DEWESoft®

CASE STUDIES

CONTENT

AUTOMOTIVE & TRANSPORTATION

AEROSPACE

CIVIL ENGINEERING

INDUSTRIAL

ENERGY

OTHER

"I am looking for a lot of men who have an infinite capacity to not know what can't be done."

-Henry Ford

AUTOMOTIVE & TRANSPORTATION


DEWESoft®
SIRIUS R2DB
SBOXe

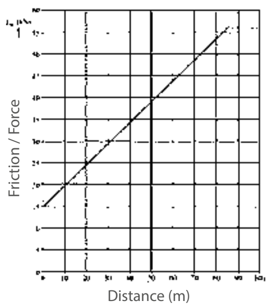
TRACTOR PULLING SPORT

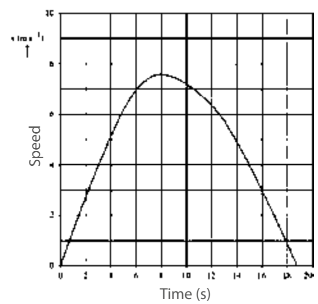
INTRODUCTION

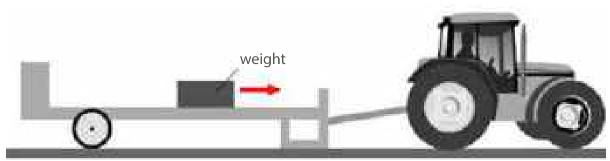
At which sport do you see the combination of C10H20…C15H28 (or CH3OH)+ 1000…8000 bhp + >100 dB on a short track of 100 meters? You are at a tractor pulling event where standard and modified tractors (running on diesel fuel or methanol) compete with each other in strength and over distance.

The sport originates in the 50's from the United States, where farmers battled with each other by pulling a weight over a certain distance. In 1977 the sport was introduced in Europe (The Netherlands) and is still growing in popularity all over Europe.

The rules are simple: pull a 28000 kg sled over a 100 m track. However the tricky part is, that the sled will dig itself, due to its weight, more and more into the soil as the distance progresses. This causes a higher and higher friction: thus more resistance to the tractor.







Sled (28 metric tons including weight) Tractor

SIGNALS AND SENSORS

TYPICAL 'STANDARD' CONFIGURATION NEEDED :

- 6 to 10 Pressure sensors (turbo(s), inlet, oil, water, gasoline)
- 6 to 16 Temperatures (one sensor per cylinder exhaust, oil)
- 2 to 6 Counters (wheel speeds, engine rpm, turbo rpm)
- Video (now post sync GoPro video)
- Math channels

EXPECTED FUTURE REQUESTS:

- GPS (at least 5 pt/sec as the run is only 10 seconds!)
- Combustion pressure (only for expert users)
- Vibration measurement
- Order tracking
- Alarms (indicator and output)
- Video camera that can withstand the huge shocks/ vibrations

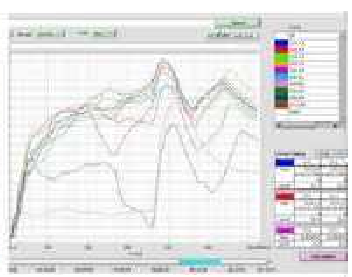
MEASUREMENT / ANALYSE

First tests were done with the Dewesoft MINITAUR system and a CAN-bus measuring unit for temperatures.

Experimental setup MINITAUR mounted under the drive shaft

MEASUREMENT HISTORY

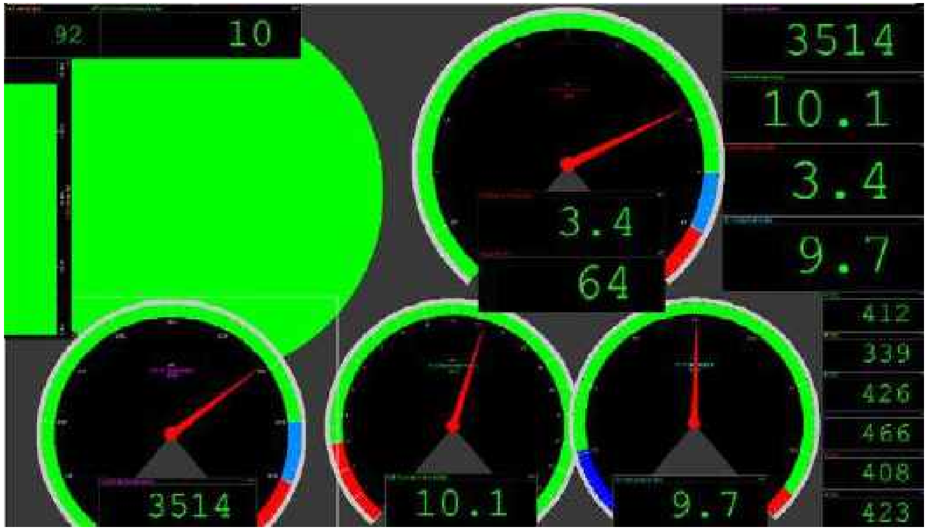
There are several classes in the Tractor Pulling Sport, from Light weight to Heavy Modified. All these Specials are unique and have an individual design based on an engine that could for instance be a tank engine or even a combination of multiple helicopter turbines. In the early years nothing was measured.



Over the last 10 years data loggers (5 to 10 pt/sec) were used for measurement, but this is not enough anymore.

Test of housing: SIRIUSi under the drive shaft

Location of the Dewesoft MINITAUR

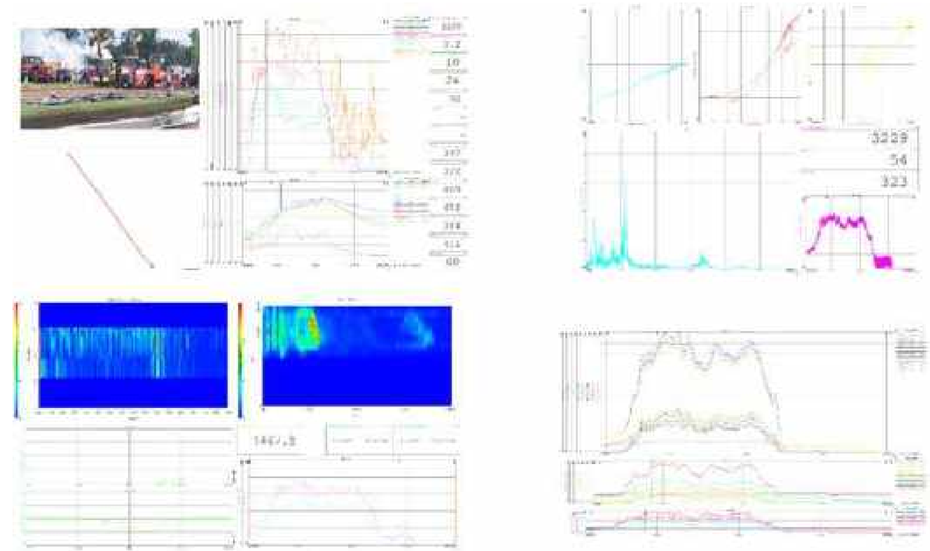


Driver view – Dewesoft driver dashboard

Data presentation

Driver view – see the Dewesoft display in the middle

Data presentation.



Post analysis of the run

CONCLUSION

By collecting data over a time span of just 1 minute (the race takes only 10 seconds) the high-speed data provides a lot of useful information to optimize the engine. Next to that, engine failures can already be detected in an early stage, which saves money and down time of the machine. The Dewesoft solution is compact, fast and has an easy to use configurable user interface. For the driver a simple interface can be configured with just some key information. After the run the experts can perform extensive offline analyses and create statistics.

IMPROVING FIELD TESTING

for a Global Farming Equipment Manufacturer

ABSTRACT

This application note shows how Dewesoft products provide an effective solution for multi-physics validation of farm tractors. The mobile measurement instruments and easy-to-setup software are used for online field monitoring and multi-physics data acquisition with more than 200 channels.

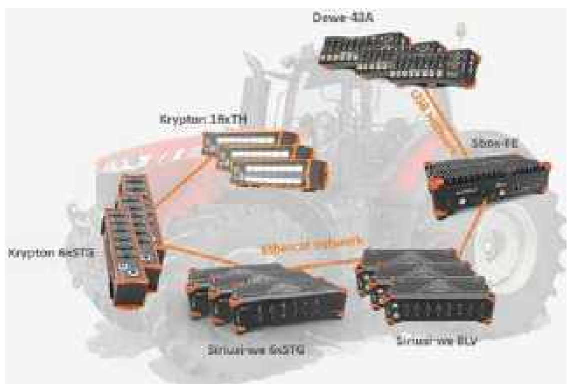
INTRODUCTION

The client, a large tractor manufacturer, is in the business of developing and producing farming machinery for the markets across the globe. With a multitude of use conditions for their machines all over the world, the engineering department needs more accurate multi-physics data for real field conditions as related to life profile specifications, numerical simulations and test bench input data.

To avoid multiple test campaigns, the client decided to simultaneously acquire multi-physics signals from over 200 channels using only one data acquisition system. If the tractor is far from the development plant, the client can access the machine for remote control and data transfer by GSM or Wifi connection.

MEASUREMENT SETUP

The data acquisition architecture is based on rugged IP67 measurement modules such as SIRIUSiwe and KRYPTON on EtherCAT® protocol (using one cable for data transfer, power supply and clock synchronization). It also involves versatile USB systems such as DEWE-43A. The EtherCAT® and USB networks work together and are managed by the SBOXfe control/storing unit.



