## EbNaut LF Reception using Sound Card Line-In

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Reception using a computer sound card line-in connection is limited to half the sampling rate. Older, simpler sound cards may be limited to 48 kbps. Thus, to receive signals in the 137 kHz region down conversion is necessary. Sampling rates are generally set by crystal oscillators and thus drift with time and temperature. The most recent Spectrum Lab software allows correction of such drift through a 1pps GPS signal applied to one side of the stereo line-in. The down converter local oscillator of course must also be referenced to GPS to realize the full potential of EbNaut decoding.

The receive setup at K3SIW is as follows: the output of either a 10' loop or a backyard eprobe (it is generally more sensitive than the rooftop eprobe) is cabled to an LF amplifier whose output is connected to the RF port of an LF mixer. The 0 dBm output of a GPS-locked HP *selective level meter* (SLM) tuned to 120 kHz is passed through an HP step attenuator set to 0 dB and on to an LF amplifier to produce an LO level of about 10 dBm which is applied to the mixer. The reason for the LF amplifier ahead of the RF input is that the mixer conversion gain is quite low, probably because it expects an LO drive level much greater than 10 dBm. By adding extra receive gain hopefully degradation of the *signal-to-noise ratio* (SNR) is kept to a minimum. The mixer IF output at around 17.5 kHz is cabled to a pair of boxes that also include GPS 1pps and NMEA signaling. The former goes to the line-in L channel while the latter goes to the R channel.

The following images show important settings for the Spectrum Lab software and a decoding example for an HP signal generator carrier:

