

Orders v Time - Comparing Overall Levels

by Dr Colin Mercer, Technical Director, Prosig Ltd.

By combining a speed signal with a data signal and using the Short Time FFT algorithm (Hopping FFT), it is possible to extract order data directly as a function of time (Orders from Hopping FFT) rather than as a function of speed (Waterfall). This is very useful when analyzing a complete operational cycle which includes run ups, rundowns and periods at operational speeds.

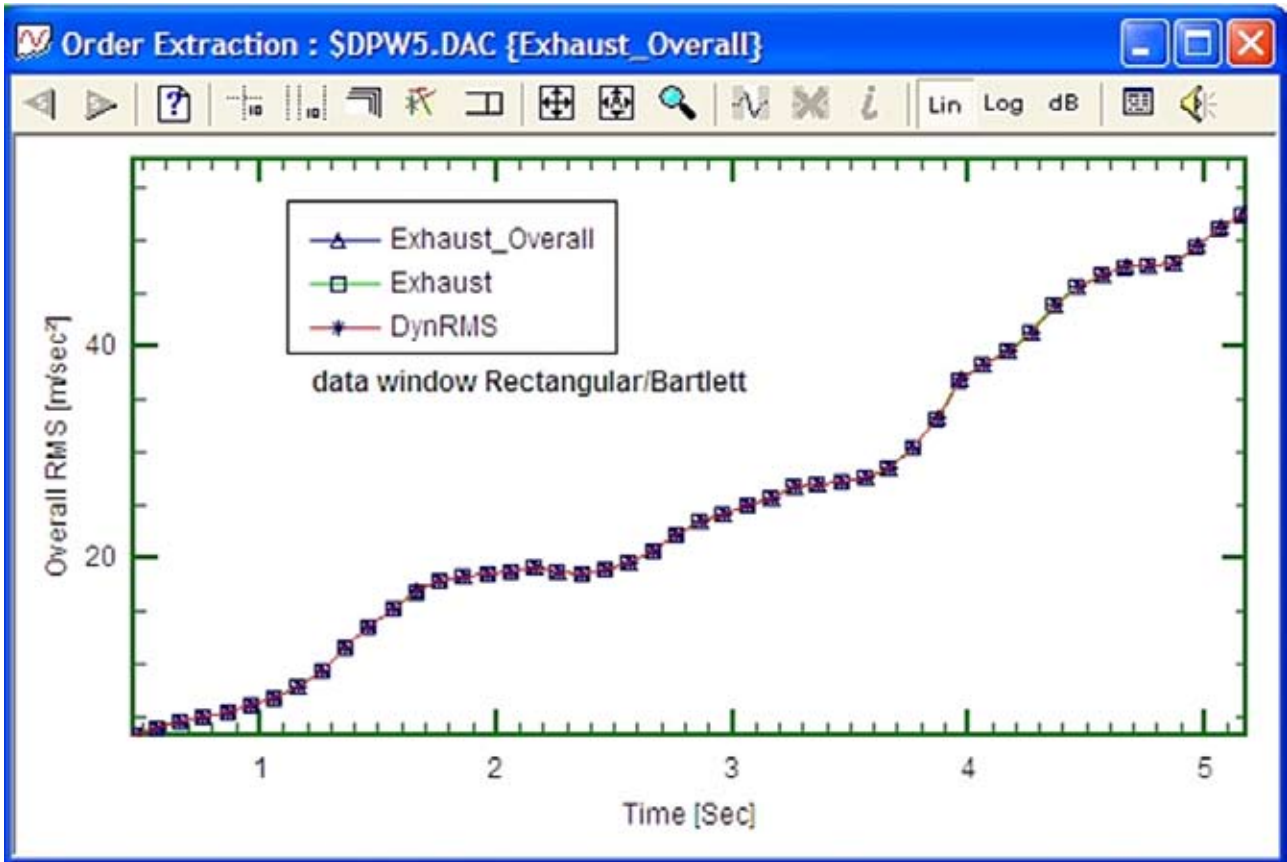


Figure 1: Using Rectangular/Bartlett window

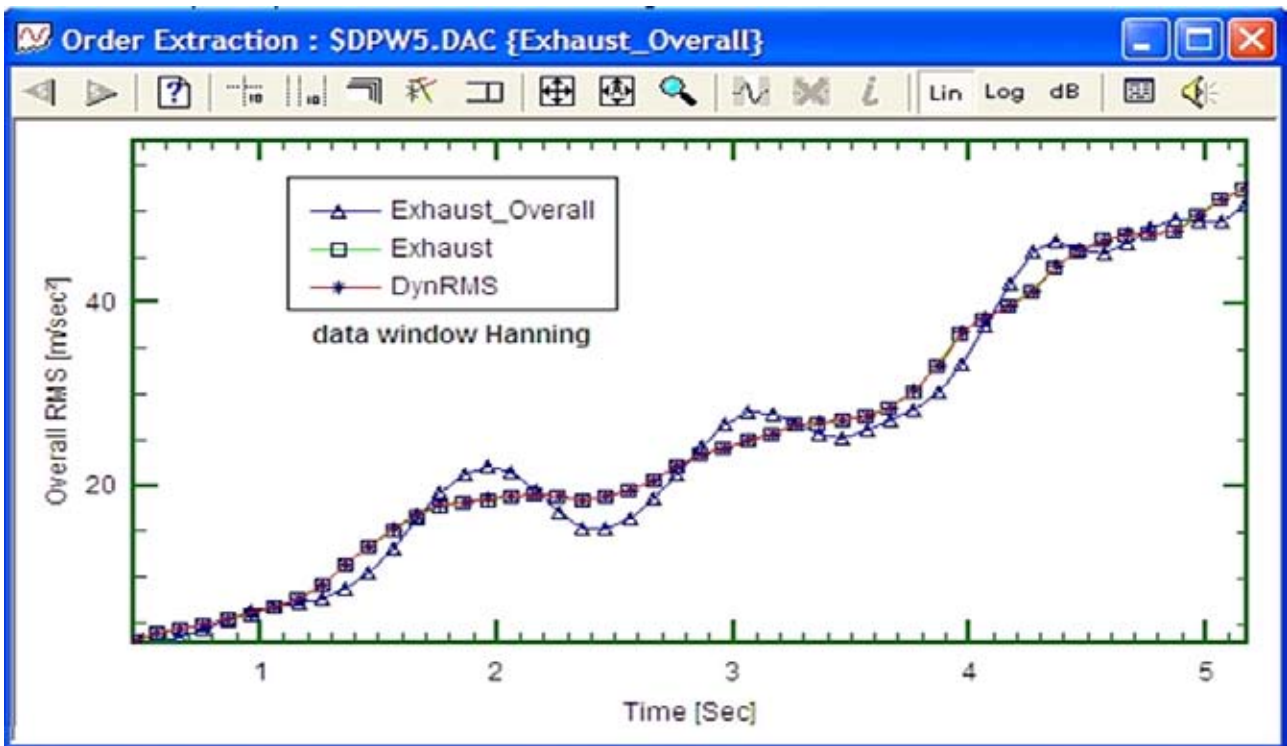


Figure 2: Using Hanning window

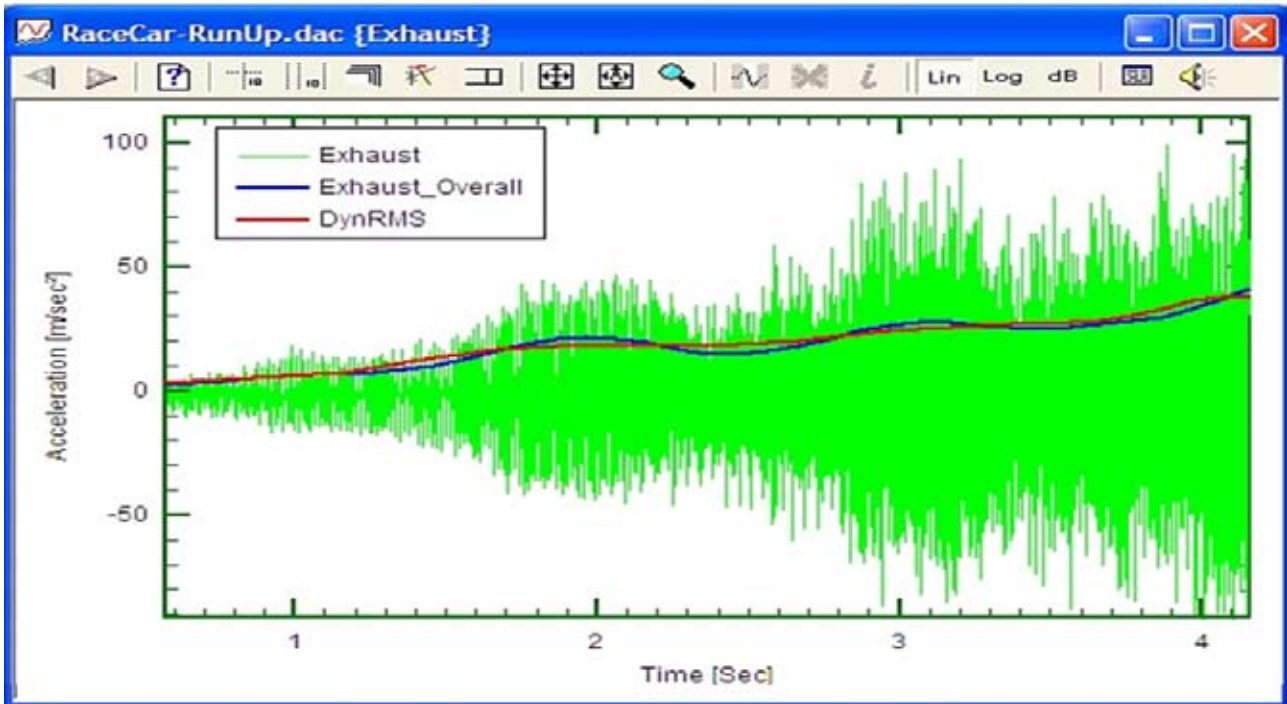


Figure 3: Over plotted on original time history

OVERALL LEVEL, DYNAMIC RMS & STANDARD DEVIATION

The overall level, the dynamic rms and the standard deviation are different commonly used names for the same quantity. They all imply that the mean or dc level of the time history has been ignored