DATA ACQUISITION SYSTEM

Dewesoft Modules	Function
KRYPTON 16xTH	Temperature
KRYPTON 6xSTG	Strain gauges and universal conditioning
SIRIUSiwe 6xSTG	High-speed strain gauges and universal conditioning
SIRIUSiwe 8xLV	High-speed voltage
DEWE-43A	Universal conditioning and CAN bus
SBOXfe with 10Hz GPS GNSS & Wifi receiver	Control unit and storing
EtherCAT® SYNC Junction	Clock synchronization

TYPE OF CHANNELS/SENSORS

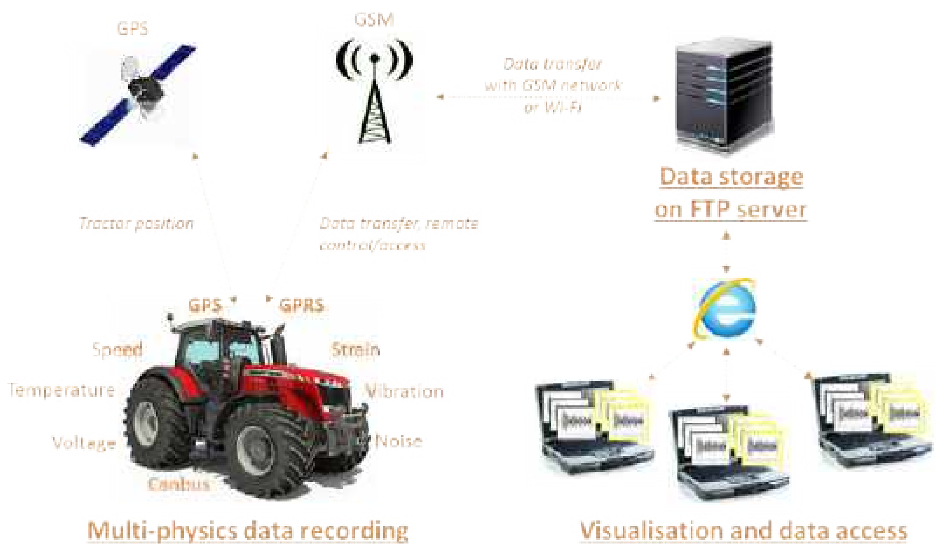
Type of channels	Applications
> 200 analog channels	Strain, hydraulic pressure, temperature, voltage, noise and vibration…
CAN bus channels	Engine, transmission, gearbox parameters…
Counters	Tachometer, rpm measurement
Video	Webcam monitoring

WIRELESS COMMUNICATION DEVICE

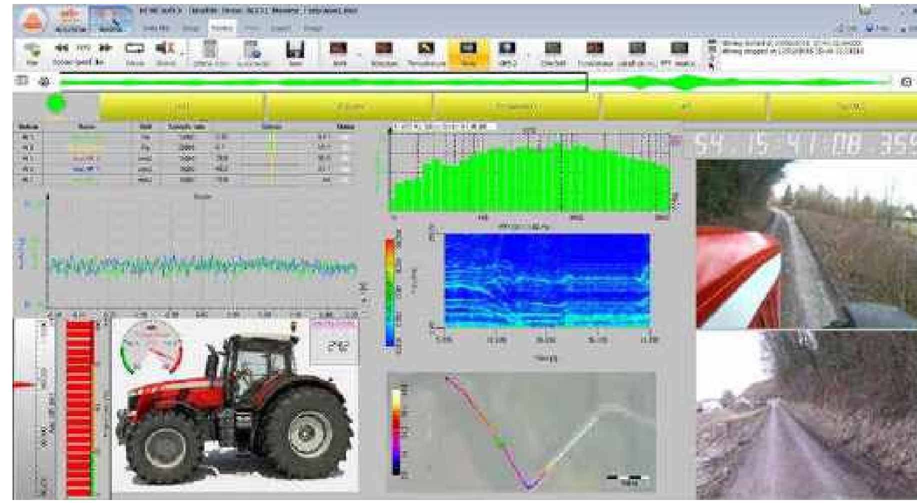
Any GSM 4G modem with USB or Ethernet port

SOFTWARE

Software	Function
Dewesoft X2	Data acquisition setup and post-processing
DSA dynamic signal analysis Plugin	Noise and vibration analysis
ODE online data export plugin	Export selective data online from a Dewesoft measurement in progress
Data Manager plugin	Copy and store Dewesoft files automatically on FTP server or local drive
Any windows sharing desktop software	For internet remote control/access to SBOX control unit
Big data search engine (optional)	Data search on request parameters



The measurement screen below is an example of Dewesoft X2 software capabilities to easily set up several different kinds of analysis representation: time signal, frequency spectrum, CAN bus parameters, level meter, GPS track (coloured channels and map overlay) and video synchronisation.



ANALYSIS

With simple GSM/internet connection, the user can access Dewesoft control units inside the vehicle for monitoring or selecting data to transfer.

KEY FEATURES:

- Time data recording and post-processing (statistics, filters, maths functions…)
- Extensive trigger features for the start/stop of the measurement
- Export in multiple file formats or video, custom reports
- Selective data transfer during acquisition
- Simple access/remote control with desktop software
- Data management

CONCLUSION

This off-road measurement configuration permitted the customer to combine different kinds of measurements with the same rugged data acquisition system. With various displays and calculations, the user was able to analyse multi-physics phenoma for any internal engineering clients or to export data in an appropriate file format for third-party post-processing software.

Based on Windows platform, the Dewesoft control unit was able to communicate/interface with a common GSM modem. With appropriate software solutions such as Dewesoft plugins and other Windows software, data were sent from the machine to the customer over large distances with possibility to view the vehicle on the road in real time through an onboard webcam

TRACTOR BRAKE TEST

ABSTRACT

This application note shows how Dewesoft products provide an effective solution for a quick validation of braking parameters in the field. The mobile measurement instruments and the easy-to-setup software are used for checking braking parameters according to regulations. At the same time similar solution is providing testing tool in case of troubles in future.

INTRODUCTION

The client, a huge tractor manufacturer in Austria, is developing and producing farming machinery including tractors for worldwide market. With increasing performance of the tractors (higher velocity) and new regulations every tractor has to pass brake test in order to pass the homologation test.

The regulation at the moment is quite basic, in comparison to automotive regulations, because the tractor has to drive either with 40 km/h or 50 km/h (depends on the HP of the engine) and brake to 0 km/h, within certain distance and achieving certain MFDD factor. At the same time also braking force is a key factor on successfully passing brake test. It does not include measurement of the temperature of brake lines and several cycles of braking.

MEASUREMENT SETUP

DATA ACQUISITION SYSTEM

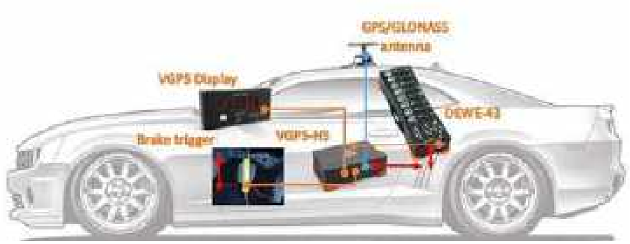
- DEWE-43 (8 analog, 8 digital and 2 CAN inputs)
- VGPS-HS (100 Hz GNSS receiver with support of GPS/GLONASS)

SENSORS

- Entron force transducer with range of 2500 N
- DEWE-Brake trigger

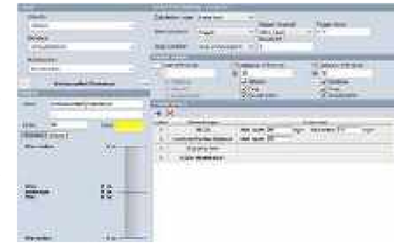
SOFTWARE

- Dewesoft X2
  Brake test plugin



BRAKE TEST SETUP

In brake test plugin, we have choose a proper start/stop condition. Which was in our case the signal coming from the brake trigger and stop of the movement with a threshold value of 1 km/h. Since the tractor was “only” 140 HP, the brake test was performed at 40 km/h. So MFDD, brake distance, stopping time and brake deceleration was calculated for this conditions.

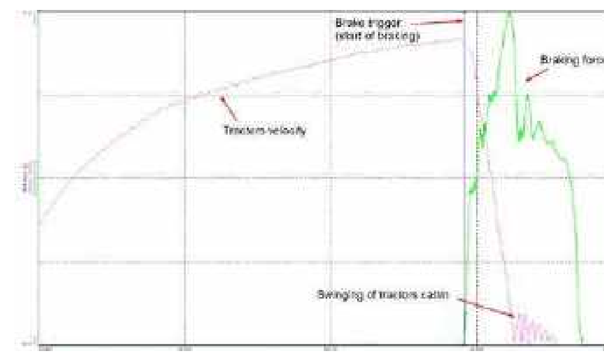


ANALYSIS

The display was created for easier online indication to the driver if the test is valid or not. Therefore all the parameters (MFDD, Brake distance, Start speed, ...) were compared to regulation conditions with the help of math channels.

ANALYSIS SCREEN

Testing engineers were of course interested in more details, therefore curves like dynamic braking force and velocity are very important for them.



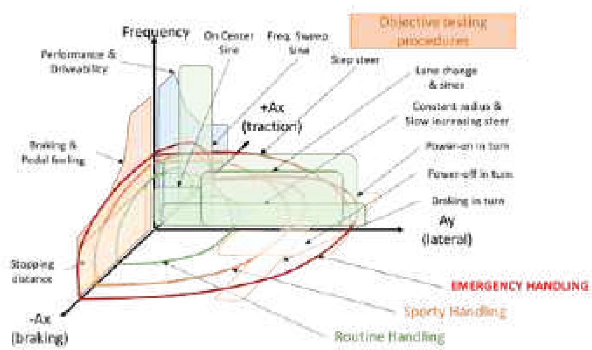
CONCLUSION

The measurement of this particular model of the tractor has been successful and tractor has passed internal check of regulation. The most interesting parameter for customer was velocity, where they were able to see the swinging of the cabin, which goes up to 5 km/h and will help them at future development of stiffness of the suspension. The whole measurement including setup of the tractor took 3 h (including soldering the connectors of special sensors provided by customer and comparison tests).

ABSTRACT

This application note shows how Dewesoft products may provide effective solutions for vehicle dynamics testing, offering an answer to technical requirements as well as to the increasing demand of effectiveness of the testing process. These goals can be achieved by Dewesoft hardware and software features. Furthermore, by the combination of global variables, test cases and sequences, display and math setups, it is possible to build a customized test environment to manage tests, support the driver during the execution, and to validate each test run.

INTRODUCTION



Objective vehicle dynamics testing has a key role in the development and assessment of a new vehicle. Testing activity is performed:

- Benchmarking and target setting
- Development
- Verification and validation

Objective testing are used more and more to correlate simulation model to the physical objects, which is a key factor to improve the accuracy of virtual prototyping.