Sampling Rate and Frequency Correction	Spectrum Lab - File Export Format		Spectrum Lab V2.93 b3		- B X
Sampling Rate Detector Frq Offset Detector Scope Debug	File Contents Filename & Activation Export of FFT results		File Start/Stop Options Quick Set	tings Components View/Windows Help	
Sync freq/ Source 1.0 Hz [GPS pulse rate] - F Enabled	This function can be used to log the results of the FFT calculations	Active	Freq Time   RDF		
Input channel R0=ADC R (direct)	Linto simple files for post-processing A new FET block will "usually" be	>	vfo 0 Hz		17480.8-
Sync'd Resample nothing (don't resample) VG GPS phase lock			fc 17.479 kHz oot		17480.6-
Mode / algorithm GPS sync w/ NMEA decode  Subtract pulse	Filter Type   bandpass - Graph   Options   Opt.2   Special   Import/expo	ort Plugin   Test	4.00		
Scope Option [0] Interpolated PPS signal  Image: NMEA after Sync	FFT Size (points) 32768 - Edt:   Fifer response (black) - 20227 H:	z,-19.3 dB Method: Points -	5 5 1 + 1 + 1 + 1 × 1 × 1		
Min arrol _30 dBtr. NMEA bit/9500.00 HZ_ Putra witth 0.00 s	Center/cutoff [Hz] 17477.5 C In C log		B Cursor [M]		17480.2
Ud. cycle 1 a Bandwidth 1.0 Hz Avro 200	Bandwidth [Hz] 2000.0		Color Legend: -71.2dB		17480.0
Max deviation from initial sample rate 50.0 ppm	Freque shift Hz1 0.0				17479.8-
Curr. SR 47999.777130 Hz >> in callo table; 48000.000000 Hz	dir down (before filtering) V				17479.6-
GPS_Pulse: IH= 75 4ms ampl +43% -30% NMEA: 40%	Frequency inversion	-40			17479.4
SR= 47999.767 Hz; Mean60=47999.77713 Hz	from 0.0 to 0.0 Hz ?		B		
StdDev60= 0.00748 Hz ~~ 156 ns/second System - GPS time: 999.7 ms	Apply! Menu Help		-150 dB -100		1/4/9.2
History 4.461 -4.586 -4.836 -4.721 -4.544 -4.425 -	Started Bypass Close		a 24 kHz NAA sim li		17479.0-
(ppm) 4.723 -4.865 -4.609 -4.447 -4.593 -4.856 - clear 4.714 -4.521 -4.439 -4.735 -4.847 Show GPS	Message from Fiter-Task	W	Capture now		17478.8-
copy Close	The Prior War = 1.46 Hz		Time: 11:18:56.7		17478.6-
Status: Pro peaks ox	The state of the s	in a first with the loss with the state state state.	pk freg 17477 794 Hz		17478.4
			P		17478.2
Position Config Time Sync Diagnostics Test Log			B provide data		
RMC: \$50PHMC.070026.00.4.4200.75335/N.08822.45601.W1 1			pk freq 17480.622 HZ		17478.0
452 4531, W 2, 1	14500 Hz 15250 Hz 16000 Hz	18750 Hz 17500 Hz 18250 Hz 19000 Hz 19750 Hz	pk amp -76.872 dBm		17477.B
omer: 30P039744.1446.20.232.30.31.30.207.34 77 516	Sound X	SpecLab Configuration and Display Control			17477.6
Citoric (citing data and a sample of a weat a sample and a same	Participal Percenters	TRX Control Memory Filenames Audio File	s Markers System Freq-Resp		17477.4-
	Playback Recording Sounds Communications	Spectrum (1) (2) (3) (4) Radio I	F FFT Audio VO AD/DA Server		
Screen Capture, Periodic and Scheduled Actions	Ig device below to modify its settings:	FFT properties, frequency resolution FFT	Input (same for all channels)	13:16 14:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16 15:16	
Periodic Actions Scheduled Actions Conditional Actions Screen Capture	e Capture Macros prophone	EET input size ("leadh") 32768	Complex, with internal frequency and	Spectrum Lab. Components	
active Number of rows: 4	06:18:56 tplugged in	Sou	ce LS=Left Output, 48 kS/s	Spectrum cab components	Wave Recorder
Nr Time of day Action (macros)	e In	✓ use anti-alias fiter for decimation	Center frequency [Hz] 17479.0	FO cal Generator	5 FFT-In FFT-In : :
1 12:59:00 wave_record	ault Device	same FFT params for all analyser channels	Sweep [ Hz/sec] : 0.0		—Þ, 🗌 : :
3 14:59:00 wave.record	reo Mix	Effect of FFT settings with fs= 11.7188 Hz:	include F.O. calibrator what's that ?		>⊕→ ,, : : :
4 15:59:00 wave.record	abled	Equiv. noise bandwidth: 357.628 uHz	Output	Left Preproc Ore Dist	
	BLE Output	FFT window time (length): 46.60 min Typ	Complex (real+imaginary)	ADC (off) 700.0	
	Debugging Display	FFT window overlap: 78.5 % Uni	dB (userdef'd reference)	R1 R2 R3 Filter	R6
	Debug CPU Load Misc Error History Comms		internal average (#FFTs)		<b>P</b> : :
	Internal processing rate: 48000.0 samples/sec		smoothing (#bins)		L1 Time domain
	FFT decimation chain : 2*2*2*2*2*2*2*2*2*2*2*2*2*2*2*2*2*2*2	L		L1 L5 L1 L5 - R1 -	R1 scope
I THE REAL PROPERTY AND A DECIMAL OF A DECIM	FFT-feeding buffer : 98304 points = 300 % of FFT size			<u> </u>	Trigger
test inte 4 ->	Average count (ner ine)	Warning: "0 Speakers / Headphones (Reatek" doesn't	Shown: Settings for Analyser 1, channel 1 (L)	Input Output Digimode Spectrum Spectrum Counts Monitor Monitor Detector Analyser1 Analyser2 0.000	er (off) 00 Hz Modulator output amplifier
🔆 Apply V 0k 🗶 Cancel ? Help	Circ Machine=MCONFIG INL Liser=SETTINGS INL	EXACTLY match any detected device.	Apply	Menu Help Lepend:	
				Trans Tech colours based C	dB
🙈 🤌 🕤 🚺 🚳 🖻	🛯 📾 👪 🍇 灯 😿 🔭 🔳	🗛 🚵 🌨 🔝 🖬	s 💿 🐥 🔣 📝	U: 3.64 kbit/s 🌚 🤞 🐺 🐼 🦓 🖉 💹	6:18 AM
					8/28/2018

Figure 1 Full screen capture while receiving EbNaut transmissions via Line-In (carrier signal is from an HP signal generator).

