

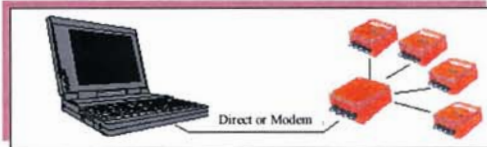
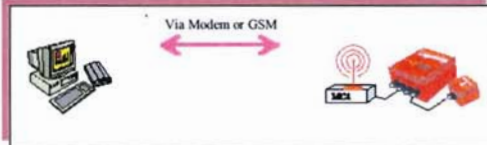


## Vibration Measurement and Monitoring ...

# ... MR 2002 / VIEW 2002

- Building sites (Pile driving, compaction etc.)
- Blasting (Tunnels, demolition etc.)
- Traffic induced vibrations (Rail, road etc.)
- Sensitive equipment and installations
- Long time monitoring of buildings and installations
- Seism. requalification (Buildings, bridges, towers etc.)
  
- Complies with DIN 45669 Klasse 1
- Measurement according to DIN 4150 Teil 2 and 3
- Data analysis according to various national codes
- Water protected casing
- Autonomy (battery) for up to 3 days
- Alarm functions / remote control / remote alarm
- Frequency range: 1 to 160 or 315 Hz
- Vibration velocity: 0.0001 to 100 mm/s
- Vibration acceleration: 0.0001 to 10 g

## Overview



**MR2002 CE Standard:** The Model *Standard* is a compact, triaxial vibration measuring unit, complete with all accessories like cables, mounting plate, communication and analysis software and a rugged transportation case.

**MR2002 CE Standard-Plus:** For more complex vibration measurement tasks, where the vibrations have to be measured simultaneously at different points. The *Standard Plus* package includes additionally three uniaxial sensors with mounting plates and 3 x 25 m cables.

**Red Alert (Remote control / Call Back):** With the *Red Alert* the MR2002 can be programmed and controlled via GSM (Mobile telecommunication). Alarm messages, system status and peak values can be sent via SMS, Fax or E-Mail automatically to up to 7 persons.

**NCC (Network Control Center):** With the NCC up to 16 MR-Stations (48 channels) can be operated in a network. (With NCC-Light up to 8 stations, i.e. 24 channels). The individual stations work autonomously, the Control Centre handles synchronisation, triggering, alarm and data transfer via fix net or mobile net.