For all these tasks it is very important to have reliable and accurate test results, in order to avoid mistakes in the design, development or (even worse) target setting process. The application of ISO standards and robust legacy test procedures are good practices for the implementation of a reliable testing process. Each car maker or system supplier has its own procedures, which are the result of technical memory and specific know-how. Nevertheless, ISO standards are a widely accepted common basis of knowledge and recommendations, which are essential to get good test results. They also provide a "minimal" set of test maneuvers to cover the main aspects of vehicle behavior on lateral, longitudinal and cross-coupled (combined) dynamics, as shown in the picture above.

From each test type, vehicle dynamics engineers get a number of performance metrics, which allow making an objective picture of the vehicle's behavior under different testing conditions. Another key factor for test efficiency and reliability is the implementation of a test automation and validation system, which is in the object of this application note.

GENERAL REQUIREMENTS (ISO 15037)

TYPICAL STANDARD AND CUSTOM TESTS
- Constant radius (ISO 4138)
- Slow increasing steer (ECE 13H)
- Step steer (ISO 7401)
- Frequency sweep sine (ISO 7401)
- On center sine (ISO 13674-1)
- Power on / power off reaction in a turn
- Lane change (ISO 3888, VDA, ADAC, ...)
- ABS or Emergency braking (ISO 21994)
- Low speed handling (parking)
- ...

PERFORMANCE EVALUATION ITEMS
- Under/oversteering
- Body motion, rail, pitch
- Transient response
- Steering effort
- On center feeling
- Agility vs. stability
- Trajectory
- Path deviation
- Stopping distance
- Turning diameter
- ...

MEASUREMENT SETUP

DATA ACQUISITION SYSTEM Typical test setup for vehicle dynamics
- SIRIUS or
- DEWE-43 or
- any HW compatible with DS-IMU2

• SENSORS
- DS-IMU2 (on CAN port)
- IMU from a competitor brand (on Analog Input)
- Optical speed and sideslip angle sensor (on Analog Input)
- Measurement steering wheel (on Analog Input)

SOFTWARE
- Dewesoft X2
  DS-IMU2 plugin
  Math channels
  Sequencer – Test cases
  Display and math setup

ANALYSIS

TECHNICAL REQUIREMENTS

Getting reliable objective metrics is a matter of proper application of testing procedures, high quality sensors and measurement system, a good driver, able to actuate commands almost like a robot in open loop test maneuvers, as well as correct signal processing and data analysis. The table below summarizes the main measurement issues, mainly related to sensor and measurement system accuracy, and the main items for a proper signal processing, taking into account filters, sensor position effects, and sensors-vehicle-road inclination effects

Typical measurement issues
- Slip angle accuracy (noise, drift, sensor position)
- Roll and pitch accuracy (drift)
- High dynamics
- Synchronization
- Narrow range accuracy
- Wide range accuracy
- GPS + IMU resolution & accuracy

General Requirements (ISO 15037)
Sensors and recorder accuracy, data acquisition, filtering, post processing

Compensation of sensor position for slip angle and velocity:
- Translation from the measurement point to the reference point (COG)

Compensation of sensor position for acceleration:
- Translation from the measurement point to the reference point (COG)

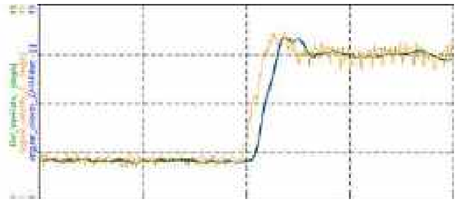
Compensation of gravitational effect (inclination):
- G-component due to body roll and pitch
- G-component due to ground inclination (roll and pitch)

These items will be shown taking some data files as case study, related to a benchmark test of DS-IMU2 vs. a competitor's IMU performed by the company in Italy International at the proving ground of one of its Italian customers.

FILTERING AND SYNCHRONIZATION

The first point is to manage different data sources: AI channels pass through anti-aliasing filters, so it is not possible to compare directly the competitor's IMU signals vs. the DSIMU2. It is possible to apply similar filters to the digital channels from DS-IMU2, in order to have the same gain and phase shift as the AI. The result is shown below for the channel "yaw rate", which does not require any further compensation.

Then the channels from the optical sensor are translated forward in time to compensate the delay of the internal filter (64ms in this case).



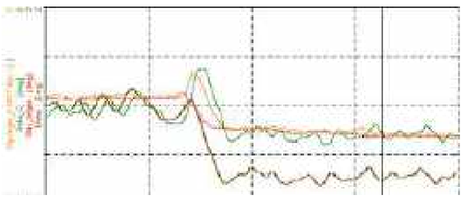
- Ref_YawRate: yaw rate from the competitor (reference) IMU on AI with anti-alias filter
- Angular_velocity_Z: yaw rate from the DS-IMU2 "as it is"!
- Angular_velocity_Z/IIRFilter: yaw rate from the DS-IMU2, filtered with a Dewesoft math filter

TRANSLATION OF SPEED AND SIDESLIP ANGLE

The second step is to translate the slip angle from DS-IMU2 and from the optical sensor to the same evaluation point.

After being translated forward, the channels from the optical sensor are synchronous with the other AI's, in particular with the output of the IMU. Then the slip angle and the velocity are translated from the sensor location to the evaluation point, using the angular rates from the IMU.

DS-IMU2 data were translated to the same evaluation point using angular rates from the DS-IMU2 itself, without need to synchronize them with each other. The result is shown in the picture on the right.



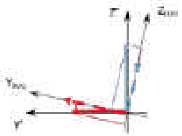
- Beta: sideslip angle from the optical sensor
- Slip_angle: sideslip angle from the DS-IMU2
- Beta_C: sideslip angle from the optical sensor shifted in time and Compensated
- (sensor position effect), i.e. translated to the evaluation point
- Slip_Angle_C/IIRFilter: sideslip angle from DS-IMU2 Compensated and filtered

COMPENSATION OF THE INCLINATION (GRAVITATIONAL) EFFECT

Finally, the the compensation of gravitational effect due to overall roll and pitch inclination is considered. In general, the problem has to be managed by the rotation matrix, which defines the orientation of the IMU relative to the earth coordinate frame or to the ground. Yet, we can keep things simple if we assume to drive on a flat horizontal surface, and with small roll and pitch angles (due only to the motion of the vehicle's body). In case of lateral dynamic, we consider the compensation on Ay on a horizontal plane related to the Roll angle:

Ay_IMU = Ay_HOR*cos(Roll) + g*sin(Roll)

Az_IMU = -Ay_HOR*sin(Roll) + g*cos(Roll)



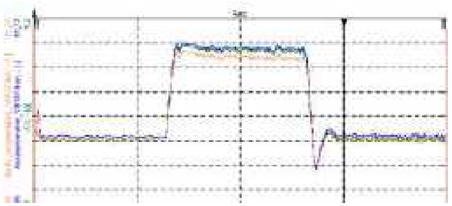
Here we are assuming an ISO based reference system, with the X axis aligned to the mid axis of the vehicle pointing forward, the Y axis pointing to the left and the Z axis pointing upward. The IMU axis rotates with the vehicle axis. The X' (not shown) Y' and Z' axis follow only the vehicle rotation on the ground (horizontal) plane, but Z' always points upwards and X' and Y' keeps on the horizontal plane. Roll angle lies between the Y_IMU and Y' axis, equal to the angle between Z_IMU and Z' axis.

The DS-IMU2 provides both the raw Ay and the "true" Ay, i.e. the lateral acceleration observed on the IMU Y axis and on the horizontal plane. Otherwise, the compensation can be calculated:

ΔAy_g_roll = g * sin(Roll) ≈ g * Roll (1st order approximation for small roll angle), with Roll in [rad]

In practice, given a vehicle with a 4 deg/g roll stiffness, the amount of this compensation over the steady state lateral acceleration is about 7%. Notice that for passive chassis (i.e. roll angle on the opposite side of the curve radius) it is always negative, i.e. lateral acceleration on the horizontal plane is less than the acceleration sensed on the IMU Y axis. This is due to the fact that the accelerometer senses a component of lateral acceleration plus a component of g acceleration.

Notice that the units are not the same: the DS-IMU2 output acceleration in [m/s2], while the output from the other IMU is in [g].



- AY: Lateral acceleration from the competitor (reference) IMU on AI with anti alias filter
- Accelerometer_Y/IIRFilter: lateral acceleration along IMU axis from DS-IMU2, filtered with a Dewesoft math filter
- Body_acceleration_Y/IIRFilter: lateral acceleration along Y' axis (parallel to horizon) from DS-IMU2, filtered with a Dewesoft math filter

TEST AUTOMATION AND VALIDATION

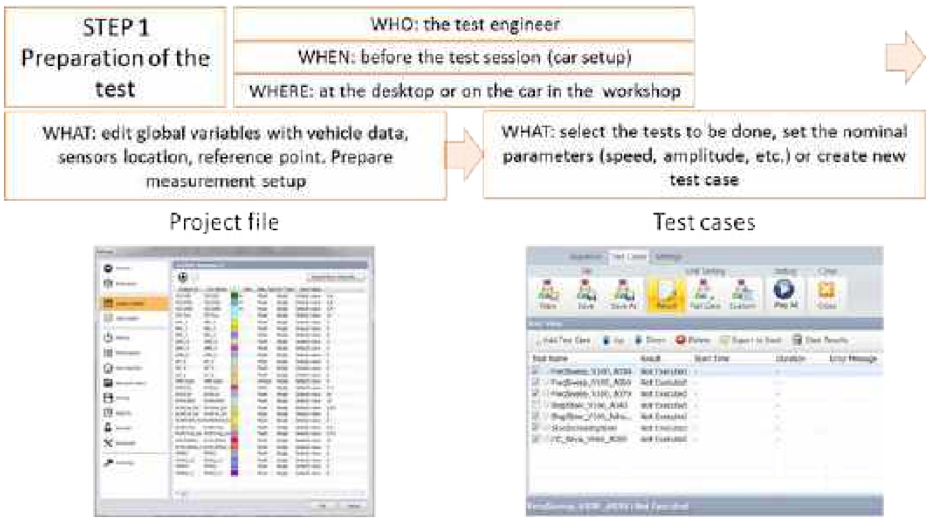
A test automation and validation tool is expected to deliver several key benefits both in the phase of preparation of the tests and in the phase of actual execution of the test maneuvers on the track. The final goal for a testing department is to implement a more efficient and more reliable test process, which definitely may lead to better test results with less effort. Here are some basic features of a vehicle dynamics test tool:

- Provide info to the driver about what to do, e.g. nominal test parameters (speed,frequency, etc.)
- Provide info to the driver about what he is doing, e.g. actual speed vs. nominal speed.
- Implement calculations to perform test validity check
- Provide feedback to the driver about what was right or wrong in the test execution
- Provide feedback to the driver about what to do next, e.g. to repeat a test run or to switch to a different kind of test
- Implement calculations to get a preview of performance metrics on board, e.g. stopping distance, step response, etc.