TRX Control Memory	Filenames	Aud	lio Files	Markers	System	Freq-Res
Spectrum (1) (2)	(3) (4	)   F	Radio DF	FFT /	Audio VO	AD/DA Serve
FFT properties, frequency i	resolution		FFT Ing	put (same for all	channels)	
Decimate input by (divisor)	4096	-	Туре	Complex, with	internal frequ	uency shif 🔻
FFT input size ("length")	32768	•	Source	L5=Left Output	t, 48 kS/s	-
FFT window function	Rectangle	•	с	enter frequency	[Hz] 17479	0.0
✓ use anti-alias filter for	decimation		□ Sw	veep [Hz/sec] :	0.0	
same FFT params for a	all analyser chann	els	-			
Midth of see FFT his, 257 (	0.00					
Equiv. noise bandwidth: 357.6 Max freq range: 17.4761 kl FFT window time (length):	28 uHz 7.628 uHz Hz 17.4819 kHz 46.60 min		FFT Ou Type	utput Complex (real+	imaginary)	<b>.</b>
Equiv. noise bandwidth: 357.e Equiv. noise bandwidth: 35 Max freq range: 17.4761 kl FFT window time (length): FFT window overlap: 78.5	528 UHZ 7.628 uHz Hz 17.4819 kHz 46.60 min %		FFT Ou Type Unit	Utput Complex (real- dB (userdefd	⊦imaginary) reference)	<u>×</u>
Equiv. noise bandwidth: 357.6 Equiv. noise bandwidth: 35 Max freq range: 17.4761 kl FFT window time (length): FFT window overlap: 78.5	528 UHZ 7.628 UHZ Hz17.4819 kHz 46.60 min %	8	FFT Or Type Unit	utput Complex (real- dB (userdefd internal avera	+imaginary) reference) ge (#FFTs) ∫	• • 1 ÷
Equiv. noise bandwidth: 357.6 Equiv. noise bandwidth: 35 Max freq range: 17.4761 ki FFT window time (length): FFT window overlap: 78.5	528 UHZ 7.628 UHZ Hz17.4819 kHz 46.60 min %		FFT Or Type Unit	dB (userdefd internal avera smoothing (#t	+imaginary) reference) ge (#FFTs)	
Equiv. noise bandwidth: 357.6 Equiv. noise bandwidth: 35 Max freq range: 17.4761 ki FFT window time (length): FFT window overlap: 78.5	528 UHZ 7.628 UHZ Hz 17.4819 kHz 46.60 min %		FFT Or Type Unit	dB (userdefd internal avera smoothing (#b	⊧imaginary) reference) ge (#FFTs) pins) [	
Vidth of one PF1-bin: 357.4 Equiv. noise bandwidth: 35 Max freq range: 17.4761 kl FFT window time (length): FFT window overlap: 78.5 Varning: "0 Speakers / Head	228 UH2 7.628 UH2 Hz 17.4819 kHz 46.60 min %	doesn't	FFT Or Type Unit	dB (userdefd internal avera smoothing (#t	+imaginary) reference) ge (#FFTs) pins) ∫	1 . channel 1 (L

Figure 2 Spectrum Lab FFT window.