in the calculation. The overall level is typically used with acoustics and measures the dynamic part of the signal. In acoustics it is usually expressed in dB but with vibration then linear units are preferred. Dynamic Rms is a term used to indicate it only pertains to the vibration content. The standard deviation is a term used by statisticians to again signify using the fluctuating part of the signal.

As part of this process the Prosig DATS software calculates the overall signal level (rms) as a function of time. This is actually available in two forms: one as the overall level computed from frequency data; and secondly as the Dynamic Rms computed by the DATS FFTHOP module from each time slice. A third and independent method of evaluating the variation of the overall level with time is to use the trend module to compute the Standard Deviation.

In the example in Figure 1 all three measures give the same results but this is not always the case as shown later.

The example the Hoping FFT sequence in Figure 1 used a Rectangular data window but in Figure 2 we see exactly the same data with the

exception that the Hopping FFT sequence used a Hanning window.

The overall level now differs from the other two measures because it is calculated after the application of the data window. In this case the Hanning data window has emphasized the central section of each time slice, so that it is more "time centered". This is illustrated in Figure 3 by showing the measures when over plotted on the original time history.

The use of the data window helps to localise the phenomenon.

Dr Colin Mercer



Colin Mercer is the Technical Director of Prosig and has prime responsibility for signal processing and its applications. He was formerly at the Institute of Sound and Vibration research (ISVR), Southampton University where he founded the Data Analysis Centre. He is a Chartered Engineer and a Fellow of the British Computer Society.

