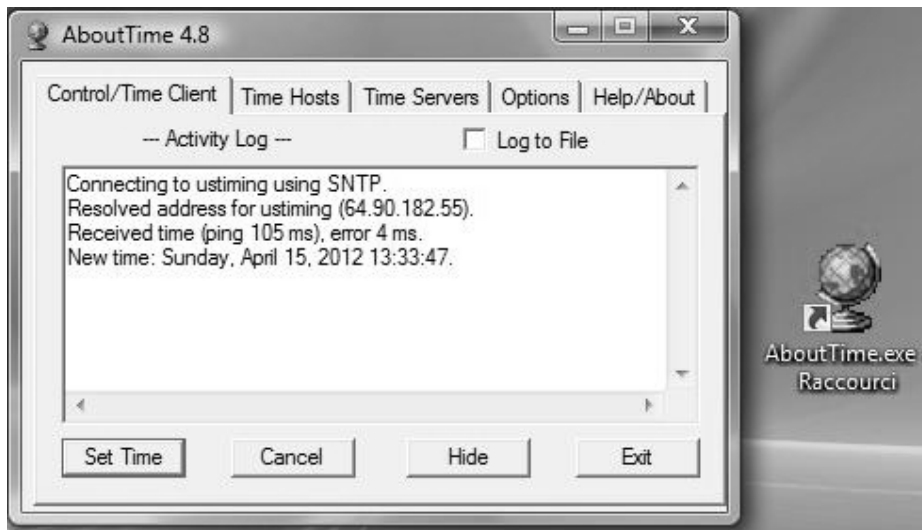
Note: on the "**LENTUS EASY WITH MULTIPSK**" DOC file available on my WEB site:

[http://f6cte.free.fr/LENTUS\\_easy\\_with\\_Multipsk.doc](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 theoretically 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).

Menu "Adjustments" then "Determination of the RX..."  
Click on the button "Determination of the 48 KHz..."  
and, afterwards, on "Determination of the offset..."

AF level indication: aim at about 50 % (not critical)

Configuration Adjustments Options Tools PSKReporter Panoramic Help

Determination of the RX and TX sound card sampling frequencies

16 bits Sound card 48 KHz Sound card 44.1 KHz Return Help

PSE, after each automatic determination, leave the result as it has been found.  
Your sound card can be a modern one at 48 KHz or an old one at 44.1 KHz.

Test of the sound card to determine if it is a 48 KHz one (steps 1 and 2)  
First step: determination of the 48 K RX sampling frequency (standard=48000)

Determination of the 48 KHz RX sampling frequency (test on 3 minutes)  
48000 samples/second

Second step: determination of the offset between RX and TX sampling frequencies  
Determination of the offset between TX/RX 48 KHz frequencies...initially: 0 samples/s

Level: 45 %

BPSK31	63	125	250	FEC31	PSK10
QPSK31	63	125	250	CHIP	PSK63F
PSKAM10	31	50		PSK220F	CW/CCW
PACKET+APRS				Amtor FEC-Navtex	
RTTY 45	50	75		LENTUS	Pactor1
THROBX	THROB	MFSK16+PIC		MFSK8	
PAX/PAX2	DTMF	VOICE	JT65	OLIVIA	
FM HELL	PSK H	FELD HELL		HELL 80	
Filters	Analysis	Binaural		ALE400	
				Amateur modes	HF FAX

Quality=5/5  
/N>+15 dB  
1500 200

## Personal data useful for Lentus

Click on LENTUS then on the Personal button.

The image shows two parts of the LENTUS software interface. The top part is a dialog box titled "my personal data" with the following fields and values:

- <MY CALL>: F6CTE
- <MY NAME>: (empty)
- <MY QTH>: (empty)
- <MY LOCATOR>: JN18ET
- <MY LATITUDE>: 48-49.86N
- <MY LONGITUDE>: 002-22.00E
- <WEB ADDRESS>: (empty)
- <WEB SITE>: (empty)
- <RIG>: (empty)
- <ANTENNA>: TWARE
- <NOTE1>: (empty)
- <NOTE 2>: (empty)
- <NOTE 3>: (empty)
- <NOTE 4>: (empty)

Buttons at the bottom of the dialog are "Cancel", "Save", and "Help". A note in the dialog states: "The fields used in Lentus are these ones. Note: for latitude and longitude the format is fixed (i.e, for longitude, don't write -2.22E but 002-22.00E)".

