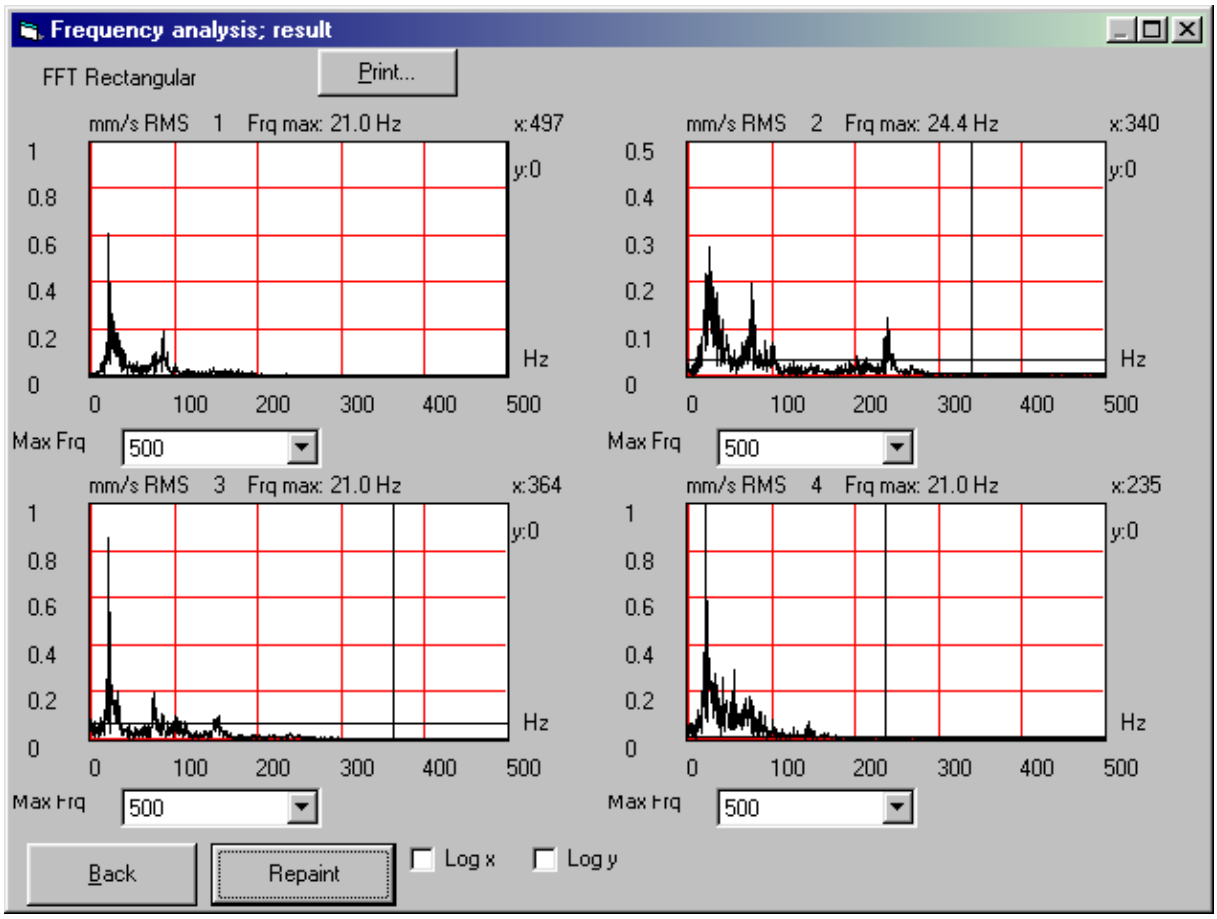
ABEM
A Nitro Consult Company

UVSZ Analysis

Extended version of UVSZ
for time & frequency domain analysis
of UVS 1500/1504 and UVS 1608 files.