Prosig Hardware & Software Used in This Tutorial

P8012 / P8020 Data Acquisition System



- **P8012 - 3 card chassis**
P8020 - 5 card chassis
- **Configurable channel options**
- **24-bit accuracy**
- **Up to 50k samples/sec/channel (24bit)**
Up to 400k samples/sec/channel (16bit)
- **Up to 20 analog channels plus tacho**
- **96dB dynamic range**
-120dB noise floor

The P8012 supports 12 high speed analog inputs plus one digital tacho. The P8020 supports up to 20 high speed analog inputs plus two tachos. Units can be stacked to expand the system up to 80 channels. Various input options are available. These include high speed analog, low speed analog, thermocouple, strain gage, high speed tacho, CAN and GPS. Each option is complete with programmable signal conditioning, which is controlled by the DATS™ software.

P8012 / P8020 systems

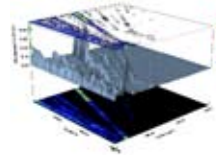
- | | |
|-------------------|--|
| 03-33-8012 | 12-channel (3 card) chassis. Includes <ul style="list-style-type: none">• P8012 chassis• PC to P8012 USB 2.0 communications cable• Mains power supply for P8012• In-vehicle power cable for P8012 |
| 03-33-8020 | 20-channel (5 card) chassis. Includes <ul style="list-style-type: none">• P8020 chassis• PC to P8020 USB 2.0 communications cable• Mains power supply for P8020• In-vehicle power cable for P8020 |

Select any combination of the following cards up to a maximum of 3 cards (P8012) or 5 cards (P8020)

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|----------------------|--|
| 03-33-8402-B | 4 high speed analog channels (BNC) * |
| 03-33-8404-L4 | 4 high speed analog channels with programmable excitation (4-pin Lemo) * |
| 03-33-8404-L6 | 4 high speed analog channels with programmable excitation (6-pin Lemo) * |
| 03-33-8408 | 8 thermocouple channels |
| 03-33-8409 | 8 analog channels |
| 03-33-8420 | 4-channel tacho/frequency card (BNC) |
| 03-33-8424 | 4-channel DAC |
| 03-33-8440 | Dual input CAN-bus/GPS card |

DATS™ Professional software (01-55-622)

- **Acquisition, analysis & reporting**
- **Wide range of analysis functions**
- **Automated processing through DATS Scripts**
- **Built-in Report Generator (Intaglio)**
- **Comprehensive QA features**

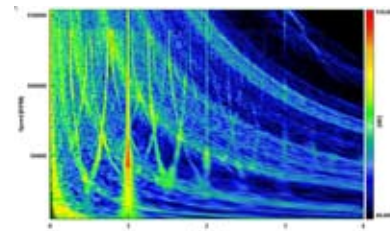


The DATS Professional software package contains all of the essential parts of the DATS software. It includes the data acquisition software for controlling the Prosig P5000/P8000 hardware and capturing data. The Professional package also provides all of the DATS analysis frameworks such as worksheets and scripting language. The Intaglio report generation facility is also included in the package.

DATS Professional Software

- | | |
|------------------|---|
| 01-55-622 | DATS Professional software. Includes Intaglio reporting suite, Macro & Script support and P5000/P8000 acquisition software. |
|------------------|---|

DATS™ Rotating Machinery Analysis Suite (01-55-802)



- **Waterfalls & order tracking**
- **Time sampled & angle sampled data**
- **Special analysis for angle sampled data**

The DATS Rotating Machinery option contains a complete set of tools for analyzing the sources of vibration and noise caused by cyclic forces such as those found in engines, gearboxes and wheel excitation. The software is designed to work with data sampled in both the time and angular domains.

DATS Rotating Machinery Analysis Suite

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| 01-55-802 | Rotating Machinery analysis suite (Requires 01-55-622 DATS Professional) |
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Visit <http://www.prosig.com/> for more details or to request a full catalogue. Or email your queries to sales@prosig.com.