The bottom part of the image shows the "LENTUS TX panel" with tabs for "Control", "Personal", and "QSO mode in progress". The "Personal" tab is active, showing a table of call signs and frequencies:

Station info.	CQ	F6CTE	/	JN18ET	HF power:	W	mW	20 W	Antenna:	Vertical	Dir.: Omni
Meteo info.	CQ	F6CTE		JN18ET	T=	20	C	Wind:	Calm	Weather:	Sunny
Complete call	CQ		/	F6CTE	/			JN18ET	CQ	MESSAGE 1	Free 1
Latit. / Longit.	CQ	F6CTE		48-49.86N				002-22.00E	CQ	MESSAGE 2	Free 2
Answer 1	HISCALL	F6CTE						JN18	CQ	MESSAGE 3	Free 3
Answer 2	HISCALL	F6CTE	/					0 dB	CQ	MESSAGE 4	Free 4
End of QSO	HISCALL	F6CTE	/					73 GB SK	CQ	MESSAGE 5	Free 5
Time	dB	Hz	Hz/mn	Received							

Arrows from the text instructions point to the "Click on LENTUS" button in the top right, the "Personal" tab in the TX panel, and the "Save" button in the dialog box. A box highlights the call sign and frequency fields in the TX panel, with an arrow pointing to the text: "The fields will be automatically filled with the personal data." Another arrow points to the "Personal" tab with the text: "Click on 'Personal'. Then the window 'My personal data' will appear."



### Lentus reception

The screenshot shows the PSKReporter software interface. At the top, there are menu options: Configuration, Adjustments, Options, Tools, PSKReporter, Panoramic, Help. A tooltip says "Click on 'QRGs' to see the proposed frequencies". Below the menu is a header bar with fields for TCP/IP, Multidex, Transceiver, Country/Loc, World, QSO, Mail, Tune, Beacon ID, and Level: 43%. A second tooltip says "Click on 'LENTUS'".

The main window is divided into several sections:

- Search and Call ID:** Includes fields for Call Name, Freq Mhz, Mode, RST, My RST, B, S, Locator, QTH, Notes, Clear, Logbook, QSO->Log, Cluster, L, A, DXKeeper, Cont, F. A tooltip says "Click on 'Local' to see the position of the received callsigns".
- Drift test:** Includes TX frequency, RX frequency, Drift, and a Drift test section with Master, 40, 100 Hz, 160, Ring, Automatic, F, GoogleEarth, Display all, World, Local, DXAtlas, Advance: Oms, File.
- Amateur modes:** A list of frequencies with modes: 136.300 KHz Forward QSO or beacon, 1837.000 KHz Forward QSO or beacon, 3589.000 KHz Forward QSO or beacon, 7037.500 KHz Forward QSO or beacon, 10138.700 KHz Forward QSO or beacon, 14074.000 KHz Forward QSO or beacon, 14085.600 KHz Forward Beacons only, 28124.600 KHz Forward QSO or beacon. Only for very stable XCVR.
- QSO Log Entry:**

Time	dB	Hz	Hz/mn	Received	Lat: 48.7917° North	Long: 2.3333° East
13:19	07	1000	-0.0	Beacon: F6CTE JN18ET Power: 20 W Antenna: Broad band Directivity: Omni.		
13:24	-02	1000	-0.1	Beacon: F6CTE JN18ET Power: 20 W Antenna: Broad band Directivity: Omni.		
13:29	09	1000	-0.0	F6CTE JN18ET Power: 20 W Antenna: Broad band Directivity: Omni.		
- Station and QSO Info:** Includes fields for Station info, Meteo info, Complete call, Latit./Longit., Answer 1, Answer 2, End of QSO, and Time dB Hz Hz/mn Received. A tooltip says "\*: fields automatically filled on reception of a message".
- Message Log:** Includes fields for MESSAGE ID, TX, RX, and a list of messages (MESSAGE 1-5) with Free 1-5.

Annotations with arrows point to:

- "Click on 'QRGs' to see the proposed frequencies" pointing to the top menu.
- "Click on 'LENTUS'" pointing to the top header bar.
- "Click on 'Local' to see the position of the received callsigns" pointing to the Search section.
- "\*: fields automatically filled on reception of a message" pointing to the Station and QSO Info section.
- "Time of reception to Noise ratio" pointing to the Time dB Hz Hz/mn Received column.
- "S/N (Signal to Noise ratio)" pointing to the dB column.
- "Central RX frequency" pointing to the Hz column.
- "Drift in Hz/mn" pointing to the Hz/mn column.
- "Message received" pointing to the Received column.

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