TRX Control	Memory	Filen	ames	Audio Files	Markers	System	Freq-Res
spectrum (1)	(2)	(3)	(4)	Radio DF	FFT	Audio VO	AD/DA Serve
Vertical Free double-widt optimum wa triggered Sp peak detecti emphasize 1 show spect show Radio	quency Axis h waterfall lin terfall averag ectrum more ng cursor MIN+MAX valu rum as bargra Station List	es e es aph	Amp     one     multi     non     peal     hold     long-     half	litude Grid (dB pixel per FFT bi strip WF, 100 scrolling WF : holding graph, time (s): 5 -term average_ life (min):0	or%) Sho in pix/strip Ma Spectr <u>ctr</u>	ow : both / Plot + an ths: none um graph area resize by dra Channels / Con	right nplitude bar (pix) 150 gging f-scale nections
Vaterfall Scroll	Interval Ins C sec ninutes 75 💌 % or	verlap	Wa Style	terfall Time Grid enabled e small ticks	Interva	al Tautoma Sec omin er-defined time	tic Source (expr) label format :
smooth scro	II, high CPU lo	ad	Lab	els hour:minute	e 🔻 YY	YY-MM-DD hh:	mm:ss
re spectrum di	splay settings	on the n	<u>ext&gt;&gt;</u> an	d on the "Rac	dio Direction I	Finder" tab >	<u>&gt;&gt;</u>

Figure 3 Spectrum Lab spectrum(1) window.

TRX Control Memory Filenames Au	dio Files Mark	ers System	Freq-Resp
Spectrum (1) (2) (3) (4)	Radio DF FFT	Audio VO	AD/DA Serve
Amplitude Range & Spectrogram Options         Range       -160       dB         Offset       0.0       ->0       dB         Offset       0.0       ->0       dB         (expression)       (calculated)         individual range/contrast/brightness per chnl         Visual AGC       off       ▼         Ref.       -100       dB         Amplitude bar (in spectrogram)       ▼         visible       ▼       with scale       size (pix):         75       Show channels from watch-window:	Options for th grid in grai grid in wa Split frequ Logarithm place freq Frequency so Fixed size (0= Radio Freq Of Special displa "stereo-co show cor show labo FREQUEN	ter Frequency Axis ph terfall ▼ di ic   LSB a scale on "other" cale style Classic =auto) 70 ffset [Hz] 0.0 iy options olor" waterfall for relationmore els like Ch1, Ch2, signed spectrogr: CY-reassigned di	otted mirror side pixel dual input Correlation am display splay
<< Basic display settings on the previous tab	Spectr	um Colours and T	rigger Options >:
Varning: "O Speakers / Headobones (Realtek" doesn'	A Shown Set	ttings for Analyse	r 1. channel 1 (L

Figure 4 Spectrum Lab spectrum(2) window.

TRX Control	Memory	Filena	ames	Audio Files		Markers	S	ystem	Freq-Resp
Spectrum (1)	(2)	. (3)	(4)	Radio DF	1	FFT	Audi	o VO	AD/DA Server
Input Device / St 0 Line In (Realted	ream / Driver k High Definitio	• ?	-Audio Pr Nominal decim	ocessing Sample Rate ate input SR	(in) by	48000	•	Correc	lerate Calibrato ct Frequency
rtri	other sour	ces >>	Resample	nothing (	don'i	t resample)	-	Displa	yed Frequency
			Sample R	ate Calibratio	on Ta	able [Hz]			
imeout/ms 500	latency/ms	J	Nominal	Input calib	0	tput calib	A	Calib	vrate Input SP
Output Device /	Pipe / Driver		5512	5512.000	55	12.000			ate input SK
Speakers / He	adobones (Pe	-	8000	7999.976	79	99.976		Calibr	ate Output SR
r speakers / ne	auphones (Re	<u> </u>	11025	11024.961	11	024.961			and a substant
arams:			12000	12000.000	12	000.000	-		
rcr Ctrl Output latency o	other destination	ons >> ns	∏ resa ∏ use o	mple to nomi different san	nal c nple	output S.R. rate for ou	tput :	Cont	inuous Calib about SR calib.
40	(a source la			nomin	al:	11025	S/s		
VQ input adjust	Stereo <u> ment</u>	Output	Resa	mpling qualit nize latency	y (use	medium	▼ iers)		
Warning: "0 Spe EXACTLY match	akers / Headph any detected c	ones (R Jevice.	ealtek" doe	esn't 🔺 🛔	Sho	wn: Setting	s for A	nalyser	1, channel 1 (L

Figure 5 Spectrum Lab Audio I/O window.