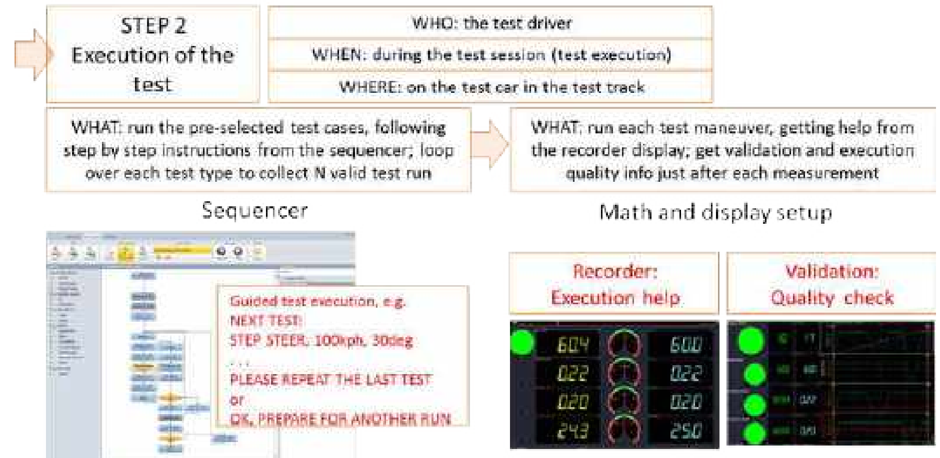
The two steps, i.e. preparation and execution of the tests, are described by the pictures below.

The prepration phase in Dewesoft relies mainly on the project environment, where some suitable global variables are defined in order to store some key parameters related to vehicle properties and sensor setup.

A number of predefined test cases may be enabled or disabled by the test engineer, according to the required test protocol. Furthermore, it is possible to add new test cases to cover new kind of tests. Each test case references a sequence, which manages the test parameters and counters and provides instruction to the driver about what to do, step by step.



On the car, during the execution of the tests, the driver will see the messages coming from the sequencer and the meters or other visual controls defined in a test setup. Each sequence deals with a given test setup, which holds specific math channels to calculate parameters or metrics needed for the validation of the test execution vs. nominal conditions, e.g. speed, steering frequency, steering amplitude, etc. The sequence will provide information to the driver about how many valid tests he performed and when he can switch to another type of test.



CONCLUSION

In the first part of this note, some basic features that may help in day-by-day vehicle dynamics testing activity were highlighted. These items provide an answer to the main technical requirements asked by ISO test standards for vehicle dynamics:

- The use of Dewesoft filters and delay channel math to compare data from different sensors and sources (AI vs. CAN/plugin)
- The use of basic math formulas to compensate the offset effect (i.e. location effect) of speed sensors and acceleration sensors
- How to deal with issues related to body and/or road inclination in acceleration measurements with DS-IMU2 and math channels

Finally, a test automation solution was introduced, conceived to actively support the driver during the execution of a predefined test session, including validation check of each test run. This solution is based on test cases, sequences and specific math setups, and it is expected to improve the effectiveness of vehicle dynamics testing at a noticeable degree.

VEHICLE DYNAMICS USING DEWESOFT (VTS)

INTRODUCTION

In recent years, virtual analysis tools have become more and more powerful and predictive, allowing to speed-up of the development process, and to manage the increasing complexity in vehicle systems.

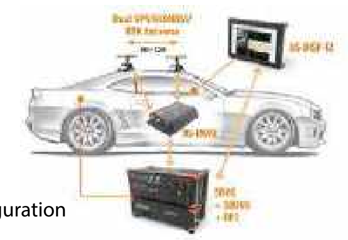
Nevertheless, the amount of testing activity is all but decreasing, due to several reasons.

• Detailed simulation models require an accurate validation, based on reliable experimental data

• The refinement of some vehicle attributes still needs the "human touch", delivered by subjective and objective test and development on physical prototypes

• The development and validation of advanced driving functions (ADAS, autonomous driving) still requires extensive real world test

In this context, in an extremely competitive global market, the testing process must be extremely efficient, time- and cost-effective.



• Overall quality of the measurement

• Compliance and reproducibility of the test execution

• Data accuracy: sensors and acquisition system

• Cost efficiency

• Preparation time: easy vehicle sensor setup and DAQ system configuration

• Actual test time: optimize the use of the time spent on the test track or on a test rig

VEHICLE DYNAMICS PLUGIN

Dewesoft Vehicle dynamics plugin is designed to carry on the pre-processing of the raw signals in accordance with the requirements of ISO standards for vehicle dynamics objective data analysis.

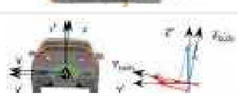
All the settings can be managed in Dewesoft setup. Main features:

• Management of coordinate system

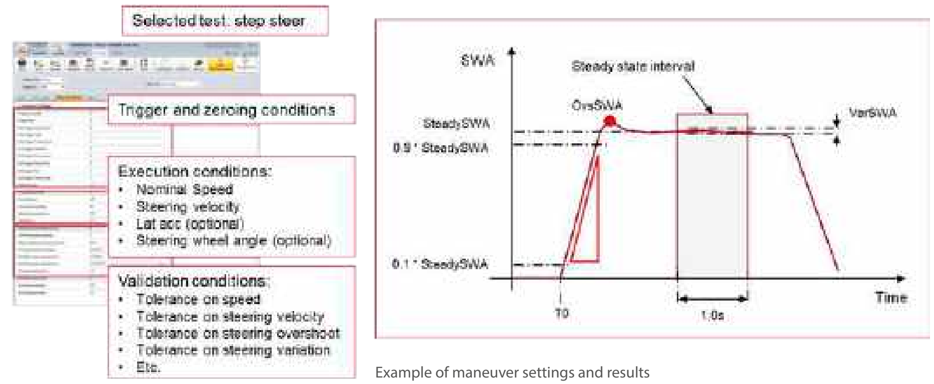
• Filters

• Compensation of sensor position effect

• Compensation of g-force effect

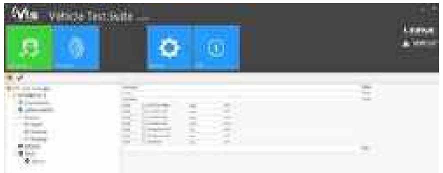
Coordinate System	Given the input channels, the output channels are calculated in the desired coordinate system.	
Filter and synchronization	Input channels are filtered according to ISO 15037-1 / -2 or ECE 13H. Known sensor delays are compensated.	
Compensation of the sensor position effect	Given the sensors location, the DS-VD plugin calculates speed and acceleration at the desired reference point.	
Compensation of the gravity effect	DS-VD plugin calculates roll and pitch angle and compensates the effect of the g-force, if the input acceleration is not in the horizontal plane.	

It also provides a catalog of test maneuvers for objective assessment of vehicle dynamics behaviour, based on ISO standards: for each kind of test, validation criteria and other objective parameters are calculated and made available as calculated channels in the measurement files.



Example of maneuver settings and results

VEHICLE TEST SUITE


Session data management: vehicle data, sensors data, etc.

LEANE VTS: VEHICLE TEST SUITE

To achieve the highest productivity on the test track with DS Vehicle Dynamics plugin, Leane international developed the application VTS

• An easy to use driver interface for Dewesoft systems

• Support for Dewesoft Vehicle Dynamics plugin

• Management of vehicle data and sensor coordinates data

• International standards or custom test procedures

• Dewesoft integrated in the VTS measurement panel

• Quick look display of the main parameters and execution check

• Automatic test file naming and storing in a custom folder structure

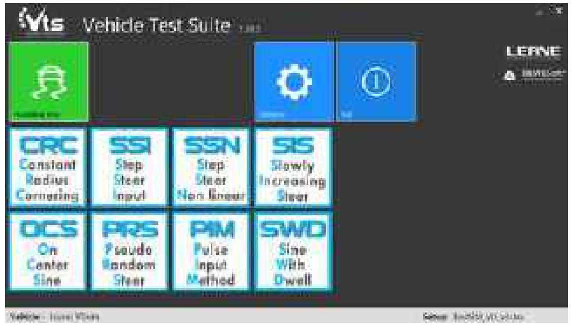
• Data overlay and statistics from multiple test runs

• Test report capability

• Modular architecture for easy extension and further customization

The Leane VTS application manages the configuration parameters of each type of test:

- Info: basic information about the test
- Measurement: sample rate, Dewesoft screen ID and other measurement settings
- Trigger conditions
- Execution conditions, e.g. the nominal speed or steer frequency, and their typical or allowed values.
- Validation condition: validation parameters and their thresholds used in the validation check



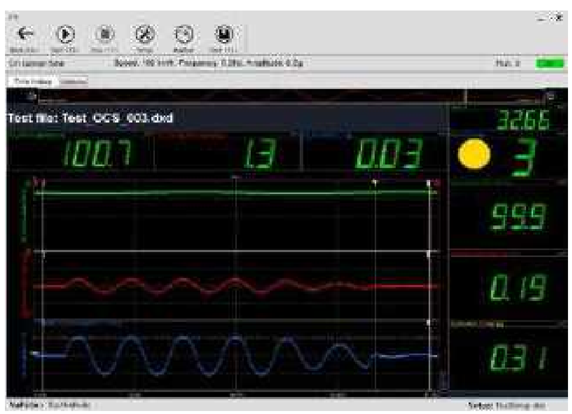
The user can edit and store the default configuration of each type of test, including pre-defined values of the execution parameters and the threshold for the validation parameters.

The test driver needs just to select the test session and the test maneuver to be performed.

Then VTS suggests the pre-defined values to the test driver, who can select these values from the measurement panel according to the test plan, with no need to open the Dewesoft setup: one touch is enough, as VTS set everything in the Vehicle Dynamics plugin via DCOM interface.