User´s Manual

Ver 2.8.9 and later



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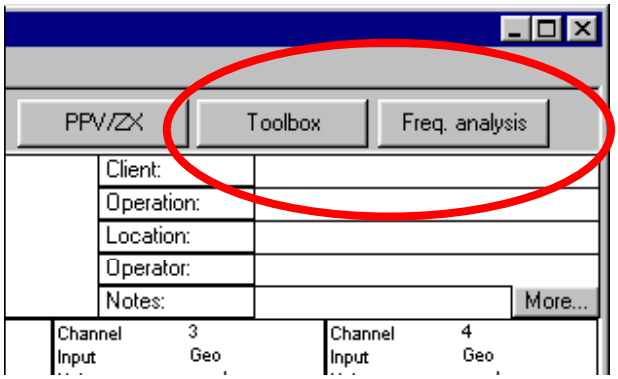
General

UVSZ Analysis is an extended version of the presentation & printout program UVSZ, and includes functions for time & frequency domain analysis of files from UVS 1500/1504 and UVS 1608.

Additional Buttons

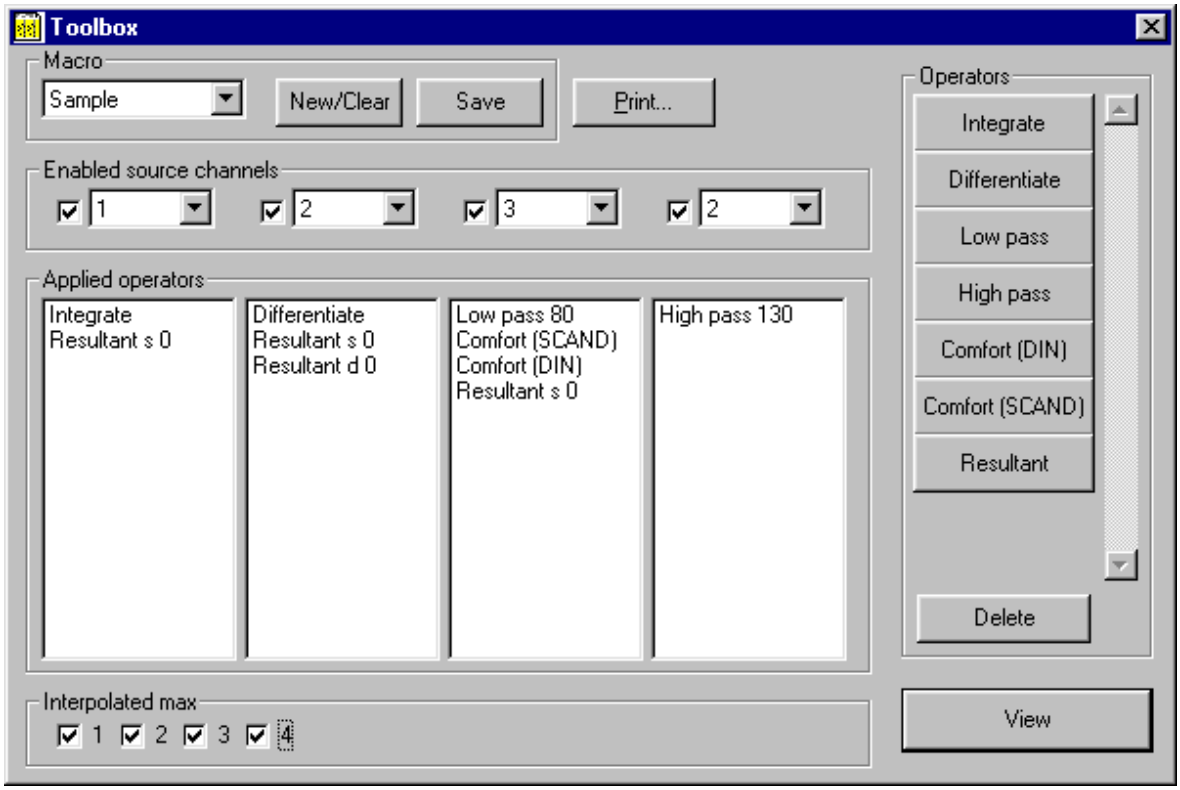
UVSZ Analysis has two additional function buttons in the main window: Toolbox and Frequency analysis.



The Toolbox

The toolbox is opened by clicking the "Toolbox" button in the main window.

