Bay Acquisition & Recording System - BARS

Record and analyse data using a full function micro PC with 4-32 channels.
A 4ch system weighs <1.5kg and is battery powered.

BARS 4 channel

BARS is a powerful data recorder integrated into a full function micro PC with all the facilities of a full sized PC. The micro PC is capable of doing every-thing that a full sized PC will do and becomes a full sized PC if you add a larger screen, keyboard and mouse.

BARS in use monitoring acceleration and SPL

Contents

Bay Systems' Mission statement.

To provide effective NVH solutions; that increase productivity by being :
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1. Easy to learn and use; they should help do a job not become the job.

2. Application focused; they should provide the answers that are needed not more data.

3. Affordable; both to purchase and maintain.

Making better products is about communication of:-
Ideas,
Designs,
Prototypes,
Test Results,
Customer Reactions.

Facilities and systems play an important part in this process by providing reliable numbers upon which decisions can be based.

Reliable numbers are not the automatic result of testing. They are only produced when systems, technicians and engineers are working in harmony with each other.

The user interface and how it relates to the job is the key to a more productive working environment. A stable design, that is easy to understand and use, is the basic requirement.

For acquisition the BARS software system puts every control within two mouse clicks and every graph is easily found and understood.

Better Faster Cheaper is the request.

In the data acquisition market many suppliers have retained an outdated high cost business model that is no longer justifiable. Software can be written using new development technologies that does operate properly and does deliver the answers you need without the vendors support engineer sitting on the end of your desk!

The digital revolution primarily in mobile telephones and personal entertainment technologies mean that what was rare and expensive is now essentially available for little more than the cost of the packaging!

We offer solutions to both low and high channel count data acquisition, importantly we offer them at a purchase and through life support price that all customers can afford.

BARS Micro System

- 24 bit ADC
- Parallel sample and hold
- IEPE 2ma transducer power
- Anti-alias protection
- AC/DC coupling
- Tachometer input
- Trigger input
- Analogue output
- …

Channel counts from 4 and a card configuration to suite most applications.
All of the nVision post processing and specialist modules work with the BARS micro-system and the Sony EX gathered data. If your company needs specialist signal conditioning or large channel counts then the Sony EX is the correct choice but for the regular jobs that make up most of the work that we all do then the BARS micro-system is the right choice.

Sample rates on all channels up to 225,000 samples per second per channel to disk on a note book PC.
The slowest card samples at 52kHz per channel – fast enough for most NVH work.
All cards sample at many lower rates to suite all applications and conserve disk space.

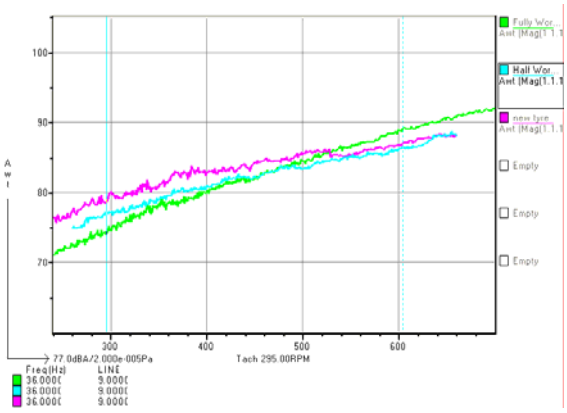
Taking data in the field and in the laboratory.

In car recording

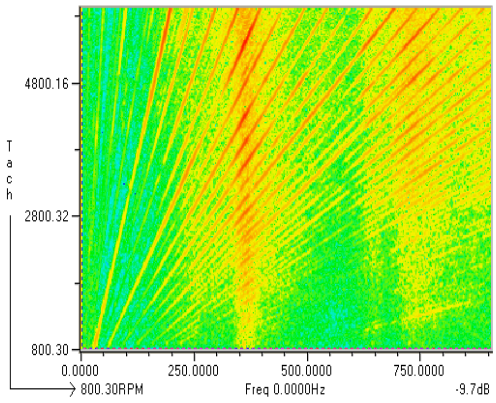
Sound power testing

EXtra-Vision is the combination of BARS hardware and nVision. The BARS system is the most capable hardware platform to be fully integrated into nVision. The software that controls the hardware was designed and written by the engineers who have designed, written and maintained nVision. The proven application modules of nVision are natural choice for post processing BARS.

Tyre noise testing



Tyre noise performance as a function of wear



Order plot

Data Acquisition BARS

Features of the BARS hardware:-

1. Excellent 24 bit ADC

2. Sample speeds to 52kHz per ch.

3. Ultra small package size

4. Light weight < 500g

5. input / output options:
   Voltage with IEPE
   24 DAC output

7. Power supply independence.
   Power from P.C. USB

8. From 4 to 192 channels.
   In 4 and 8 channel modules

8. Best price structure in market

9. Low cost of ownership
   6% annual support contract.

Benefits of owning the BARS

No time wasted re-taking data due to the excellent dynamic range & sampling capabilities of the hardware.

Easy to carry & support safely; will fit in the slimmest briefcase and stow in the overhead aircraft locker

Capture any NVH signal first time from voltage and IEPE transducer with no external boxes.
Reduces clutter and guarantees the calibration accuracy

With the micro Vaio PC you will get > 1 hour recording with no external power.

Replay what you have recorded into headphones, speakers or shakers.

Direct excitation of structures for FRF and other transmission test measurements

Use it anywhere with confidence

Start small at low cost and grow as your needs expand. Swap 4 channel modules between measurement groups for true flexibility.

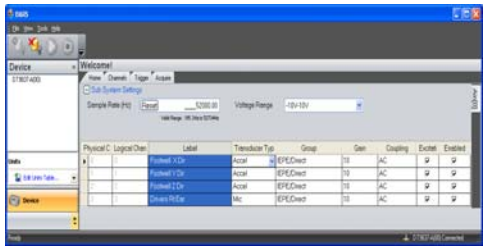
Quality measurements even when budgets are tight.