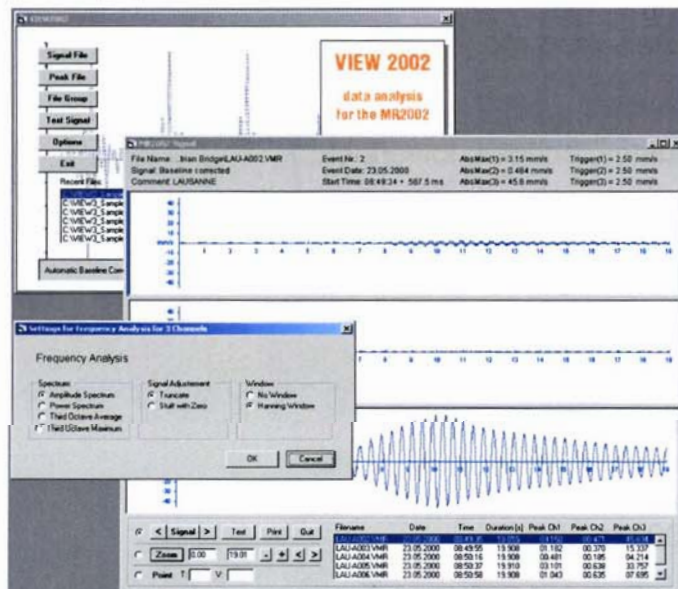
## Introduction



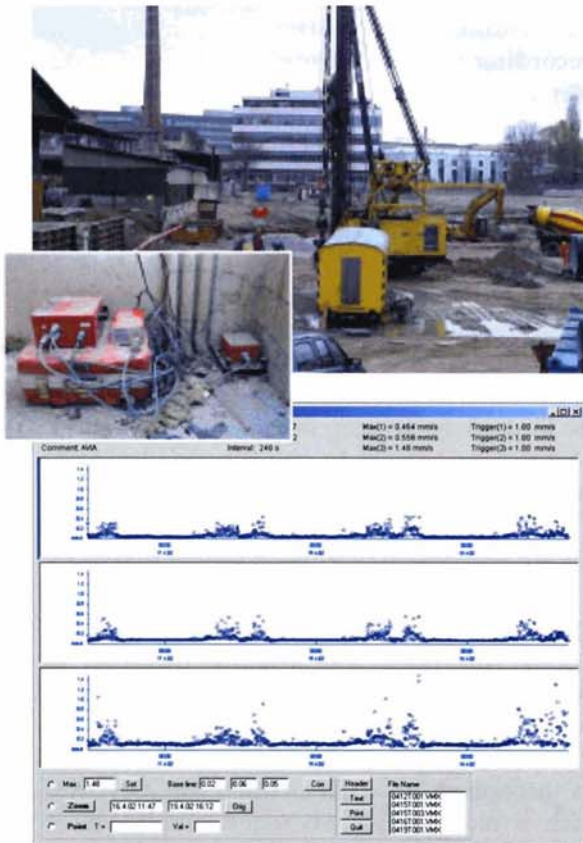
The MR2002-CE is a compact, triaxial vibration recorder, especially developed for the needs in civil engineering. The instrument consists of a recording unit and a triaxial sensor (velocity or acceleration) both in a rugged aluminium casing. The instrument is very easy to install and operate. Vibration measurements and monitoring tasks are carried out with minimal effort.

For long time vibration monitoring the dual mode operation is an important asset: With the dual mode operation the strong events are recorded as time histories while at the same time the vibration level for the entire monitoring time is recorded (e.g. as peak values for each 1-minute interval).

With the analysis software VIEW 2002 the recordings of the MR2002 are analysed and presented in a professional way. VIEW 2002 is a very powerful analysis tool specifically developed for the MR2002. VIEW 2002 includes analysis in time and frequency domain as well as specific evaluations according to different national codes such as DIN 4150/2, SN 640 312a, Ö-Norm S9010.



## Vibration Monitoring on building Sites



Vibration monitoring on building sites requires rugged and 100% reliable measuring equipment that is easy to install and to operate. Depending on the size of the building site and the number of affected neighbouring buildings 3 to 6 (and sometimes more) MR2002 are installed. As each station works independently no cabling system is required. For each station the trigger values are entered and the background monitoring mode is activated. For critical stations the call back module (Red Alert) is installed.

In general the recorded data is downloaded each week with the laptop. For each station an overview diagram is created as shown in the picture left. For the stronger vibrations time histories are plotted. Stations with call back systems (Red Alert) send their alarm messages in the form of SMS or fax messages to the pre-programmed numbers. The daily test messages and the messages about the memory or battery status ensure that the monitoring works without interruption.

If alarm messages come in (from stations with call back system) the recorded data can be downloaded and analysed. This way appropriate measures can be taken immediately in order to avoid damage.

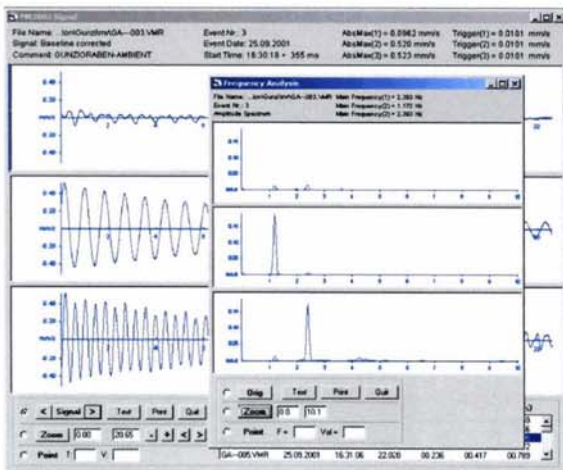
## Eigenfrequency of Bridges



In the context of seismic requalification of high way bridges the eigenfrequency and damping of 10 bridges of the Simplon Pass had to be determined. Various excitation methods such as impulse excitation, harmonic excitation and ambient vibration have been applied. For the vibration measurement the MR2002-CE has been used.