A number of operators can here be applied to channel data, be saved to disk as a macro, and be reloaded at a later occasion.



File Management

To load a saved macro, you select it from the list in the upper left corner of the window. If you want to clear everything and start over again, press "New". Alternatively set the cursor on an operator and click "Delete" to just get rid of the selected operator.

To save your own macros, just press "Save". The macros are stored in the directory <programdirectory>/macro. These files can be removed or copied manually using Windows Explorer.

Composing Operator Sequences

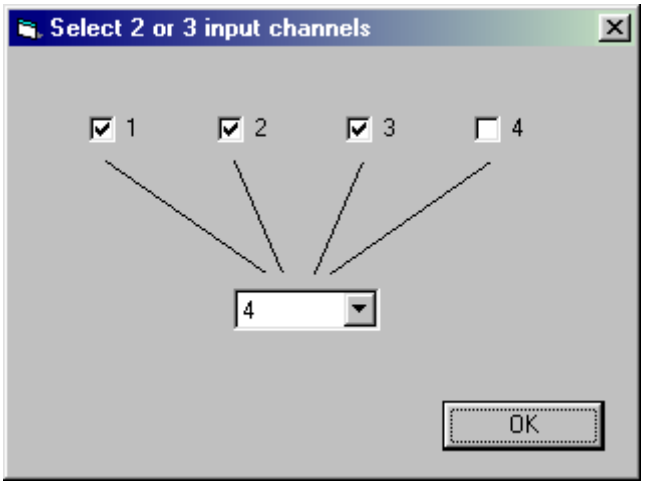
Above each column containing a sequence of applied operators, you can activate or deactivate a channel by checking the little box. Next to the checkbox you specify which channel that will provide indata to the macro. For example, if you want to try different operators simultaneously, you select the same indata channel for two operator columns in the toolbox.

Click inside a column to make it active. Now, if you choose an operator from the list to the right, it will be placed in the latest activated column.

If you already have a number of operators in a channel column, you can choose the insertion point with the mouse by clicking on an already inserted operator. If the newly inserted operator did not end up where you wanted it, you can always select it and delete it.

Please note that some operators require arguments. These are selected at the moment of insertion when you press an operator button, e.g. a frequency for the low pass filter. If you at a later occasion would want to alter the chosen frequency, just double click on the inserted operator in the channel column and a popup dialog will ask you for a new frequency value.

A special case is the "Resultant" operator, where you must choose two or three input channels and one output channel. Two or three input channels must be checked and one output channel selected in the list below.



The result in the channel column after a resultant operation is three or four operator rows. To remove the operation, you select one of these rows and press "Delete". All inserted rows will then be deleted.

The inserted rows will have, within brackets, an identifier consisting of the letter 's' or 'd' for source or destination, plus a number that is common for the just inserted rows.

"Interpolated max" provides a more precise value of "max" in the main window channel information.

When all desired operators are inserted, the result can be presented in the UVSZ Analysis main window by clicking "Show".

Operators

The following operators are available in the toolbox:

1. Integration (including unit handling)
2. Differentiation (including unit handling)
3. Low pass filtering (2-pole; selectable threshold frequency)
4. High pass filtering (2-pole; selectable threshold frequency)
5. Comfort (DIN) mm/s rms from geophone signal (accelerometer signal must first be integrated)
6. Comfort (SCAND) mm/s rms from geophone signal (accelerometer signal must first be integrated)
7. Resultant
8. Interpolated max

Tip: If you intend to analyze UVS data, you should record with 1 – 315 Hz to avoid losing analysis possibilities.

N B: There is no warning if, for example, you try to apply "Comfort" on a signal which is frequency-wise too narrowly recorded.

About the Operators

1) Integration

Integration of	mm/s	will result in	μm
	ips		in
	m/s^2		mm/s
	g		ips
	Pa		Pas

It is possible to double integrate a signal, i.e. apply the integration operator twice.

If the signal has the unit μm, mm, or in it is not possible to integrate.