No hidden costs – probably the lowest cost of ownership in the industry.

The acquisition software BARS

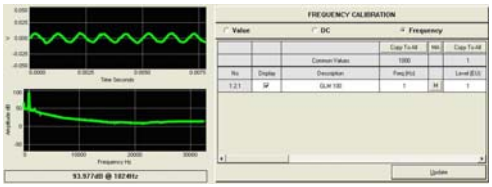
Only buy what you need; there are no upgrade penalties and what you need is sensibly priced.

BARS – Standard.



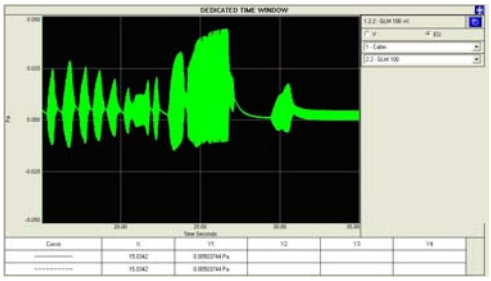
This software is always supplied with the hard-ware and is included in the purchase it : -

- Sets up all the channels using a layered panel with copy and paste for speed.

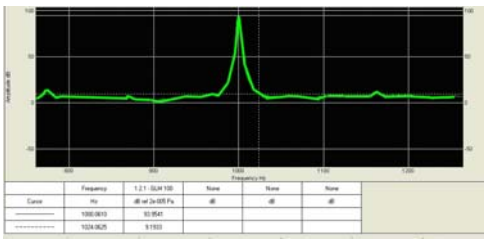


- Validates the inputs channels using an auto-matic multi-channel display.

- Calibration of channels individually or in groups.
- Triggering on all inputs on level and time
- Time history display with over-view



- Frequency display with 95– 65,000 spectral lines.
- Full control over the displays while re-cording to disk



- Large choice of output file formats available

Additional Bars software modules include:
Advanced online signal processing including FRF, Coherence, Correlation ……

Solutions for common tasks

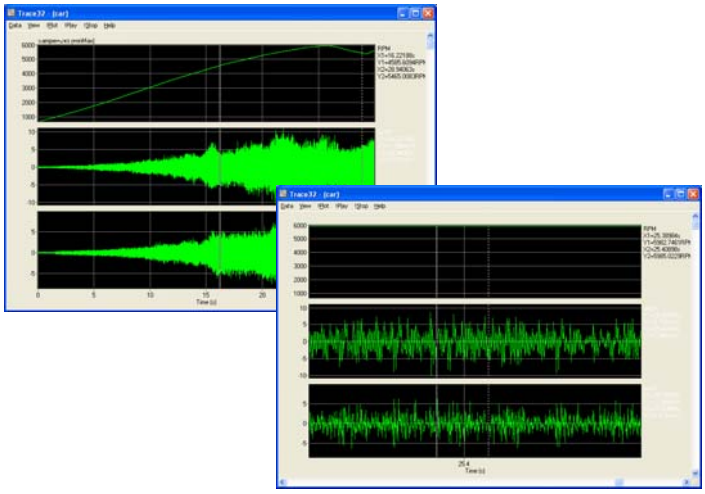
Recording signals for playback or analysis

A variety of solutions are available: -
Sound card – The sound card driver and calibration routine is shipped in every nVision system.

Data Translation USB acquisition card - a low cost multi-channel front end. The open layers driver makes this solution a very affordable multi-channel acquisition system.

BARS – a modular high performance front end with a range of inputs possible.
Data objects created are imported automatically into nVision

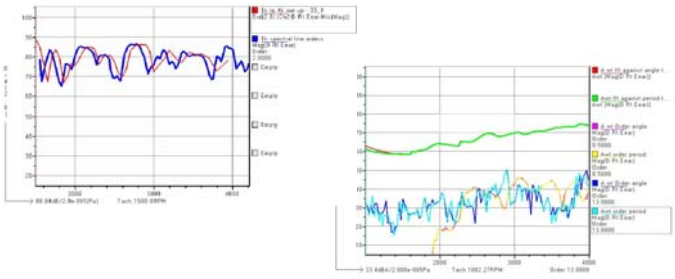
Once the data is recorded it can be viewed in the Trace display, again standard in the Base nVision system. Up to 256 channels can be accepted. The number displayed can be as large as the screen resolution permits. Simply dragging the solid cursor "zooms" the display
Times marked by the cursors can be edited and new data objects created. When using the BARS where large numbers of channels might be recorded the input dialogue allows for selected channels and events.



Clicking on the PLAY button causes the selected channel to play through the PC's sound card. Choices include mono, Stereo and back to back. This simple arrangement makes sound quality evaluation possible when using good quality headphones.

When undertaking a new project it is a good idea to try at least two measurement and analysis techniques to prove that the results are not a product of a certain approach. The correct answer should be independent of the measurement/analysis method used to obtain it. nVision provides a wide range of acquisition, filtering and analysis techniques. The principle choices :

Bandwidth
window function
FFT size
Tacho processing
Averaging type.

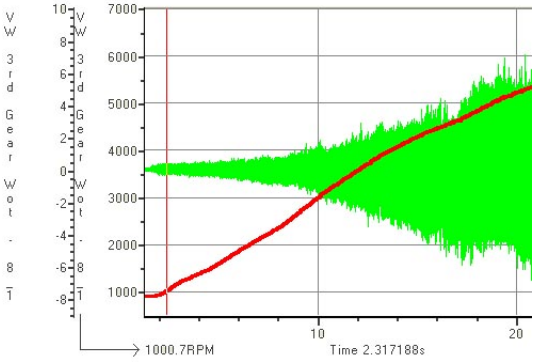


The two traces on the right are analysis of the same engine run up using two different analysis techniques. The original data was unwittingly under sampled, this led to a severe tacho pulse jitter. The effect of jitter in the tacho pulse train is to mask the true instantaneous rpm. If the true rpm is not known then the FFT block with the correct order data cannot be reliably selected. The result is the wrong values in the orders and even for overall level. The 2nd order trace demonstrate that these errors can be significant and will make comparisons invalid.