The ambient vibration measurement proved to be the most efficient method to determine the vertical and transverse eigenfrequency. Due to the high sensitivity of the velocity transducers of the MR2002, having a resolution of more than 0.0001 mm/s, even the slightest vibrations of a structure are sufficient for the determination of the eigenfrequency.

For the proper measurement of the ambient vibrations the traffic had to be stopped for a short time in order to avoid disturbances from vehicles. After the decay of all traffic induced vibrations 10 measurements of 20 seconds duration have been recorded. With VIEW 2002 the main frequencies could be determined very easily with the frequency enhancement method. The damping was also calculated with VIEW 2002 using the built-in functions.



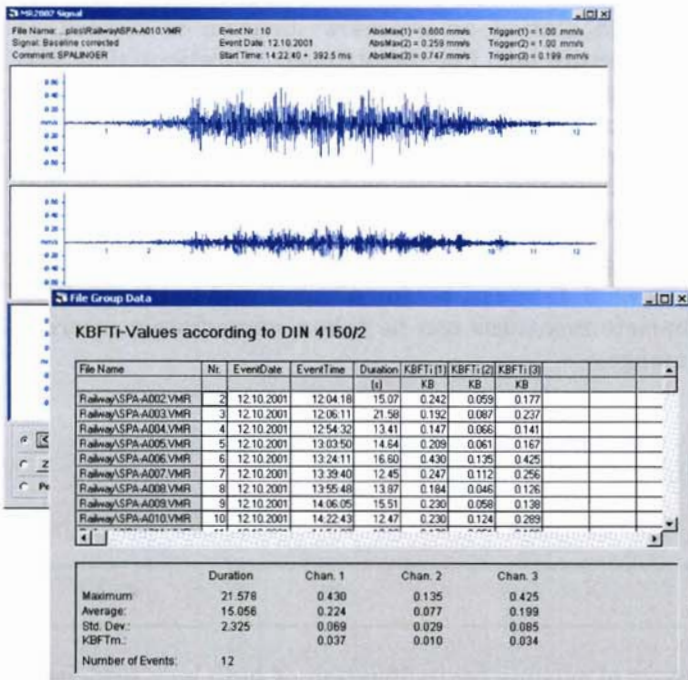
# Vibration Measurements for Railways



Vibration measurement for railways requires in general the recording of huge amount of vibration data. Without an adequate measurement system and a dedicated software these measurement tasks are nearly impossible. Both, the MR2002-CE and the software VIEW 2002 are perfectly geared to this task.

Quite often the model MR2002 Standard Plus is used for this type of work. With the three uni-axial velocity transducers the vibrations in the living room, on the building foundation and in the free-field can be measured simultaneously. The free-field transducer is used as trigger sensor in order to record only vibrations caused by the train and not the vibrations from the movement of persons in the building. Thus, fully automatic measurements over 24 or 48 hours can be carried out without undue effort.

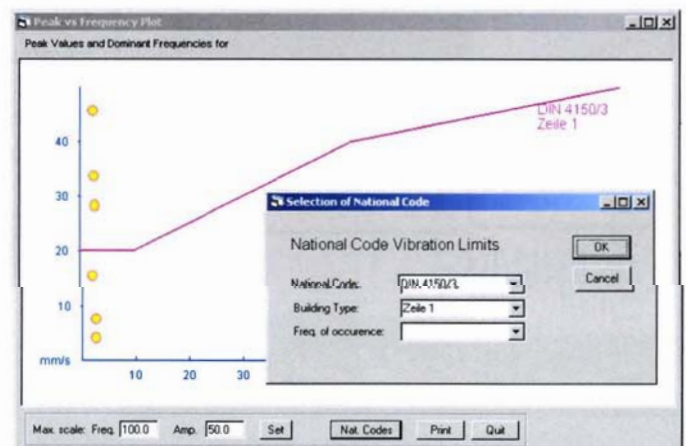
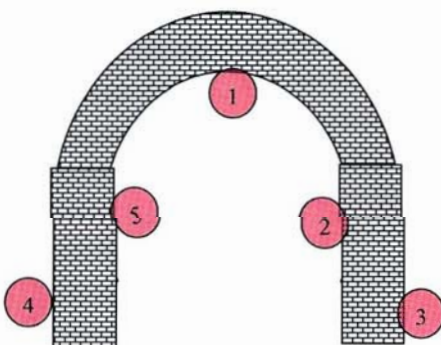
Most of the evaluations required in the context of train induced vibrations are already included in VIEW 2002. The event plot displays the temporal distribution of the trains over the measuring period. The file group processing in VIEW 2002 allows evaluation according to DIN 4150/2 or ÖNORM S9010. With a mouse click averaged amplitude or octave band spectra are computed or transfer spectra between measuring point are calculated.