2) Differentiation

Differentiating	mm/s	will result in	m/s2
	ips		g
	mm		mm/s
	μm		mm/s
	in		ips
	Pa		Pa/s

If the signal has the unit m/s^2 or g it is not possible to differentiate.

3) Lowpass filtering (cutoff frequency, selectable between 1 and 500 Hz**)**

UVSZ Analysis uses a second order filter of Butterworth type, which provides 3 dB damping (approx. 70% of the signal amplitude remains) at the selected cutoff frequency and a roll-off of 12dB/octave. This means that 25% of the signal amplitude remains at 2 times the selected cutoff frequency, and 6% at 4 times the cutoff frequency.

4) Highpass filtering (cutoff frequency, selectable between 1 and 500 Hz)

Basically the same characteristics as for lowpass filtering, but the highpass filter passes high frequencies and attenuates frequencies below the cutoff frequency.

5) Comfort (DIN)

Calculates the RMS on a signal in mm/s.

This operator can be applied directly on a geophone signal. An accelerometer signal must be integrated to create a velocity signal before applying the Comfort (DIN) operator.
The calculation includes highpass filtering (single-pole) at 5.6 Hz, followed by an RMS detection with the time constant 125 ms.

6) Comfort SCAND

Calculates the RMS in the same manner as Comfort (DIN), although with the time constant 1000 ms (1 second).

7) Resultant

Operates on two or three channels and provides one outdata vector.

The resultant is calculated as the square root of the sum squares of the indata signals.

With two indata channels the resulting vector is 2-dimensional.

With three indata channels the resulting vector is 3-dimensional.

The resultant is the length of the vector, and is therefore always positive.

8) Interpolated max.

A simple way of calculating values between the samples is the Lagrange interpolation.

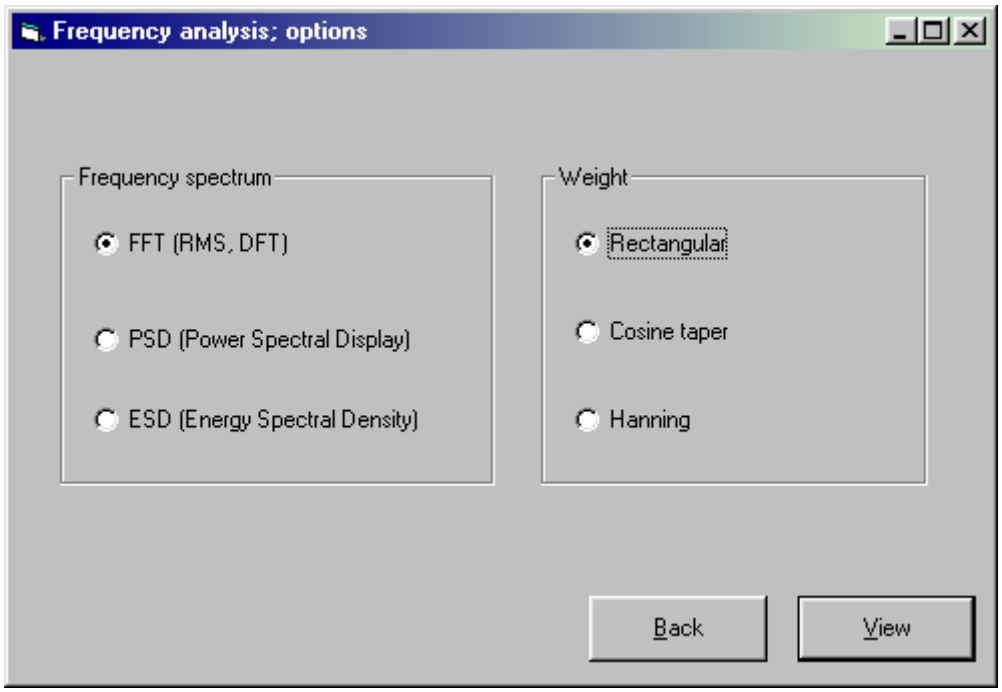
If you choose to present interpolated max-values, the program calculates the values of the signal at five times more dense intervals than the sampled data. The presented max-value is that of all measured and calculated samples which has the greatest amplitude.