TRX Control       Memory       Filenames       Audio Files       Markers       System       Free         Sample format       32 bit floating point <ul> <li>Audio Recorder Options</li> <li>Triggered</li> <li>use <u>universal</u></li> <li>Post-Trigger 5.0</li> <li>sec</li> <li>PRE-Trigger 5.0</li> <li>File index</li> <li>Source Decimated FFT Input, 11.72 S/s</li> <li>Mode</li> <li>Create a sequence of files</li> <li>Name</li> <li>EbNaut_<yyyymmdd_hhmmss>.W</yyyymmdd_hhmmss></li> <li>Not enabled.</li> <li>Start</li> <li>Stop</li> <li>Replay Options</li> <li>Replay Options</li> <li>Play audio file in endless loop</li> </ul>		(4)	(3)	(4)	Radio DF	FFI	Audio VO	AD/DA Serv
Save Options         Sample format       32 bit floating point         Use RAW file instead of WAVE-format         Image: allow extra chunks in WAVE-headers         Image: don't save until timestamps are valid         Save extra data in auxiliary files (*.aux)         Image: decimate saved audio samples         to roughly 4000.0       samples / second         (possible: fs/2, fs/3 fs/243)         Image: mixed requency conversion + I/Q output         Image: mixed requency shift         0.0       Hz         Replay Options         Replay Options	TRX Control	Memory	Filena	imes	Audio Files	Markers	System	Freq-Res
stop saving in the exceeds       1400       kB         If file already exists,       If file already exists,       If overwrite old data (with a new empty file)         If overwrite old data (with a new empty file)       If interpolate or decimate sample rate         Analysis speed w/o DSP       Medium	Save Options Sample format Use RAW allow extra don't save save extra decimate s to rough (possible: Use fre vinvert internal fre stop saving if if file already ex o verwrite re-open ok	32 bit floati file instead of a chunks in W until timestan data in auxili aved audio s aved audio s aved audio s hy 4000.0 fs/2, fs/3 fr equency conv Ω channel ( " equency shift file exceeds kists, old data (with d file and app	ing point f WAVE-fo VAVE-head mps are va iary files (* amples samples / s/243) version + I. s/243) version + I. 1/ -Q" inste t 0.0 1400 h a new en pend new o	rmat lers lid :aux) / second /Q output ead of "VQ Hz kB npty file) data	Audio R Trig Post-Trig File inde: Source Mode Not enal Str Replay Replay Stop Stop I stop I inte Analys	Recorder Opligered gger 5.0 x 2 Decimated F Create a sec EbNaut_ <yy bled. art Options y audio file in p analyzer w rpolate or de sis speed w/</yy 	endless loop when audio files when audio	niversal trigger ger 5.0 se S/s umss>.WAV Phelp ends rate m

Figure 6 Spectrum Lab Audio Files window.

Spectrum (1)		AD/DA Server
TRX Control	Memory Filenames Audio Files Markers System	Freq-Resp
use relative p	ath if possible, base: C:\Spectrum_v2.92	
Machine Config :	MCONFIG.INI	
User Config :	SETTINGS.INI	
Spectrum Ref:	spectrum.ref	
Capture Image :	screenshots\capt	
Command file:	command_files\testcmd.txt	
Audio Recorder:	EbNaut_ <yyyymmdd_hhmmss>.WAV</yyyymmdd_hhmmss>	
tadio Station List:	frequencies\default.txt, frequencies\Eu_NDB_list.tx	t
nput stream log	logfiles\stream_log_in.ogg	active
Output stream log	logfiles\stream_log_out.ogg	active
o/p Stream Config		
Warning: "0 Spea	kers / Headphones (Realtek" doesn't 🔺 Shown: Settings for Analyser	1, channel 1 (L)
EXACTLY match	any detected device.	11 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

Figure 7 Spectrum Lab Filenames window.