Analysing data
Presenting the results

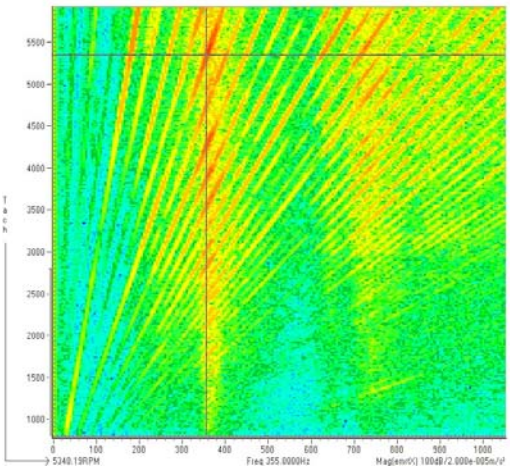
nVision-Standard

All the basic and advanced 2 & 3D displays plus the advanced signal processing capabilities needed by everyone analysing data. In addition to what you might expect there are also a powerful set of tools that allow you to manipulate the data. These include the standard acoustic and vibration weightings A,B,C,D, Whole Body and hand Arm.



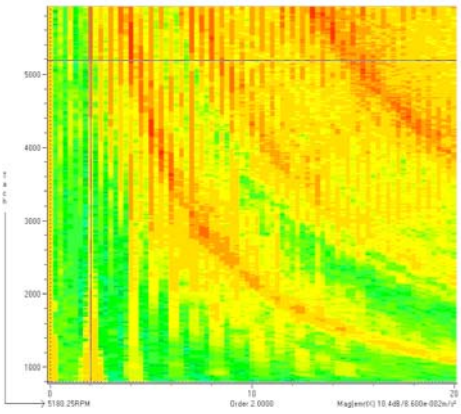
Signal overlaid with the rpm profile

An important aid to productivity is the ability to synchronise the way different data sets are viewed. It is normal to want to compare precisely the same point in a number of events. If this has to be found in four independent data sets containing three or four hundred spectra the task will become tedious and with tedium comes error. nVstan contains the standard tacho pulse processor that converts a tacho pulse train to an rpm profile. The data produced can then be displayed with order cursors.

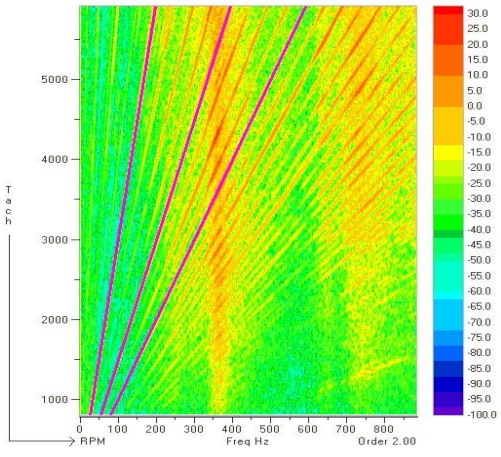


Spectra at every 20 rpm plotted as a colour map; the orders are clear to see.

The order cursors, shown bottom right, provide a quick and easy way to identify orders and the critical spacing between orders. Once the important orders and their separation is established the full order set can be successfully extracted from the FFT data and presented, see the figure, bottom left.