To obtain a correct interpolated value, data must be sampled at a frequency exceeding the highest frequency component of the signal. In such a case, the original signal can be recreated completely. If you use only the sampled peak value, most standards and “rules of thumb” stipulate that the sampling shall be made at 10 times the highest signal frequency.

Frequency analysis; options

To make a frequency analysis you have to select a time span in the time window:

- Select the start point with the left mouse button
- Click with the right mouse button and select “Insert ref. here”
- Select the end point with the left mouse button
- Click on the “Frequency analysis” button in the main window.



Frequency spectrum and weighing must be selected before you continue with "View".

Which type of frequency spectrum to use (FFT, PSD or ESD), depends on the characteristics of the incoming signal.

To obtain a completely correct result of a frequency analysis, it would be necessary to analyze the signal during infinite time. Since only a limited time period can be selected for the frequency analysis, an error of a certain magnitude will always be introduced. However, by softly fading the signal in and out by using a weighting function, this error can be minimized.

Which weighting to use (Rectangular, Cosine taper or Hanning), depends on the selected frequency spectrum and the characteristics of the incoming signal.

- FFT (Fast Fourier Transformation) should be used for continuous, sinusodial signals, or if only assessment of the dominating frequencies of the signal is required

  If a continuous sinusodial signal is analyzed with FFT, the peak value in the frequency diagram corresponds to the RMS level of the signal. If the signal contains two or several sinusodial components with different frequencies, it will be possible to

determine their relative amplitudes in the FFT spectrum. This will not be possible in the other spectra.

FFT provides a spectrum with the same unit as the signal.

The **Hanning** weighting is recommended for frequency analysis with **FFT spectrum**.

- PSD (Power Spectral Density) should be used for noisy signals, for which the properties remain relatively stable during the analysis period (stationary signals).

  The area below the PSD graph between two frequencies corresponds to the *effect* of the signal in the same frequency interval.

  If the input signal is in mm/s or ips the resulting unit will be $(mm/s)^2/Hz$ or $(ips)^2/Hz$ respectively**.**

  The **Hanning** weighting is recommended for frequency analysis with **PSD spectrum**.

- ESD (Energy Spectral Density) is suitable for transients, because the analysis result will not be affected by the length of the zero value signal before and after the transient included in the analysis time window.

  The area below the ESD graph corresponds to the energy of the signal in the same frequency interval.

  If the input signal is in mm/s or ips the resulting unit will be $(mm/s)^2*s/Hz$ or $(ips)^2*s/Hz$ respectively.