Sampling Rate an	d Frequency Correction	×
Sampling Rate Det	tector Frq Offset Detector Scope Debug	
Sync freq/ Source	1.0 Hz [GPS pulse rate]  Enabled Enabled Enabled	
Input channel	R0=ADC R (direct)	
Sync'd Resample	nothing (don't resample)	
Mode / algorithm	GPS sync w/ NMEA decode Subtract pulse	
Scope Option	[0] Interpolated PPS signal 🖵 🦳 NMEA after Sync	
Min ampl80	dBfs NMEA bit/s 9600.00 Hz Pulse width 0.00 s	
Ud. cycle 1	s Bandwidth 1.0 Hz Avrg 200	
Max deviation from	initial sample rate 50.0 ppm	
Curr. SR 47999.76	65962 Hz >> in <u>calib table:</u> 48000.000000 Hz	
GPS-Pulse: tH= 80 SR= 47999.773 H: StdDev60= 0.0087 System - GPS time	0.3ms ampl: +52% -31% NMEA: 40% z; Mean60=47999.76596 Hz 70 Hz ~~ 181 ns/second e: 1000.6 ms 7 Help	1
History 4.702 -5.0	34 -5.085 -4.702 -4.650 -4.927 -	
(ppm) 5.100 -4.8 clear 4.581 -4.7 copy	08 -5.067 -5.085 -4.733	
Status:	PPS peaks ok Close	
	1	

Figure 8 Sampling Rate and Frequency Correction window.

Debug CPU Load Misc	Error History	Comms	
Internal processing rate: 48000	).0 samples/s	ec	
FFT decimation chain : 2 * 2 * FFT window time : 46.6 r	*2*2*2*2 min	*2*2*2*2*	2×2 = •
FFT-feeding buffer : 98304 poin	its = 300 % of	FFT size	
Average count (per line) : #-	#		
Cfg: Machine=MCONFIG.INI, U	ser=SETTIN	GS.INI	

Figure 9 Debugging Display window.

		· · · · · · · · · · · · · · · · · · ·
8K19A	✓ CRC 16 ✓	Symbol period: 3.0
Decoder Sett	ngs	
File: C:\Spec	trum_v2.92\EbNaut_2	20180827_17590( Browse
Message len	gth: 13 Start of	fset: 61.1
l ist length <sup>.</sup>	20000 Freq of	fset: 1.6161
	ince of	
CPUs: 1	Phase	step: 30 degrees 🗾
Decoder Stat	JS nsed 312 seconds	
Finished' ela	pacu are acconua	
Finished: ela		
Finished: ela Decoder Outj		
Finished: ela Decoder Outj Message: ***	ut	
Finished: ela Decoder Outy Message: *** Rank: 0 Es Symbol error	ut ********* /N0: -2.4dB Eb/N0: s: 127/896 BEB: 14.2	8.4dB ? %
Finished: ela Decoder Outy Message: *** Rank: 0 Es Symbol error Reference pl	ut ********** /N0: -2.4dB Eb/N0: s: 127/896 BER: 14.2 ase: 180,150,-150,18	8.4dB 2 % 0
Finished: ela Decoder Outy Message: *** Rank: 0 Es Symbol error Reference pl Carrier S/N 3 Info rate: 99.	ut ********** /N0: -2.4dB Eb/N0: s: 127/896 BER: 14.2 ase: 180,150,-150,18 2.03 dB in 372.0 uHz, ?4 bits/hour, 5.6 % of	8.4dB 2 % 0 . carrier Eb/N0: 13.3 dB Shannon capacity

Figure 10 EbNaut Decoder V07.b software decoding the HP signal generator carrier.