Order map shows orders as straight lines

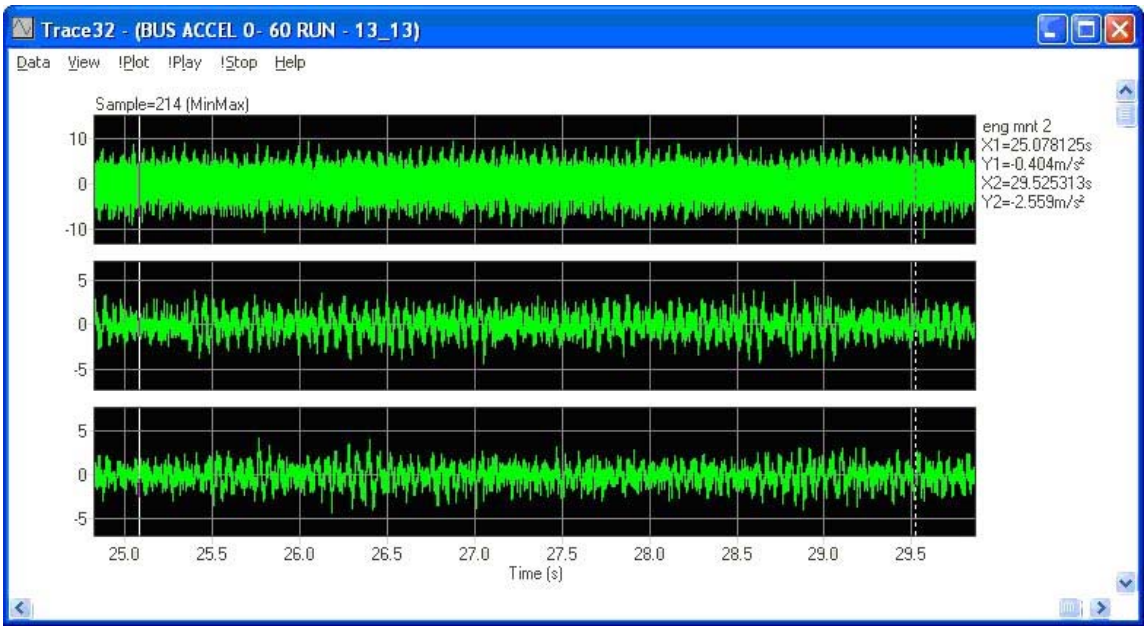


Order Cursors help identify the orders

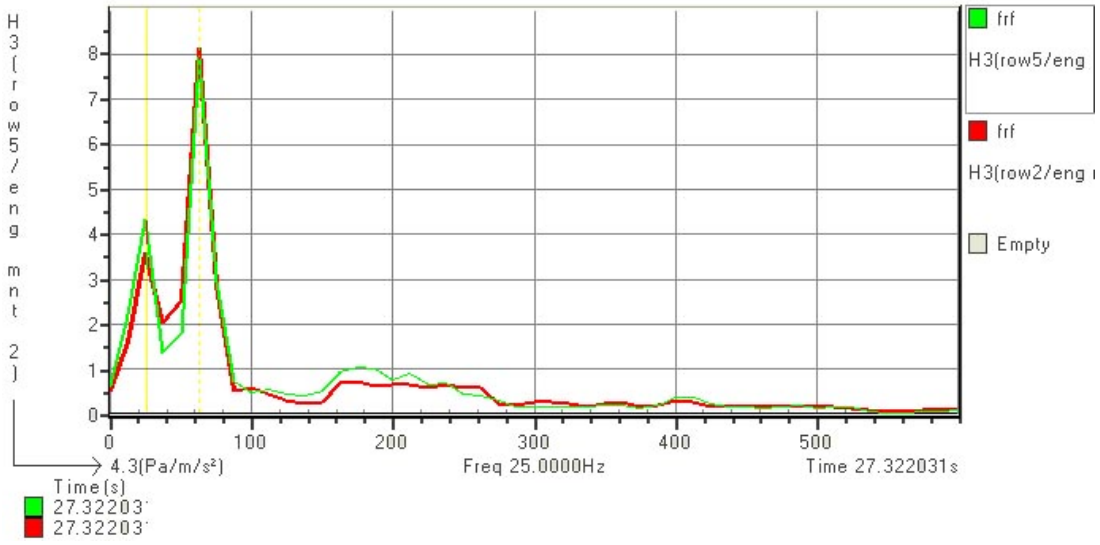
Solutions for common tasks

Performing Frequency analysis

BARS has a standard FFT capability giving Magnitude, Power Spectrum and Power Spectrum Density in narrow band and 1/3rd octave presentations. The time history can be stored to disk allowing the data to be post processed. It is common practice for the definitive analysis to be completed using recorded rather than live data. The ability to record to disk while viewing results on the screen is very important to many users. The basic FFT capability of the BARS is then all that is typically required to confirm the quality of the recorded data. BARS advanced signal processing and display modules are available that allow additional online capabilities. The two figure below shows the typical engine mount acceleration (channel 1) and two microphone responses. The upper figure is the time history and the bottom the acceleration to sound pressure level "Transfer Function".



Time history

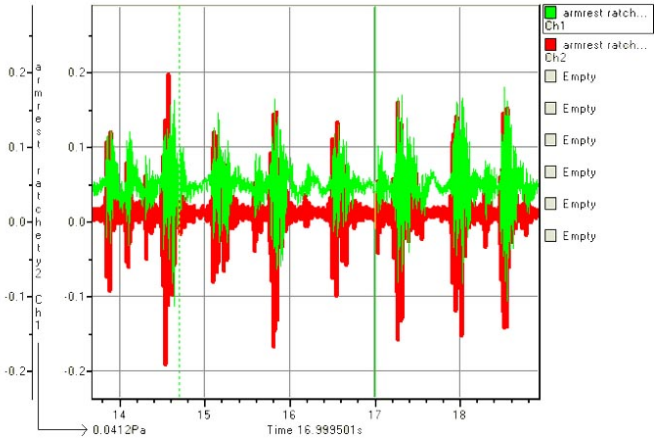


Transfer function

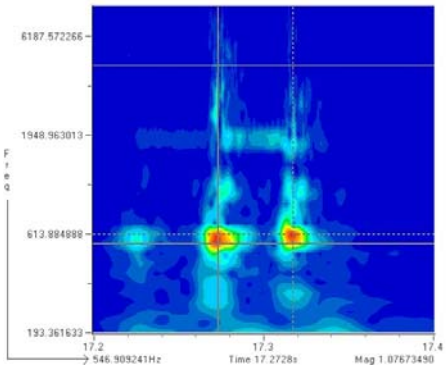
Solutions for common tasks

Time/Frequency Analysis– Wavelets

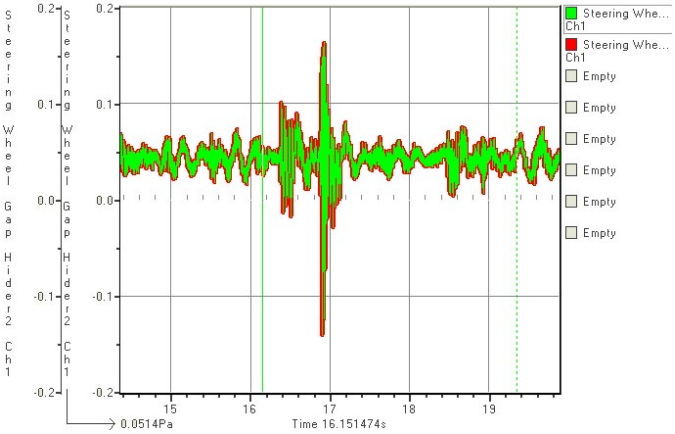
There are many possible applications for wavelet analysis; one that has been a success is the "finger printing" of Buzz, Squeak & Rattle (BSR) noises in cars and other products. The nVstan bundle provides all the acquisition and processing needed. A short training course is also available.