All the main functions are available with just a single touch:

- Start / stop storing
- Test setup
- Test analysis
- Save / cancel the test file



Test type	Ref. standard
Steady state cornering	ISO 4138
Step steer input	ISO 7401
Step steer non linear	Based on ISO 7401
On center sinus steer	ISO 13674-1
Pseudo Random Steer	ISO 7401 / ISO TR-8726
Pulse Input Method	ISO 17288-2
Slowly increasing steer	ECE 13H
Sine with dwell	ECE 13H
More test manoeuvers under development	

CONCLUSION

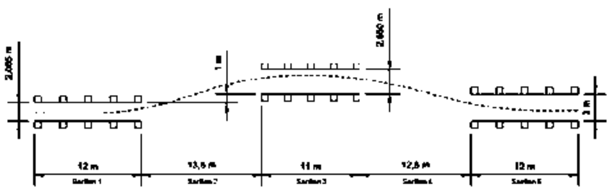
The new Vehicle Dynamics plugin is now available in Dewesoft to manage all the essential tasks related to objective vehicle dynamics testing, according to the main international standards.

The application VTS by Leane allows to achieve the highest productivity with VDplugin, thanks to an easy to use customizable user interface that provide the user with seamless access to the plugin settings and the results.

ISO LANE-CHANGE TEST

ABSTRACT

This application note shows how Dewesoft products provide an effective and flexible solution for a quick validation and measurement of ISO Lane-change test (ISO 3888). The mobile measurement instruments and the easy-to-setup software are used for checking and visualization of measured parameters to guide the driver through the measurement and check the results online.



INTRODUCTION

The client, a car manufacturer in Italy, designing, testing and manufacturing different vehicles including cars asked for help at shorting time of testing and improving quality of results at vehicle dynamic maneuvers, which includes online check of results and gives direct feedback to the driver either if the test was successful or they have to repeat it.

One of such maneuvers is the double lane-change maneuver, which is used worldwide to evaluate handling and safety of vehicles and their key components. Therefore various parameters are being checked by the test engineer, but for a driver it's crucial, to have an online check if the test has passed or failed (cones were hit or not). Tested with pure GNSS device and combination of GNSS with AHRS, to compare results.

MEASUREMENT SETUP

DATA ACQUISITION SYSTEM

- DEWE-43

SENSORS

- DS-IMU2 (inertial meas unit) with RTK -->1 cm accuracy
- DS-RTK-BASE (GPS based unit) to provide RTK accuracy for vehicle

SOFTWARE

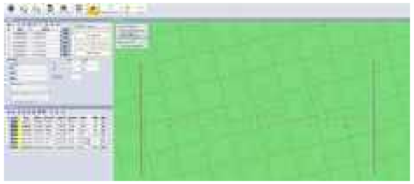
- Dewesoft X2
  Polygon
  Special Lane change setup

POLYGON SETUP

Polygon objects (fixed and moving cones) have been set up according to the ISO 3888 standard. The advantage of using moving cones, is that the driver can quickly change the car and edit vehicles length/width. With having those parameters, the configuration of the maneuver is changed according to the standard (width of the track,..).

Several additional calculations have been added to evaluate different parameters (like velocity, roll,..) versus distance on the track, which is shown in results.

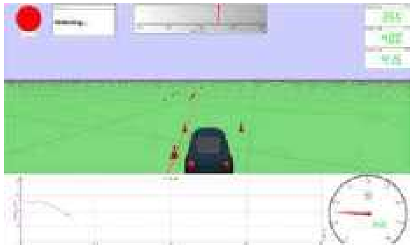
By having certain lines as Start and Stop trigger, it is possible to reduce the file size and capture only the points of interest.



ANALYSIS

MEASUREMENT SCREEN COMBINED TOGETHER WITH ANALYSIS FOR ONLINE CHECKING

The display below is included in a Lane Change setup. It shows online validation of the data, so the driver has direct feedback if the test has passed or failed, which is located in top left of the screen. The 2D display shows the graph of velocity during the track (Velocity/PosX on the track). At the same time it's also possible to display the graph of PosY/PosX, to see the lane change maneuver.



In addition we were measuring the vehicle CAN bus to have information of RPM, steering angle and other vital analysis parameters.

CONCLUSION

The measurement with DS-IMU2 with 1 cm RTK upgrade has shown very accurate position (centimeter level) and 3-axis velocity results. Due to this it can be used for regulation and going even further due to inertial platform it can be used also for research and development, where additional parameters as Roll, Angular velocity in Z-axis and Ay for evaluation of vehicle handling are needed.

After teaching the drivers and performing several tests, with different cars, time of testing, in comparison with setting manual cones and measure complete track every time, has been reduced for at least 30%, which is a great improvement.

AEB TEST

INTRODUCTION

Our customer, a new manufacturer of Electric Vehicles, wants to validate the performance of ADAS functions of their products.

We did the AEB test according to the GB/T 33577-2017 standard. We did the tests below due to time and test field.

- Record the AEB's commands via CAN & video and display them live during testing
- Constantly measure the distance between subject Vehicle and the target vehicle
- Stationary POV test. This test evaluates the ability of the FCW function to detect a stopped lead vehicle. In order to pass the test, the FCW alert must be issued when the time-to-collision (TTC) is at least 2.1 seconds.

MEASUREMENT SETUP

DATA ACQUISITION SYSTEM

- DEWE-43-A

- R2DB (works as RTK station)

SENSORS AND TRANSDUCERS

- DS-VGPS-HSC
- DS-IMU2
- DS-WIFI2
- Logitec C920 cameras (3x)

SOFTWARE

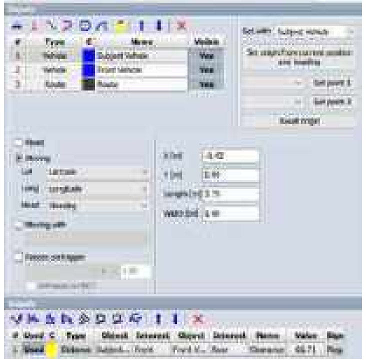
- Dewesoft X2 SP10
  Polygon plugin

Subject Vehicle with DS-IMU2

Front Vehicle with DS-VGPS-HSC

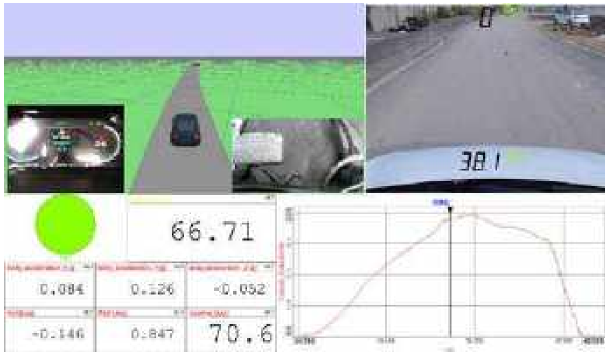
AEB TEST SETUP

We need to setup CAN, video, DS-IMU2 and DS-VGPS-HSC in Dewesoft. We also need to configure the Subject vehicle, the Front vehicle and the route in the Polygon plugin. Clearance and TTC can be calculated by polygon and math function.

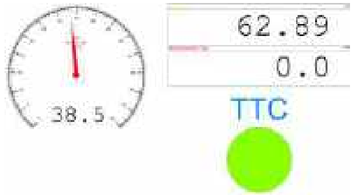


MEASUREMENT/ANALYSIS

When the customer did the test, he could see important parameters (velocity, clearance, TTC and so on) online clearly.



When the customer finished the test, he was able to see more details. Everything is recorded synchronously.



CONCLUSION

The whole measurement took less than one day. We installed all the devices and sensors in the morning. The real tests were performed in the afternoon. The customer's Electric Vehicle could pass the test, but we couldn't get all AEB data from the CAN port, because the manufacturer doesn't output all parameters. The customer is satisfied with fast installation, easy setup and powerful online data processing.

TRUCK GSO HOOD TEST

INTRODUCTION

A long-time customer of Dewesoft located in Greensboro, North Carolina. They are the Research and Development Center in the US for some well known Truck brands. A leading group there is the Durability and Reliability team which conduct on Track and MTS Rig testing.

Field issues on the Hoods of some trucks had an issue with cracking in the Grill frame. The issue was determined to be to the grill diagonalization. This resulted in visible cracking and damage to test articles. Dewesoft SIRIUS system was used for in vehicle and MTS rig testing on potential solutions.

MEASUREMENT/ANALYSIS

After the Track data was collected and analysed it was export from Dewesoft to the MTS Flex test control systems as a profile was created to focus on specific events to re-create the proper Unit failure conditions.

The Dewesoft SIRIUS system was used to provide additional signal conditioning to the MTS Flex test controller for the Rig testing of new revisions of the hood. This allows the same signal conditioning and A/D's to be used to collect the data on the track as in the Rig test configuration.

MEASUREMENT SETUP

ON TRACK TESTING

DATA ACQUISITION SYSTEM

- SBOX with
  4 x SIRIUSi-8xSTG-L2B10F
  with Analog Output option

SENSORS

- Silicon Design Accelerometers

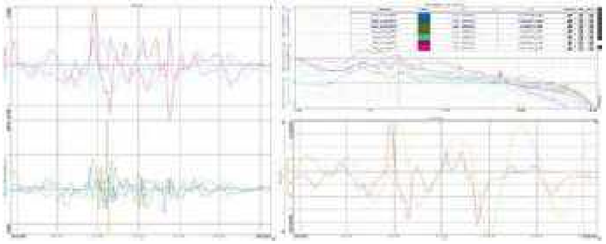
Dewesoft SIRIUS system in Passage floor

Rear side of SIRIUS System

SIRIUS systems were mounted in the passage seat foot position. Then measured numerous sensors around the front end of the vehicle. Then the truck was taken out on the customers test track to experience the custom-made events to simulate field condition. Dewesoft recorded all the data on board the SBOX computer module while on the track.

ANALYSIS

Using Dewesoft for quick visualization of the data to confirm good data. The data was then exported to the MTS software for the Rig collection. Then from there third-party software was used for detailed analysis to derive a final design change.



CONCLUSION

After extensive on-vehicle track testing and MTS rig testing the customer was able to redesign the hood structure to allow for this new grill shape. It was determined that a thicker material in certain areas would allow counter the new vibration profile to prevent any cracking on production units.

BRAKE TEST BED

INTRODUCTION

The Customer, a Chinese vehicle manufacturer, is developing a new type of vehicle. They want to make some tests for their new brake system in the brake test bed.