## Blast Monitoring with the MR2002-CE and NCC



The monitoring of vibrations caused by blasting is a typical application of the NCC (Network Control Centre). With the NCC up to 16 stations can be controlled in a network. The individual stations work independently. Synchronisation and triggering is handled by the NCC. Download of data and the programming of the individual stations can also be carried out through the NCC.



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## Transducers for the MR2002

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### Tri-axial Velocity Transducer MS2003

Principle: active, electronically compensated geophone  
Direction: 3 orthogonal directions  
Measuring range: 0.0035 to 114 mm/s (option: 0.00007 to 2 mm/s)  
Frequency range: 1 to 315 Hz  
Casing: Alu (122 x 120 x 91 mm); approx. 1500 g  
Codes: complies with DIN 45669 Klasse 1



### Uni-axial Velocity Transducer MS2003

Principle: active, electronically compensated geophone  
Direction: vertical or horizontal direction  
Measuring range: 0.0035 to 114 mm/s (option: 0.00007 to 2 mm/s)  
Frequency range: 1 to 315 Hz  
Casing: Alu (80 x 75 x 57 mm); approx. 400 g  
Codes: complies with DIN 45669 Klasse 1



### Tri-axial Acceleration Transducer MS2002+

Principle: Capacitive Acceleration Transducer  
Direction: 3 orthogonal directions  
Measuring range: 0.1 to 100 m/s<sup>2</sup>  
Frequency range: 0 to 150 Hz  
Casing: Alu (80 x 75 x 57 mm); approx. 400g



### Tri-axial Acceleration Transducer MS2005

Principle: Piezo-electrical Acceleration Transducer  
Direction: 3 orthogonal directions  
Measuring range: 10 to 1000 m/s<sup>2</sup>  
Frequency range: 0 to 1000 Hz  
Casing: Alu (80 x 75 x 57 mm); approx. 400g



### Tri-axial Acceleration Transducer MS2002

Principle: Capacitive Acceleration Transducer  
Direction: 3 orthogonal directions  
Measuring range: 0.01 to 10 m/s<sup>2</sup>  
Frequency range: 0 to 315 Hz  
Casing: Alu (80 x 75 x 57 mm); approx. 400g