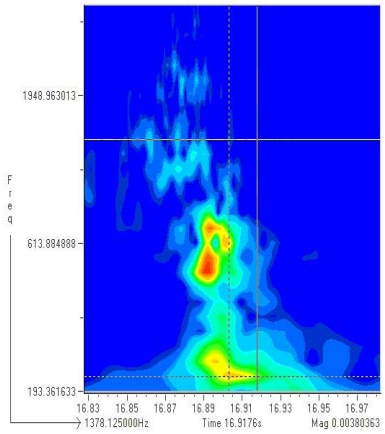
Time history of armrest squeak



Armrest wavelet display



Time history of steering wheel gap hider



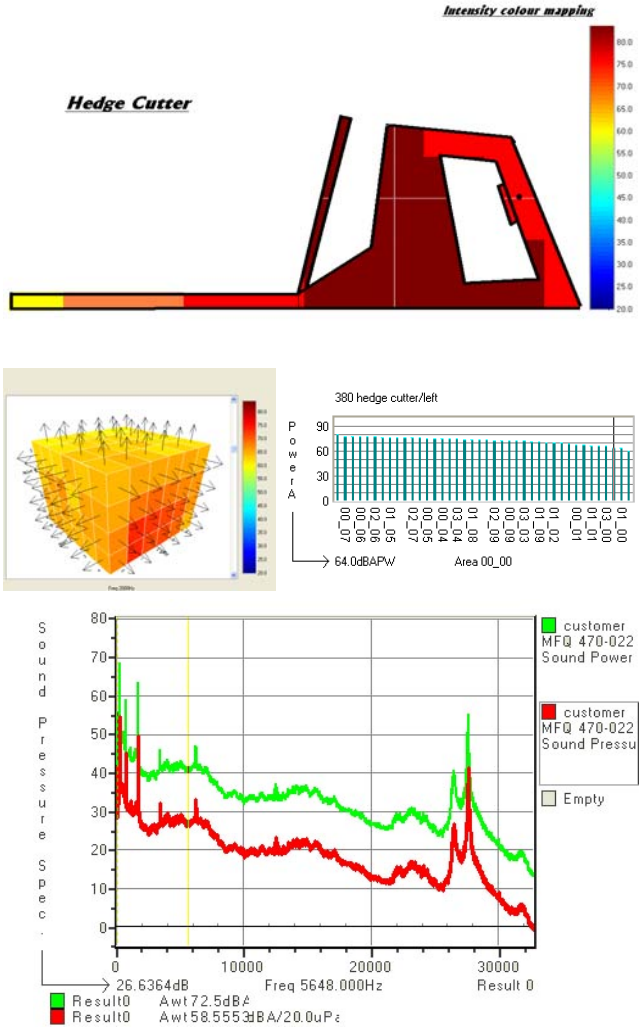
Steering wheel gap hider wavelet

The two time histories are similar but the wavelet plots are clearly different. Wavlet plots allow the event to be represented in a meaningful way and comparisons made before and after a "cure" has been applied. For companies manufacturing products around the world the wavelet plot together with a sound file will provide a definite record of the problem and aid production facilities in finding and eradicating defects. The wavelet plots can be tuned to be very sensitive to damping in a structures response. This means that in an automotive application sample doors can be tested to check on quality.

Solutions for common tasks

Sound Power and Sound Intensity

Sound power measurements are made in the genuine free field, a reverberant, semi or fully anechoic room. For the UK the free field i.e. out of doors measurement is impractical due to aircraft noise and the ever present chance of rain. Bay Systems designs and builds economical semi-anechoic chambers that achieve very low background noise levels; e.g. NR20 when the ambient exterior noise level is 80+ dBA. The sound power acquisition system is a simple to operate module that requires only an averaged sound pressure level data object to be dropped into it.



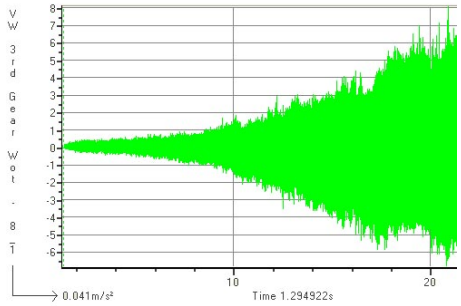
software accepts data from B&K and Larson Davis analysers. These more expensive laboratory grade systems are still a less expensive alternative to building a semi-anechoic chamber. The workshop standard probe with notebook sound card offers repeatable measurements for less than £6000.00. This solution is ideal for the smaller company or where the primary need is to track effect of engineering changes on sound power radiated.

The alternative to building or renting time in a semi-anechoic room is to measure the acoustic intensity vector and hence deduce the sound power. In principal sound intensity measurements can be made in any stationary sound field where the local environment is not close to reverberant. The best option is usually to move the product to be tested to a quiet open field. To make measurements in an open field requires a fully portable, battery powered solution. The nVision solution uses the sound card built into a notebook computer. For this to work the response has to be normalised. The low cost (workshop quality) sound intensity probe includes a white noise source for this purpose. This configuration enables a sound power probe to be supplied for less than £1500. Where budgets allow the nVision sound intensity

Analysing difficult data

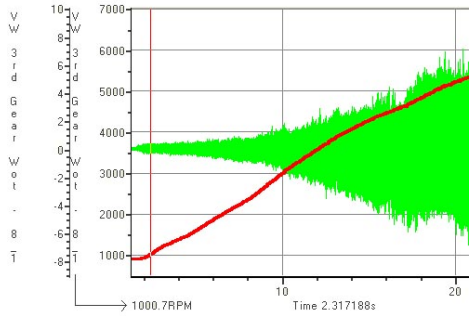
Data from rotating machinery will occasionally be difficult to analyse for at least one of the following reasons: -