They want to measure the brake line pressure values of four wheels when they brake at different speeds.

MEASUREMENT SETUP

DATA ACQUISITION SYSTEM

• DEWE-43A

SENSORS

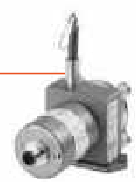
• Kistler CPFTA
(Brake Force Sensor)

• Kistler WP-500
(Brake Displacement Sensor)

• KELLER 21Y
(Brake Line Pressure)

SOFTWARE

• Dewesoft X2



The brake line pressure sensors and the brake force sensor have been installed and connected to the analogue input channels of the DEWE-43.

Brake Force Sensor

DEWE-43

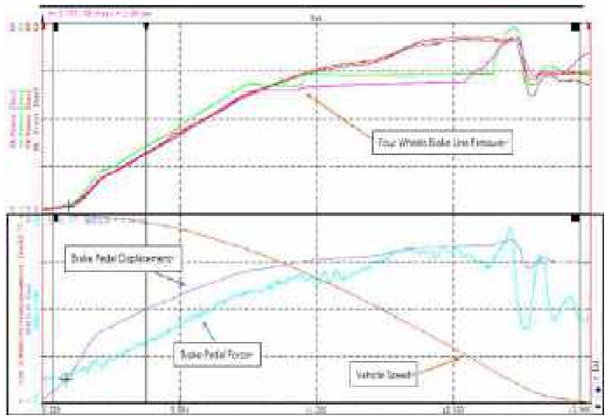
Brake Test Bed-Driver

BRAKE TEST BED

ANALYSIS

The testing engineers chose the measured value that they focus on, and put them in the measure view.

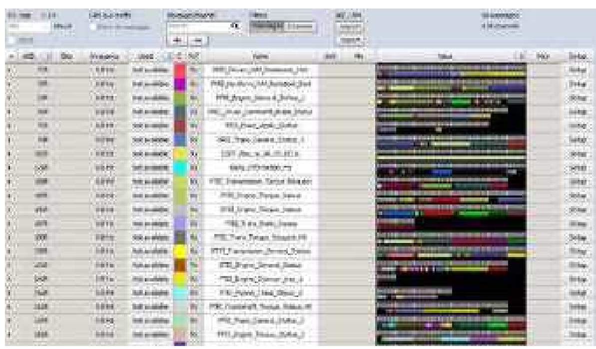
Here we can see the brake line pressure value of the four wheels (FL, FR, RL, RR), the brake pedal force and displacement.



Brake pressure curve when the speed decreases from 80 km/h to 0 km/h.

At the same time, the customer also wants to watch the CAN messages from the ECU controller of their test bed.

With the DEWE-43 and Dewesoft X2 it has been very easy to fulfill the needs.



CAN Message

CONCLUSION

The measurement of the brake test bed has been successful. The customer has collected several data groups at different speeds (80 km/h, 70 km/h, 60 km/h…).

They can find the relationship between the brake line pressure and brake force, speed from the measurement value and curve, and they also can watch the CAN messages from the ECU at the same time.

This helps them to improve their brake system.

PENDULUM TEST

INTRODUCTION

A large car manufacturer is using Dewesoft X and SIRIUS® for all tests and measurements in all of their departments.

The car manufacturer simulates the impact on the front axle when the car hits a sidewalk. A metal pendulum collides the chassis on several spots, with different speed and strength. The pendulum sends the information of speed and efforts. The chassis is instrumented with accelerometers. Until now two existing Photron cameras were used for video acquisition.

The measurement department uses Dewesoft and now acquires video with the DS-CAM-600. The hardware synchronization between video and analog data was an important point in their decision.

MEASUREMENT SETUP

DATA ACQUISITION SYSTEM

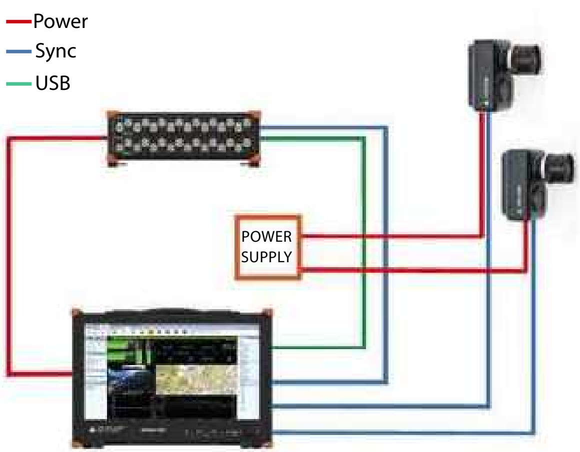
- R8-DB with two SIRIUS HD 16 STG-LEMO slices

CAMERAS

- DS-CAM-600m
- DS-CAM-600C

USED SOFTWARE

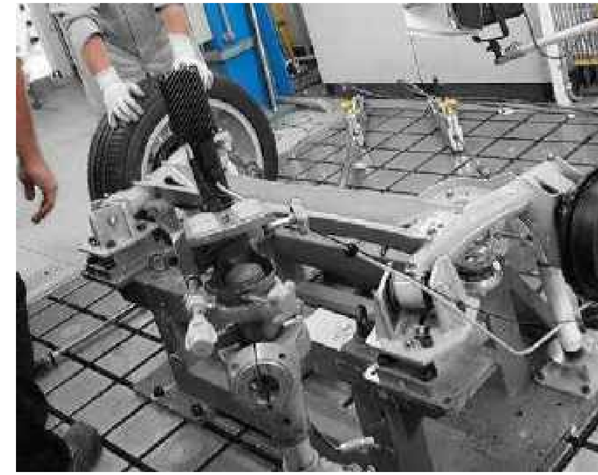
- Dewesoft X3 SP1



Schema of demonstration

The measurement system is placed outside the test area, for the safety of users in case of projectiles. Two DS-CAM-600 are placed around the specimen, which complicates the passage of cables. That's why we use long distance cables. Test area is equipped with powerful light projectors.

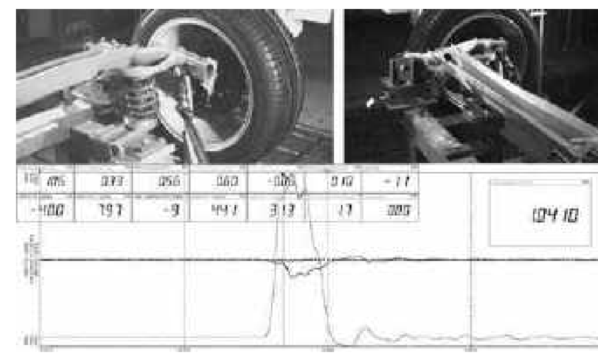
Video configuration on R8 system



Camera integration

SOFTWARE SOLUTION

The measurement system is placed outside the test area, for the safety of users in case of projectiles. Two DS-CAM-600 are placed around the specimen, which complicates the passage of cables. That's why we use long distance cable. Test area is equipped with powerful light projectors.



CONCLUSION

The DS-CAM resolution was adapted to visualization of mechanical deformations. The video acquisition at 600 fps is adequate for this test, so it's not necessary to use Photron camera to 1000 fps. Furthermore, DS-CAM are slimmer, compact, and require low light compared to the camera already in place.

Thanks to DewesoftX we offered a unique solution which combines fast video and analog measurement. This helps to simplify users's trainings and the analysis of such tests.

INVESTIGATION OF A SEMI TRAILER AXLES VIBRATION

with FFT Analysis Method

AIM OF THE STUDY

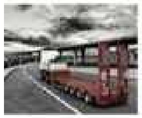
- Establishing of measurable axle selection criteria depending on the type of product
- Making the appropriate axle choice according to vehicle and usage profile
- To select an economic and functional axle
- Providing Know-How transfer for local axle studies


Curtainsider


Container Chassis


Stainless Steel Tanker


Aluminum Tank/Silo


Lowbed & Special V.


Tipper


Reefer


Box

SCOPE OF THE STUDY

The scope of the study is to examine the effect of airbags, which have different diameters and are located on the selected axle assembly, defining the damping effect and vibration characteristics.

TEST CONDITIONS

Test Routes:

Test route which includes Off-Road and Asphalt road profile

Loading: Unloaded

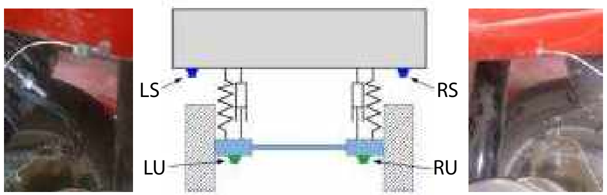
MEASUREMENT SETUP

DATA ACQUISITION SYSTEM

- Datalogger
  SIRIUS-STGM

SENSORS

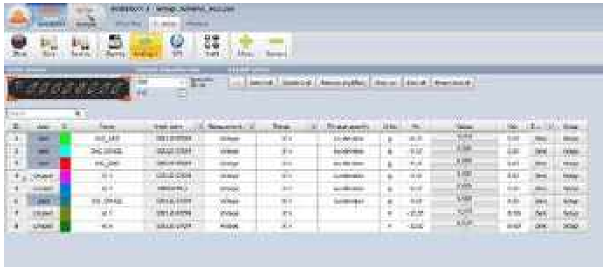
- Accelerometers
  1 pcs. - Axle Right side (RU)
  1 pcs. - Chassis Right side (RS)
  1 pcs. - Axle Left side (LU)
  1 pcs. - Chassis Left side (LS)
- GPS
  1 pcs. – GPS antenna (10 Hz)

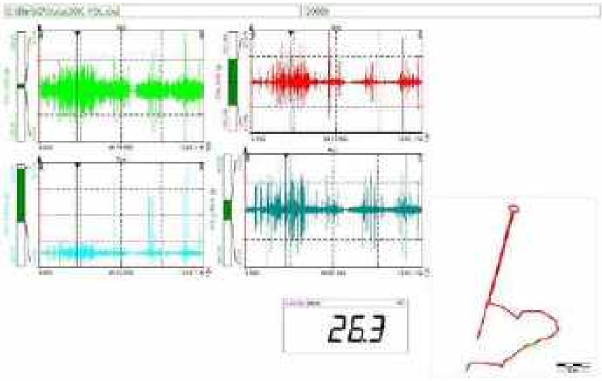


SETUP & RECORDING

On the right the channel setup in DEWESoft X shows a small picture of the instrument with the amplifier and sensor settings. Channel names, physical quantities, units and colors are assigned.