# Alarm / Remote Control / Call-Back System

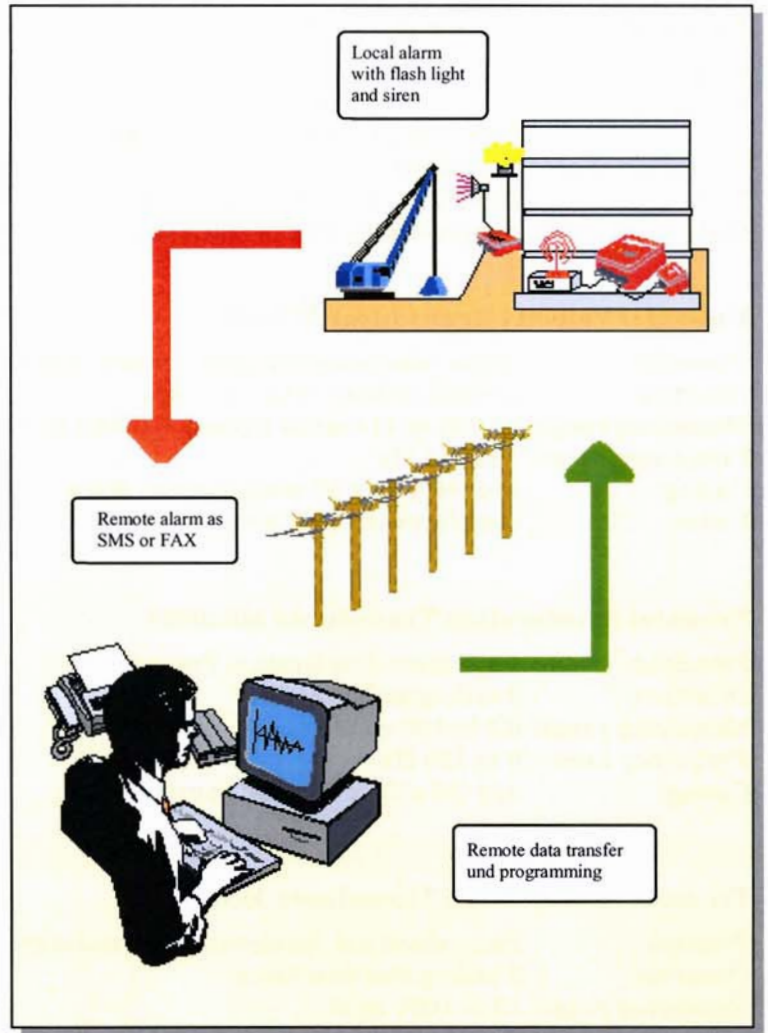
**Z-Alarm:** In many cases vibration monitoring alone is not sufficient. To avoid damage, alarm has to be dispatched immediately after vibration limits have been exceeded. The alarm box is simply connected to the alarm exit of the MR2002. Three lights (Error, Low Level Alarm und High Level Alarm) indicate the status of the MR2002. Corresponding to these three light the alarm box has three plugs, where alarm indicators (turning lights or sirens) can be connected.

**Remote control:** The communication with the MR2002, i.e. the programming of the recorder and the data transfer can be carried out in one of three ways:

- Direct link
- Modem link via fix net
- Modem link via mobile net

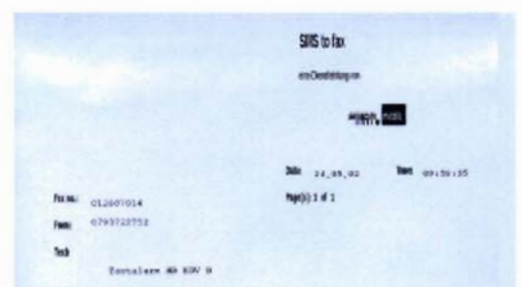
With Direct Link the MR2002 is directly connected to the PC or the Laptop via the RS232 cable. This connection, which is after all the most often used one, is used when the measuring points are easily accessible and no long travelling distances are required.

With long travelling distances controlling the instrument and data transfer can amount to a considerable cost factor. Here a Modem Link might prove useful and can reduce costs effectively.

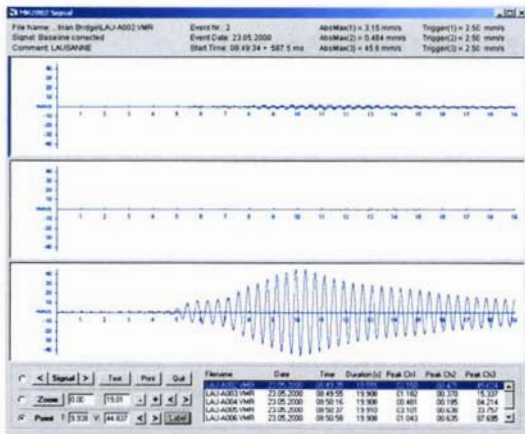


The **RedAlert** contains a GSM (= Global System for Mobile communication), which allows you to be connected from your office to the instrument on the building site at any time. With the Red Alert you can save time and travelling expenses; furthermore the vibration monitoring tasks can be carried out more effectively. Trigger levels can be changed at any time and test measurements can be carried out easily from your office..

**Call Back System:** For critical vibration monitoring tasks an automatic alert system is indispensable. The MR2002 forms together with the **RedAlert** a perfect monitoring system with automatic call back in case of threshold exceedance. The **RedAlert** stores all Fax- or Mobile phone numbers, which should receive a message. As soon as the pre-programmed thresholds are exceeded or in case of a system error (e.g. low battery) the **RedAlert** sends out the corresponding messages. If needed more information like signal time histories can be downloaded with the **RedAlert**.