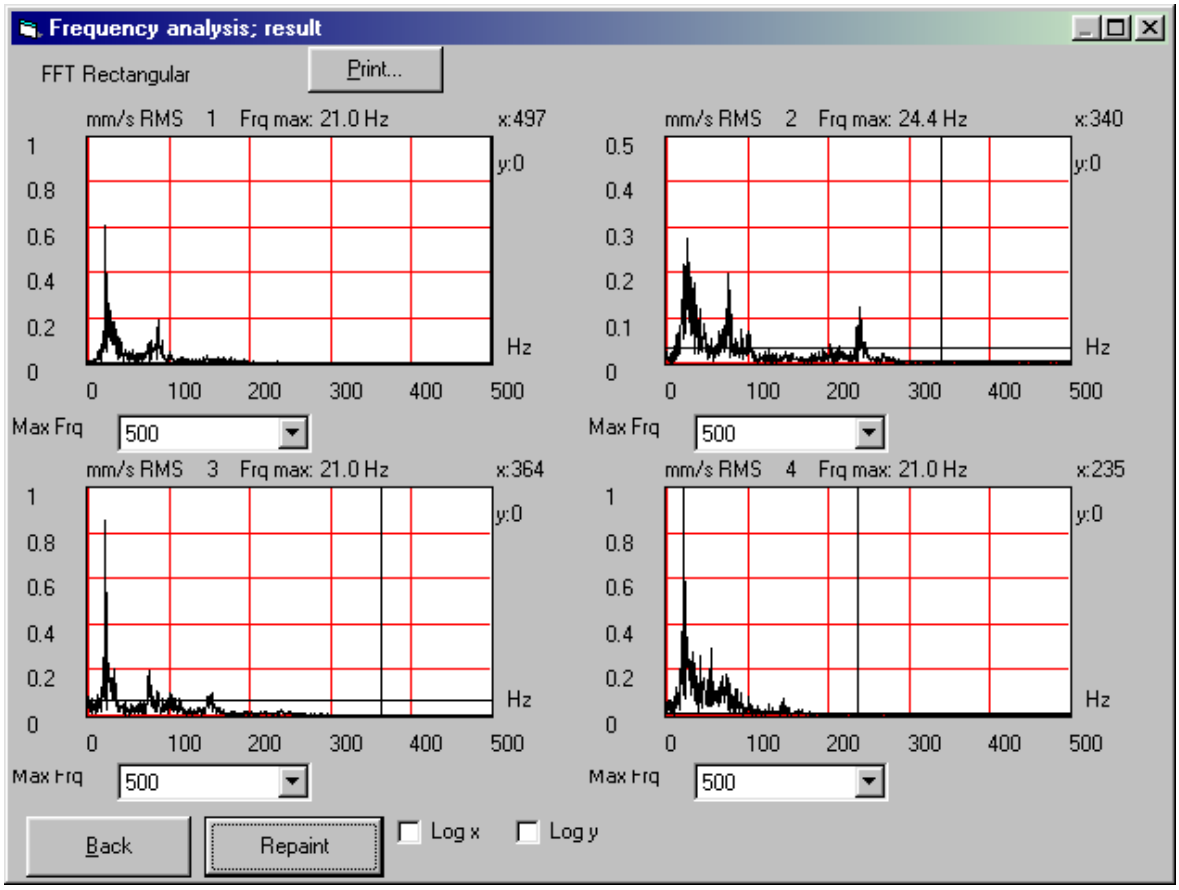
  If the analyzed part of the signal contains a complete transient, which starts and end at zero, no fading out is required at the ends. In this case Rectangular weighting is recommended.

  However, if a part of a transient is cut out, Cosine taper is recommended. This weighting reduces the first and last 10% of the signal with a cosine function, so that the analyzed signal starts and ends at zero.

For further studies the following literature can be recommended:

Richard G. Lyons:	Understanding Digital Signal Processing Addison-Wesley Publishing Company
Julius S. Bendat & Allan G. Piersol:	Random Data: Analysis and Measurement Procedures Wiley-Interscience

Frequency analysis results



In each window a frequency analysis of the channels in the main window is shown, with the spectrum and weight indicated in the upper left corner (Rectangular ESD in this example).

N B: If a macro with operators have been applied on the channels and the toolbox is still open, the frequency analysis will be applied on the modified channel data.

In the list below each window you can change the upper frequency limit, and then apply the new frequency by clicking “Repaint”.

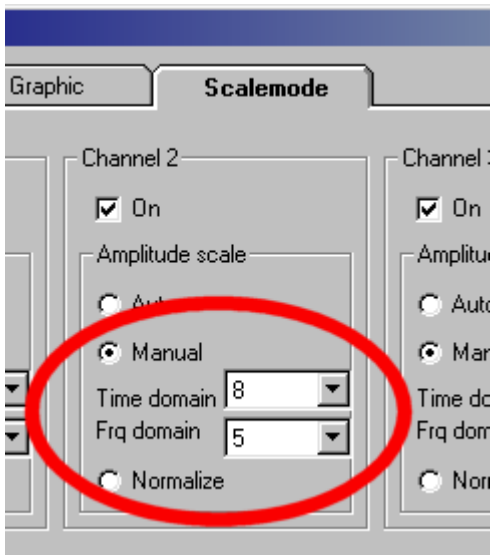
To logarithmize the horizontal and vertical scales check "Log x" and “Log y” respectively.

You can also change size of the window, whereby the contents is automatically redrawn. This can take a while on slower computers, especially if the option "Show window contents while dragging" is checked in the “Effects” tab in “Screen properties” in Windows.

Manual amplitude scale in the frequency analysis

Please refer to the UVSZ manual.