- The tacho pulse train is missing
- The tacho pulse train is poor
- The run up/down is very fast

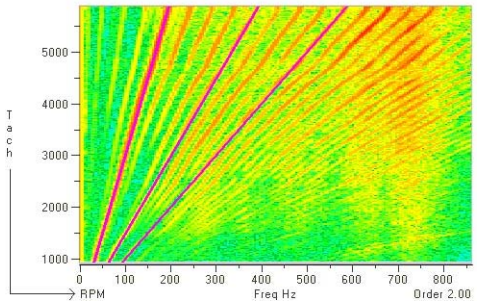


Raw time history

This data was taken when there was no tacho available



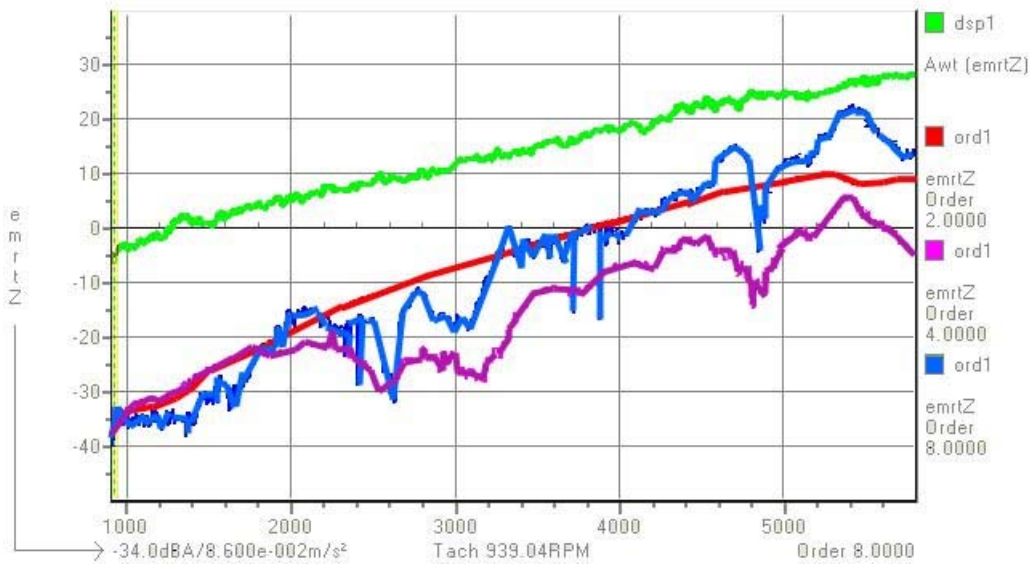
Synthesised rpm profile



Contour plot with order cursors

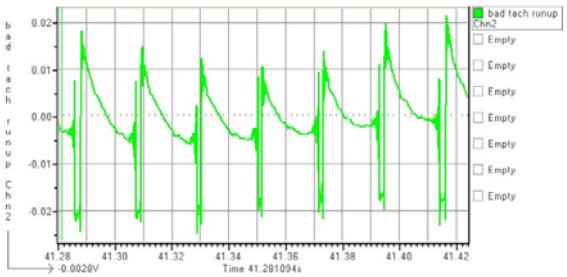
The sequence of events is: - the raw signal with no tacho pulse train, the synth tacho module produces the red rpm profile which is used to compute the rpm referenced colour contour plot that is shown above with order cursors.
The raw data is now A weighted and the A weighted overall level is plotted against rpm. Superposed upon this result are the levels of a number of A weighted orders. For this vehicle, like many others, the 2nd order levels are not necessarily the most important after A weighting is applied.

NB. Levels are uncalibrated



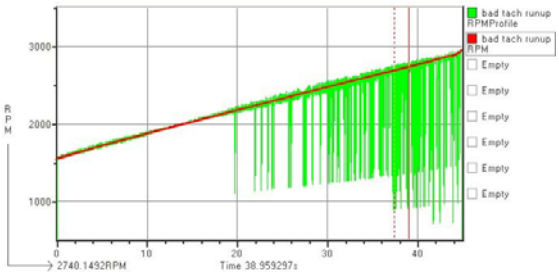
Analysing difficult data

Angle domain and time series editing help to recover good order plots from very poor data. The original tacho may have various defects such as changing level and missed pulses. These can be corrected by hand in some cases but doing so is very time consuming.



The pre-pulse spike and the slow drift away of tacho level make this a very difficult pulse train to process. This type of diesel fuel line sensor is not commonly used in the laboratory but is fast to fit when benchmarking competitors vehi-

The angle domain tacho module allows for missed and extra pulses and rejects pulses that would cause an instantaneous acceleration beyond a user set limit.
The red trace is the result of an angle domain tacho the green is a normal period tacho with quadratic smoothing.



The rpm profile calculated using a standard period estimator is shown in green. The red rpm profile has been generated using the Angle Domain technique.

Angle domain editing is a way to remove unpleasant valve train and piston slap noise from an engines signature. By doing this a development engine, with a correctable defect, can be fairly evaluated. The module will remove and substitute a better/worse section of time history data on a cycle-by-cycle basis irrespective of how fast the run up is. In the example below the piston slap in the upper trace will replace the slap of another cylinder. As a result the engine can be listened to with and without the poorly performing cylinder/piston. Two bad pistons can also be inserted to demonstrate the noise from an engine built with two bad pistons.

Useful features

Systems on the market today typically have a host of features some useful and some less so; nVision is no exception.