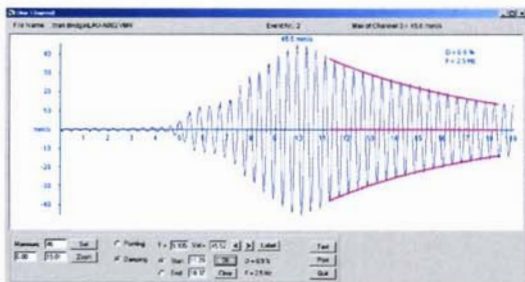


# Data Analysis with VIEW 2002



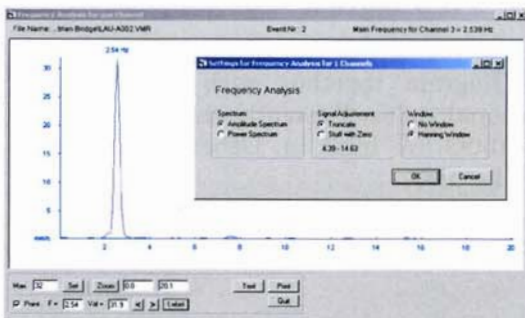
## VIEW 2002: Time Domain

The time domain analysis includes the representation of the recorded signals as time histories, the calculation of the derived signals such as displacement, velocity and acceleration and the calculation of the vector sum. The recorded signals are displayed as triplets (three orthogonal directions); they can also be enlarged and viewed as single channels. With Zoom and Point functions the important parts can be displayed and labelled.



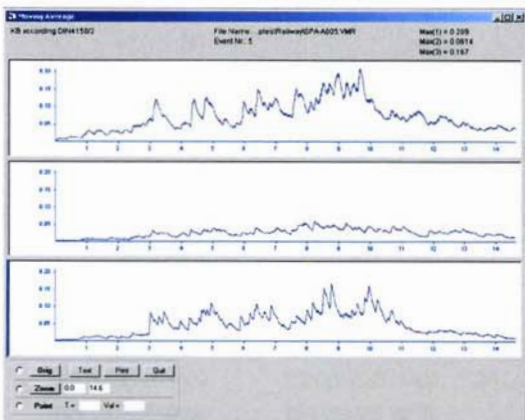
## VIEW 2002: Damping

The Damping function enables the calculation of eigenfrequency and damping for a decaying vibration. VIEW 2002 calculates the damping in terms of percent of critical damping (assuming a single degree of freedom system) for the signal section determined by the user. The graphical representation allows a straightforward control of the computed result.



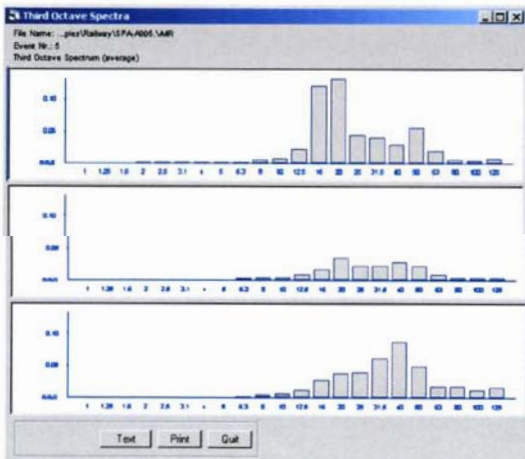
## VIEW 2002: Frequency Domain

Frequency analysis in terms of amplitude or power spectra are readily produced with VIEW 2002. Due to the intelligent user interface even complicated procedures like the effect of „zero stuffing“ and „windowing“ are easily understood. With zoom- and point-functions the important parts of the diagrams can be displayed and labelled.