In the measure mode the interesting signals can be displayed live on various instruments, here four recorders show the time trend, on bottom you see a digital meter and the GPS route.



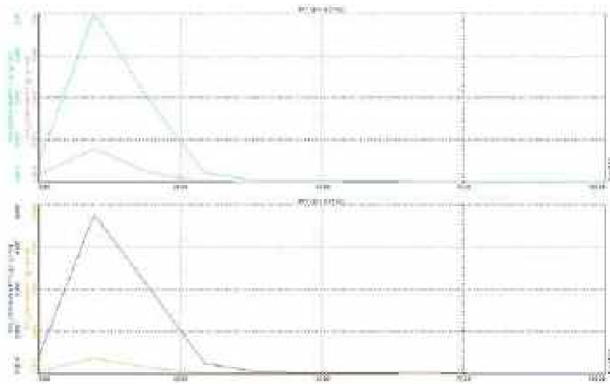


SIGNAL PROCESSING

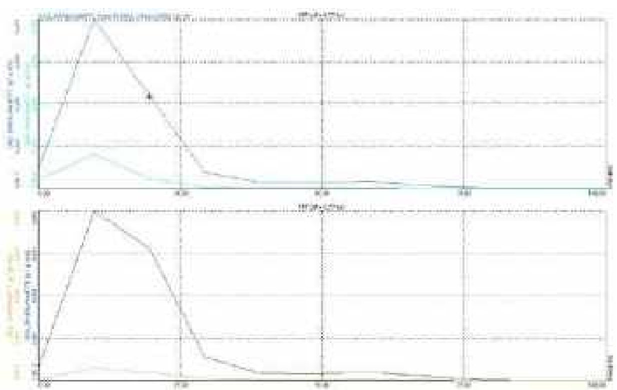
FFT ANALYSIS

Among its powerful settings, the FFT Analyser of DEWESoft provides useful cursor functions. You can freely define to look at one or multiple signals to compare the results. Furthermore you can have multiple FFT Analysers with different settings at the same time.

36 K - Airbag

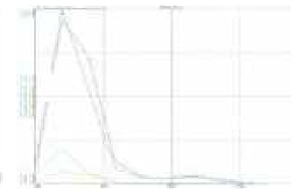


33 K - Airbag



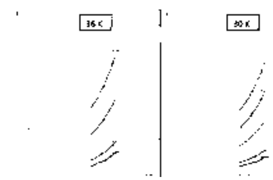
RESULTS

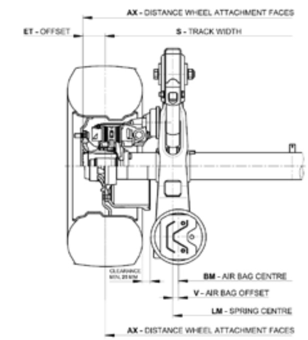
It was observed that there were no differences between the test results regarding the damping effect and vibration characteristics of the airbags which have different diameters.



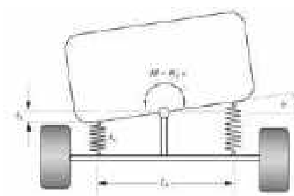
Also theoretically the 30K and 36K Airbag type have the same characteristics.

Furthermore the 30K Airbag has assembly advantages.





The roll stiffness of the vehicle which has the 30K Airbag type is higher than the other, in the same lateral acceleration when evaluating both airbags in terms of roll characteristics.



SUMMARY

- Airbag characteristic is determined
- Airbag selection criteria are defined
- Know-how transfer was provided from partners according to study

DYNAMIC TESTS ON INDUSTRIAL SHELTER

INTRODUCTION

This presentation describes the test campaign carried out, by personnel of Rina Consulting S.p.A, on an industrial shelter for telecommunications. The scope of this was to check, evaluate and improve the capacity of the shelter to dampen the vibrations that affect the antenna during transportation by a truck along urban and not urban roads. This shelter can be used to ensure emergency communications during natural catastrophes (earth quakes, avalanches, etc). For this reason, it must have the ability to avoid damages to antenna and other systems during transportation, especially on rough roads. Tests were performed using Dewesoft SIRIUS 8xACC and X2 software to show raw data in real time and data analysis to our client.

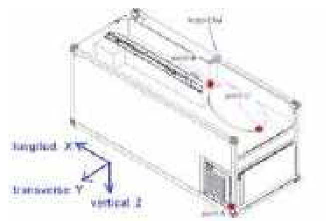
Two test campaigns were performed for a total of 11 measuring runs for a total of 120 km covered. At each run the constraints and the damping characteristics were changed to find best configuration able to minimize amplifications of the antenna's vibrations. Three measuring points, two tri-axial and one bi-axial, were implemented using IEPE accelerometers and an action-cam connected by USB to the laptop.

TEST CAMPAIGNS

The tested telecommunications system was designed to work standalone both in urban and not urban contexts. It's made up of a shelter, containing electronic devices, generators and fuel tanks, of a system of four self-levelling legs, which permit to install it onto irregular terrains and of an extensible arm with a rotation pin on the top. The rotation pin supports a rotating antenna.

Three measuring points were installed:

- One on the "iso-corner", to measure input accelerations to the structures. Tri-axial. Point A
- One on the pin of the arm, at the base of the antenna. Bi-axial (Y and Z directions). Point B
- One on the antenna, to measure accelerations response. Tri-axial. Point C



Rina Consulting S.p.A. took care about all activities involved in this work:

- choice of measuring points, in accordance with client indications and necessities
- sensor chain installation
- setting of Dewesoft X2 measuring software
- data acquisition and post analysis

COMBINATIONS OF CONSTRAINTS AND DAMPERS

Tests were performed during transportation of the system with a truck for a total of 11 measuring runs. For each run, the types of constraints and damper elements were changed by client personnel. This was done to find the combination that permits to minimize movements and vibrations of the antenna.

First campaign:

1. Elastic hooks at the level of the antenna rotation pin. Random free
2. Rotation pin and radom free
3. Rotation pin blocked. Radom free

Second campaign:

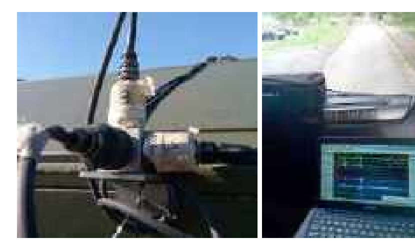
1. Rotation pin free and radom on damping mat
2. Rotation pin resting on 6 dampers and random on rigid supports
3. Rotation pin resting on 6 dampers and random free
4. Rotation pin resting on 4 dampers and random on dampened support
5. Rotation pin fixed on 4 dampers and random on dampened support
6. Not communicated by client
7. Not communicated by client
8. Not communicated by client

MEASURING CHAIN

The sensors and the camera were fixed on the measuring points by epoxy glue and by mechanical solutions. Coaxial cables RG58 were installed from the sensors to the SIRIUS-8xACC, located on the drive cabin. Accelerometers used were PCB 393A03 (IEPE, 1 V/g sensitivity). Sampling rate was 1200 Hz, to assure a band of 500 Hz for data signals. Camera signals were achieved directly in Dewesoft X2, as signal sensors.

acquisition mode X2; shelter on the truck

Point C (left) point A (right)



Point B (left), a phase of measure (right)

COMBUSTION MEASUREMENT SETUP

and it's theoretical influence to typical result values

INTRODUCTION

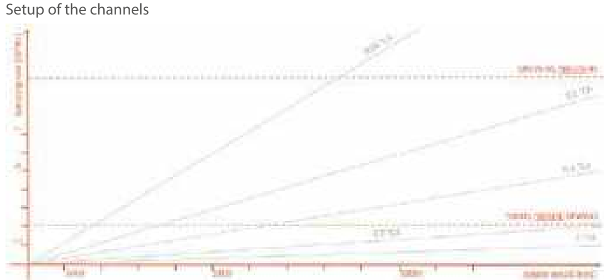
Combustion measurements are different from most standard measurements as the calculation and judgement of the measurement is typically done in crank angle and cycle but not in time mode. This leads to a different setup of the measurement chain with impact to the result values. The application note shows the main steps of the setup, the calculation base of typical results values and at the end a qualitative judgement of the setup impact to the results. The influencers are described in this application note separately, a combination of the influencers is in principle possible and can have worse effect.

SETUP IN X3

The setup of a measurement chain is based on five steps. The first two steps are typical steps while setting up a measurement, all other steps are combustion measurement specific steps.

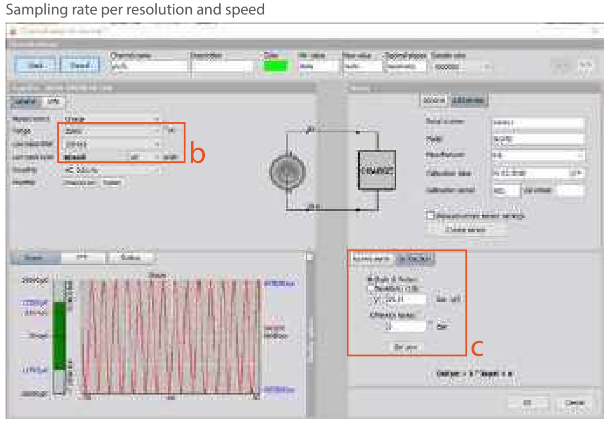
First step is the setup of the channels. The sampling rate needs to high enough for all calculations without of aliasing. Second pre-demand is that this sampling rate correlates with the expected resolution (in °CA) and the maximum speed of your engine.

Setup of the channels



Sampling rate per resolution and speed

The analog input channels are typically piezoelectric sensors for cylinder pressure. These sensors can be used with external amplifiers on an analog input (e.g. ACC) or directly to the CHG inputs. Most important settings are the measurement range which needs to fit to the expected pressure to avoid saturation and the filtering to avoid signal changes. The sensor needs also to get the correct gain to transfer the analog signal to correct pressure values.