In UVSZ Analysis the amplitude scale setting affects both the main window and the frequency analysis window. The manual scale choices can be set independently of each other.

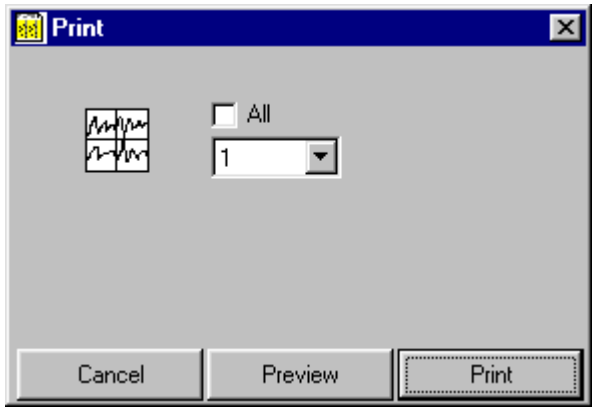


Printout of Frequency analysis results.

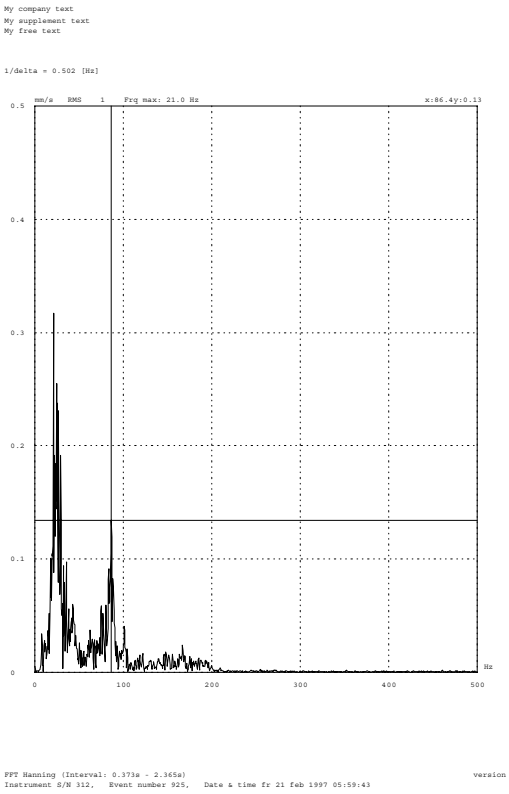
Click on the "Print…" button at the top of the "Frequency analysis, results" window.

You can choose between printing all channels on one paper or just one channel selected in the box.

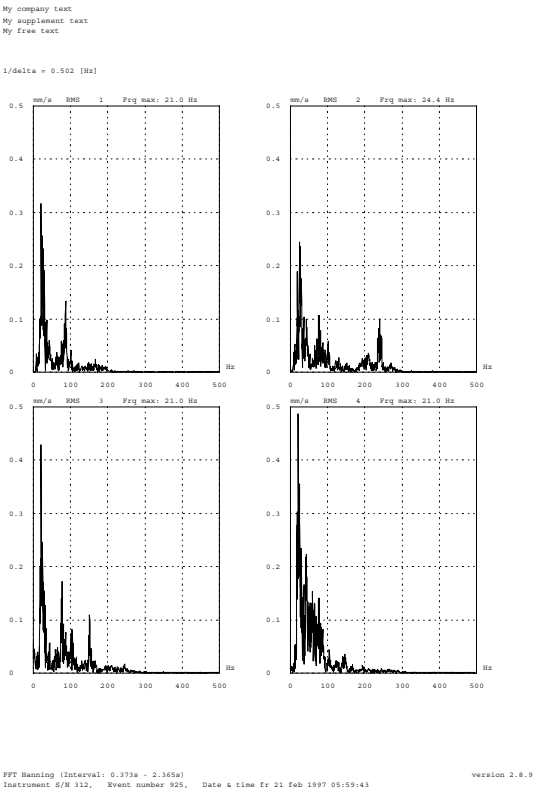
See next page for an example of a printout.



Printout examples



Printout of frequency analysis for channel 1.



Printout of frequency analysis for all channels.