## VIEW 2002: National Codes

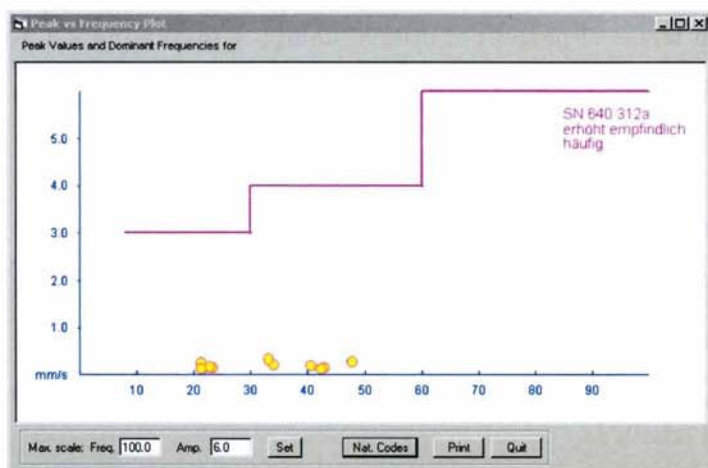
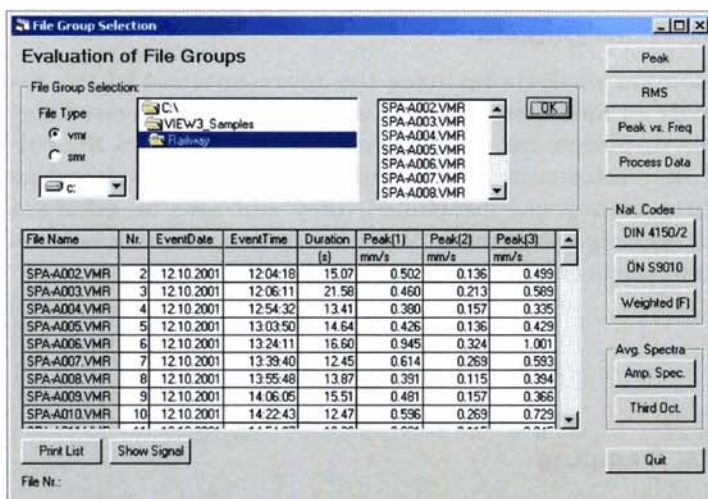
VIEW 2002 supports the evaluation according to various codes. Presently the evaluation according to DIN 4150/2, ÖNORM S9010 and the evaluation according to „Arrêté relatif aux exploitations de carrières .. 22.9.1994“ are included. In these evaluations both, single signals and file groups, can be handled. Single signals are processed according to specified rules (e.g. KB-weighting of an individual signal), entire groups of signals are processed and statistically evaluated (e.g..  $KB_{FTm}$ -calculation).



## VIEW 2002: Octave Band Spectrum

The representation of the frequency analysis in terms of an octave band spectrum is primarily used in connection with train induced vibrations. Numerous analysis programs for train vibration prediction use these spectra. VIEW 2002 includes two types of octave band spectra: the average octave band spectrum und the maximum octave band spectrum.

# Data Analysis with VIEW 2002



## VIEW 2002: File Group Analysis

*File Group Analysis* is a very powerful tool for the evaluation of large amount of data. With this tool all files in a directory can be processed and statistically analysed according to the selected method. The following methods are available:

- Peak values and vector sum
- RMS-values with threshold values
- Peak vs. main frequency

File Group Analysis includes also the analysis according to the following national codes:

- DIN 4150/2
- ÖNORM S9010
- Arrêté relatif aux exploitations des carrières ..

Tailored analysis methods can be created in the menu «*Process Data*», where various analysis procedures like Filters, Integration, Differentiation, Frequency analysis etc. can be combined.

## VIEW 2002: P-F-Diagram

A very useful feature is the display of the Peak-Frequency-Diagram together with the limits of various national codes. Presently the SN 640 312a and DIN 4150/3 are built in. Other limits can be entered by the user.



DR. A. ZIEGLER - DIPL.-ING. ETH/SIA/ASIC  
GLADBACHSTR. 121 - CH-8044 ZÜRICH  
TEL.: 01 260 70 10 - FAX.: 01 260 70 14

**SYSCOM Instruments SA**  
Kornhausstrasse 15  
CH 8037 Zürich

Phone: +41 (0)1 365 27 00  
Fax: +41 (0)1 362 06 50  
email: [info@syscom.ch](mailto:info@syscom.ch)  
<http://www.syscom.ch>