Features	Advantages & Benefits
Import /Export of Files Read and write many file formats	Import and export data to lots of formats and so allow many people to share the data
Display of data records Graph module accepts irregular data	Plot 0-500Hz data on top of 0-10kHz data and see the whole 0-10kHz with the 0-500Hz neatly positioned on top.
Line types Graph modules have many styles, line types and thickness	Plots can be made to stand out regardless of the presentation media chosen.
Object sequencer Automatic object naming	Reduces the chance of misnaming the data. Produces accurate and logical file names.
Synchro Synchronises cursor position and view across data objects	For example when comparing run ups from a group of vehicles the exact matching rpm can be found with one mouse click allowing accurate comparisons to be made.
Weighting, Leq & noise dose For any frequency data block the overall Lin, A, B, C, D weights are added as additional information in the block.	Produce Awt and other wtd orders as required by many automotive manufacturers. The large choice of weighting functions allows the significance of acoustic data to be quickly assessed. Weightings can be removed (un-weight).
The actual weighting curve can be imposed on the data. Hand/arm and whole body vibration curves are also supplied. User defined curves can be easily added. Time domain A weighting is provided in the Leq module	Time domain weighting with Leq allows the calculation of noise exposure. The Noise dose module allows short recordings to be used to produce a full shift exposure calculation. If the desired limit is exceeded then the mix of exposures can be changed to allow the optimum working practice to be adopted. This can make an enormous contribution to efficiency in enabling a safe full shift to be worked even in noisy conditions.
DataBase Optional when saving data the user defined fields may be completed	Quality assurance ISO 9000 type record keeping is much simpler using a database. Finding data takes seconds rather than hours and all archived locations are recorded.
Channel Tools Add, subtract, multiply, divide and average one or more channels in a data record	Performing simple operations is often needlessly complex using some systems. This simple tool allows the basic manipulations to be completed by anyone. Averaging the output from 10 microphones when making a sound power measurement requires only two mouse clicks.

Useful features – continued

Features	Advantages & Benefits
Angle domain Tacho and editing Uses pulse arrival and other smoothing techniques to produce an accurate rpm profile even when the pulse train is very poor.	Allows excellent results to be derived from data with a poor tacho. Saves the time that would have been spent retaking the data.
Articulation Index & Sound Quality Calculates all the standard sound quality indicators used by the major motor and other manufactures in a straightforward manner	Articulation Index and other indicators make noise comparisons between vehicles easier. In general each indicator tries to mimic a human's reaction to noise. Loudness is always the primary indicator & the least subjective.
Kalman Filtering & Digital Order Tracking Extracts individual order signals from the composite recorded noise. The "sound" of each order can then be heard in isolation and re-mixed to form a "new" acoustic signature	Used with the Angle Domain Tacho to improve the quality of the tacho pulses this module will extract the Kalman order tracks where other systems fail. This means that results can be computed without repeating the test. The Digital order tracking output is in the order domain and allows very fast run ups to be analysed. Used with Angle Domain Tacho to recover very poor quality data.
Buzz Squeak and Rattle Fingerprinting The system produces reliable colour map fingerprints of BSRs.	Describing BSRs is nearly as difficult as finding them. The system provides a universally applicable method of identify BSRs. This has enabled OEMs and suppliers to work together to effectively remove them from their products.
Sound Power Calculates the sound power radiated by a product for n microphones and makes full allowance for the environment.	The dedicated module takes care of all processing needed producing the total sound power and sound pressure levels together with the averaged spectra. The module saves a considerable amount of time when compared to a manual calculation.
RASTI Rapid Speech Transmission Index is an alternative to AI (Articulation Index) for the assessment of speech intelligibility in a noisy environment. The system generates a test signal and then processes the measured response. The results are used to certificate public address systems on trains and in buildings.	The system can be run entirely from a note book computer. Provided the characteristics of the source and receiving devices are acceptable the results of each measurement can be stored to disk and analysed later. The availability of the measured data for archive is a major advantage of this system over an instrument based approach.

Useful features – continued

Features	Advantages & Benefits
Leq and time domain Awt Applies the Awt Computes the Leq directly on the time domain signal rather than the traditional method of using the FFT algorithm and subsequently weighting the result	Very fast and simple to use and you can see the original time history, its A wt overall level and the Leq in a single scrollable display.
Tacho-Generator Used to add a tacho signal to data where no tacho exists. The module Generates a tacho signal using an order identified in the colour contour plot produced from overlap FFT processing.	The module saves many hours by removing the need to fit a tacho sensor. The time spent in deriving an accurate tacho profile is less than 5 minutes while the time spent fitting a tacho is normally > 1 hour.
Calculate Hand Arm Vibration Legislation requires that operators of equipment are not exposed to high levels of vibration. The limit for an 8 hour day is 5 MS^{-2} .	CHARM accepts narrow band and third octave data generated by the Sony EX and other acquisition front end systems. The module calculates the exposure value for any number of channels and also tri-axial combinations. The resulting spectrum is available for viewing and the test result is produced as a printable html file.
Transmission Loss Calculates the transmission loss due to a material sample. The module is a calculator designed to remove any chance of error when making large number s of measurements.	Results are calculated reliably with minimum operator intervention meaning.
Watchdog Automatically imports defined data types as they are created on disk by an acquisition front end e.g. Sony EX.	The data you need is immediately in memory and displayed in the data list on the screen; ready for use – saves time and the tedium of loading files from disk.
Watchdog AI Articulation Index (AI) is a very useful tool in assessing the noise environment. This module automatically processes the raw time domain data gathered by a front end and computes the AI	Of particular interest to automotive engineers involved in wind and road noise testing as the AI value is computed quickly and easily direct from the time domain.
Module descriptions The tool bar document contains a description of every module in the nVision system.	Modules are members of a tool bar or as options to tool bars. The custom modules can often be configured with just the base tool bar making them very cost effective.

Data Acquisition System Feature	Specifications
Number of analogue input channels	4, single-ended, simultaneous 8,12,16,24, 28, 32channels with additional input cards of 4 or 8 channels each.
Resolution	24 bits
Ranges and gains	±10 V (gain of 1), ±1 V (gain of 10)
Gain error Gain of 1: Gain of 10:	 ±0.02% ±0.5%
A/D type	Delta-Sigma
Maximum sample rate	52.734 kHz (conversion rate = sample rate * 512)
Minimum sample rate	195.3 Hz
Group delay	38/Sample Frequency
Stop-band	0.49 x Sample Frequency
Pass-band ripple	±0.005 dB
Signal/noise (typical)	106 dB
Total harmonic distortion (–0.5 dB) using 1 kHz sine wave, sampled at 50 kHz	 –90 db typical
Spurious free dynamic range (SFDR) using a 1 kHz sine wave, sampled at 50 kHz 10 V full-scale signal (–0.5 dB): 1 V signal (–20 dB): 100 mV signal (–40 dB): 0 V signal:	 –90 dB typical –105 dB typical –115 dB typical –115 dB typical
Data encoding	Offset binary
Maximum input voltage (without damage) Power on: Power off: Input impedance Overvoltage protection (power on/off) ESD protection Arc: Contact: Current source Compliance voltage Current noise @ 1 kHz bandwidth Current source accuracy DC offset AC coupling at –3 dB	 ±30 V ±20 V 1 MΩ, 20 pF (cable capacitance of typically 30 pF per foot must be added) ±40 V 8 kV 4 kV 4 mA 18 V 5 nA rms ±1.0% 1.5 mV 0.5 Hz

Data Acquisition System Feature	Specifications
Input impedance	1 MΩ, 20 pF (cable capacitance of typically 30 pF per foot must be added)
Overvoltage protection (power on/off)	±40 V
ESD protection Arc: Contact:	 8 kV 4 kV
Current source	4 mA
Compliance voltage	18 V
Current noise @ 1 kHz bandwidth	5 nA rms
Current source accuracy	±1.0%
DC offset	1.5 mV
AC coupling at –3 dB	0.5 Hz
Number of analogue output channels	1 –6
Resolution	24 bits
Output range	±10 V
Data encoding	Offset binary
Output current	±1 mA maximum load (10 V across 10k)
FIFO	8192 Samples, total per 4 channels
ESD protection	
Arc:	8 kV
Contact:	4 kV
DC offset	±1.5 mV
Gain error	±3.0%
2-pole, low-pass Butterworth filter	10 kHz
Time delay (typical)	34/output frequency
Power fault and reset	Goes to 0 V ±10 mV if the USB cable removed or the power fails
Total harmonic distortion (typical at 1 kHz)	0.0015%
Internal clock	output frequency x 256
Sample frequency	46.875 kHz
Pass band ripple (typical ±0.002 dB)	0.454 x output frequency
Pass band (typical)	0.454 x output frequency
Stop band (typical)	0.546 x output frequency
Weight of 4 channel ADC system	500 grammes
Size of ADC system	100 x 200 x 18 mm

Feature	**Computer Technical Specifications**
Processor	Latest Intel Centrino Intel® Core™ Solo Processor U1500 (1.33GHz , 2MB L2 Cache)
Screen size	4.5" Wide XBRITE SVGA LCD, Touch Screen (1024x600) Daylight readable
Memory	1GB RAM
RAM Disc	40GB HD None Volatile RAM disc
Networking	Intel® PRO/Wireless 3945ABG Network Connection (802.11a/b/g)
Navigation	GPS Navigation.
Audio	Built-In Speakers
Graphivs processor	Intel® Graphics Media Accelerator 950 with 224MB dynamically allocated RAM/Video memory
Ethernet connectivity	Fast Ethernet 10BASE-T/100BASE-TX (RJ-45)
Additional none volatile memory supplied	16 Gig Byte - The accessory slot supports Optional Memory Stick DUO™ media with MagicGate® functionality.
WiFi	Integrated Wireless Wide Area Network (WAN) accessing high speed wireless EDGE Network with SmartWi™ technology.
	Supports speeds up to 247.4 kbps.
Camera x 2	2 Built-in Cameras (front: 0.3M pixels and back: 1.3M pixels)
Microphone	Built-in microphone
USB	USB 2.0 Port
Audio connections	Microphone jack, Headphone jack
Security	Biometric Fingerprint Sensor
Power	110V-240V AC Adapter compatible with Voltage in the United Kingdom
Battery Life	Up to 7 Hours Battery Life
Operating System	Windows Vista Business. Language upgrade available
Weight	500grammes

Accessories included

GPS Navigation.
AC Adapter
Port Replicator - 1 4-pin i.LINK® interface, 3 USB 2.0, Ethernet, VGA-Out, A/V-out and DC-in
Soft Carrying Case
Power Cord
Stylus
VGA/LAN Adapter - Ethernet, VGA-Out and A/V-Out
Strap, Detachable Stand, 2 Additional Stick Pointer Caps

Application Software

Data Acquisition	BARS standard software supports calibration of channels, sample rate, IEPE,AC/DC coupling, storage location, ASAM and other file exports allowing the BARS to be used a simple data recorder. The data can then be accessed by any post processing package supporting industry standard file formats e.g. ASAM, SDF, UFF, WAV...
Post processing using nVision	Optional post processing modules that provide all spectral and time domain DSP functions: - Spectrum, PSD, Cross Spectra, FRF, Coherence, Wavelet…
Displays	Graph (XY) Multiple (8) overlay, Bode Log Mag/Frequency, Colour Contour, Waterfall, multi channel time trace, overlay time, third octave with text readout...
Arithmetic functions	Add, sub, mult, divide, ave , record max and min values, calculate lin (rms) overall value. Calculate A,B,C,D and user defined overall level. Apply ABCD&U weight to data (both narrow and octave band) Multiple channels together and by a constant in time and frequency domains

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