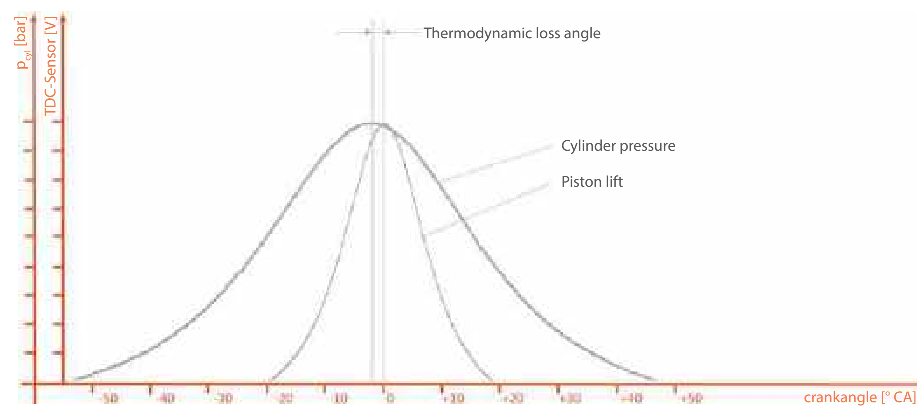
Setup of each sensor

Second step is the engine definition. The engine definition has a major impact to the definition of the volume curve which is needed for many calculations and the polytropic coefficient. This coefficient is often based on experience in correlation with the kind of fuel and the estimated fuel air ratio (lambda).

Engine definition

Third step is the definition of the crank angle encoder and the TDC offset. The TDC offset gives the correlation between the volume curve and motored pressure curve together with the thermodynamic loss angle. This determination has a huge influence to some result values (e.g. IMEP determination) and needs to be determined carefully. A determination of the TDC offset with the motored curve is okay as long as the loss angle of the engine is known. A TDC determination with a TDC probe is recommended if the loss angle of the engine isn't known. The loss angle is based mainly on two factors. These factors are wall heat loses and blow by of the combustion chamber. The volume increase just before the TDC is so small that these loses are bigger and lead to an earlier pressure drop. Wall heat loses and blow by are different from engine type to engine type (or even from engine to engine) which makes the determination with a TDC probe essential for unknown engines (figure Thermodynamic loss angle).

Crank angle definition



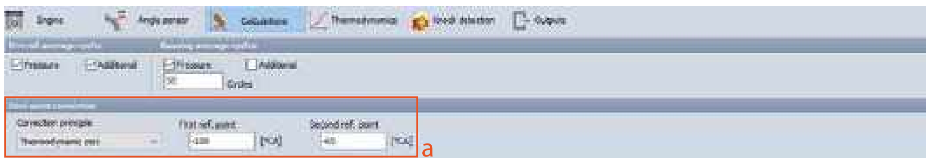
Thermodynamic loss angle

Fourth step is the definition of the zero level correction or pegging. A piezoelectric sensor is only measuring relative pressure differences and the pressure curve needs to be adjusted to the correct value. Different principles are available for this:

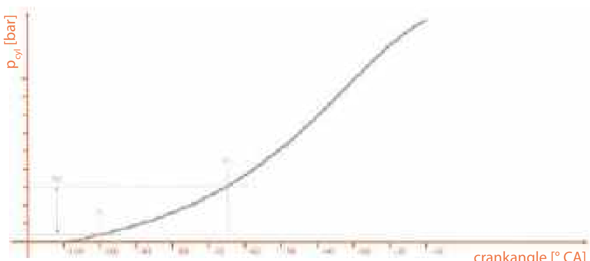
- Pegging to fixed value: Principle is an old principle and based mainly on natural aspirated engines. The intake pressure equals ambient pressure and allows the correction to a fixed value.
- Thermodynamic pegging: Principal is one of the two principals used for charged engines (see figure a). Base is a polytropic compression with fixed polytropic coefficient (κ). This is an easy calculation and suitable for most measurement tasks with no need of extra intake pressure channels. The calculation is as follow:

$$p_1 = \frac{\Delta p}{\left(\frac{V_1}{V_2}\right)^{\kappa} - 1}$$

- Pegging to another channel is the second principle used for charged engines. Base is the assumption that the pressure in intake port fits at a defined crank angle to the cylinder pressure. The intake pressure is measured in parallel and the cylinder pressure is pegged to this value.



Definition of pegging



Thermodynamic pegging

Fifth step is the definition of the heat release and MFB point calculation. The calculation base will be described in the next chapter. The calculation is based on the already existing values cylinder pressure, combustion chamber volume and polytrophic coefficient. All other parameters are only start, stop and resolution parameters (see figure b).

Heat release calculation

CALCULATION BASICS

COMBUSTION MEASUREMENT CALCULATION BASICS IN DEWESOFT X3

Combustion measurement is only the base for the calculation of result values. The number of result values is huge and we will concentrate here only to the standard result but the systematic behind could be extrapolated to all other result values.

Table of Variables

[°CA]	Degree crank angle
AIx%	Mass Fraction Burn Point x
Ax	Position of x
[Hz]	Hertz
IMEPn	Net Mean Effective Pressure
IMEPg	Gross Mean Effektive Pressure
κ	Polytropic coefficient
max(x)	Maximum
P	Pressure
PMEP	Pumping Mean Effective Pressure
[Rpm]	Rate per minute
V	Volume
[V]	Volt

MAXIMUM PRESSURE

Maximum pressure is one of the easiest calculations. It is defined as the highest cylinder pressure and delivers one result value per cycle. For some measurement tasks it might also be interesting to deliver the position of the maximum pressure.

$$p_{max} = max(p_{cyl})$$
$$ap_{max} = x(p_{max})$$

Influencers to the calculation of the maximum pressure is only the absolute pressure curve. This means that the gain factors of sensor and amplifier need to fit. Second point is the correct zero level correction, which could include also the volume setup (depending on type).

Influencer to the position of the maximum pressure is only the correct TDC position.

MAXIMUM RISE

Maximum rise also an easy calculation. It is defined as the highest value of the cylinder pressure derivate and delivers one result value per cycle. For some measurement tasks it might also be interesting to deliver the position of the maximum rise.

$$dp_{max} = max\left(\frac{d(p_{cyl})}{d\alpha}\right) = max\left(\frac{p_{i+n} - p_{i-n}}{2 \cdot n \cdot R}\right)$$
$$adp_{max} = x(dp_{max})$$

i … measurement point
n … step size
R … measurement resolution

Influencers to the calculation of the maximum rise are only the gain factors of sensor and amplifier. Influencer to the position of the maximum rise is only the correct TDC position.

IMEPn, IMEPg, PMEP

The mean effective pressure calculation is the integration of the volume according to the volume of the engine. This value is afterwords devided by the stroke volume in order to be independent from the displacement. The result is one value per cycle. The difference between IMEPn, IMEPg and PMEP is only the integration border and with this the area of interest. IMEPn is defined over the hole cycle, IMEPg is defined as the mean effective pressure of compression and expansion phase and PMEP as difference of both.

$$IMEP_n = \frac{1}{V_S} \cdot \int_{-360}^{360} p \cdot dV = \frac{\sum_{i=-360}^{360} p_i \cdot (V_{i+1} - V_{i-1})}{2 \cdot V_s}$$
$$IMEP_g = \frac{1}{V_S} \cdot \int_{-180}^{180} p \cdot dV = \frac{\sum_{i=-180}^{180} p_i \cdot (V_{i+1} - V_{i-1})}{2 \cdot V_s}$$
$$PMEP = IMEP_g - IMEP_n$$

i … measurement point
Vs … stroke volume

Influencers to the calculation of mean effective pressure are the gain factors of sensor and amplifier, definition of the volume curve and most important the correct TDC. Pegging doesn't have any influence at all.

HEAT RELEASE AND MASS FRACTION BURN POINTS

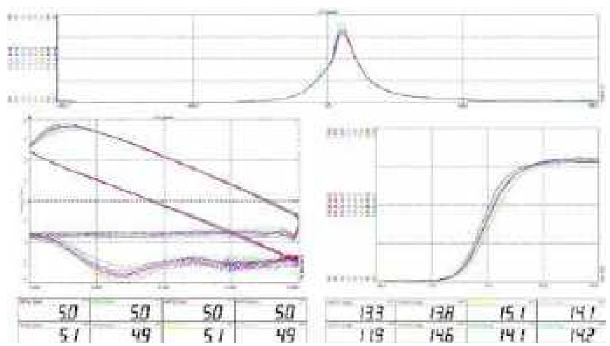
The rate of heat release and integrated heat release show the energy conversion per crank angle. The mass fraction burn points are the positions of a part of the total heat release (e.g. AI50% equals the position of 50% of the total energy). Many approximations are available for this. The version used in Dewesoft is based on the already available information volume, pressure and the polytrophic coefficient defined in the engine definition. The details are as follow:

i … measurement point
n … step size
κ … polytropic coefficient

$$TQ_i = \frac{1}{\kappa - 1} \cdot \left(\kappa \cdot p_i \cdot (V_{i+n} - V_{i-n}) + V_i \cdot (p_{i+n} - p_{i-n})\right)$$

$$TI_i = TQ_i + TI_{i-1}$$

JUDGEMENT / CONCLUSION



Combustion results are depending on standard measurement setups and special measurement setups relating to combustion measurement plugin. The standard measurement setups are shown at the beginning of chapter 3 and won't be judged in this conclusion as this is a base for a reliable measurement.

The special setups of combustion measurement need some experience and have different influence to different result values.

The main influences are shown in the following table:

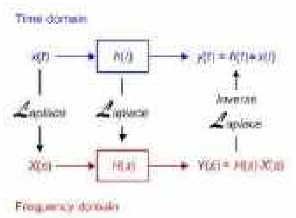
	p_{max}	ap_{max}	dp_{max}	adp_{max}	MEP	TQ	TI	AIx%
Gain factors (sensor and amplifier)	x		x		x	x	x	x
Engine geometry (volume curve)	(x)				x	x	x	x
TDC determination	(x)	x		x	x	x	x	x
Polytropic coefficient	(x)					x	x	x
Pegging (zero level correction)	x					x	x	x

() in combination with pegging of type thermodynamic

DYNAMIC TESTS ON INDUSTRIAL SHELTER

ANALYSIS

As mentioned before, the main scope of this work is to quantify magnifications of antenna's and arm's vibrations comparing to the vibrations going to the shelter, in iso-corner point. To perform this request of the client, a simple calculation of the transfer function H(s) was performed on accelerometers time data.



For each measuring direction the X, Y and Z signals of the accelerometers were used to calculate the H functions as HXA,B HXA,C HYA,B --- HZA,C . Or, in other words, three matrices were built, one for each measuring direction:

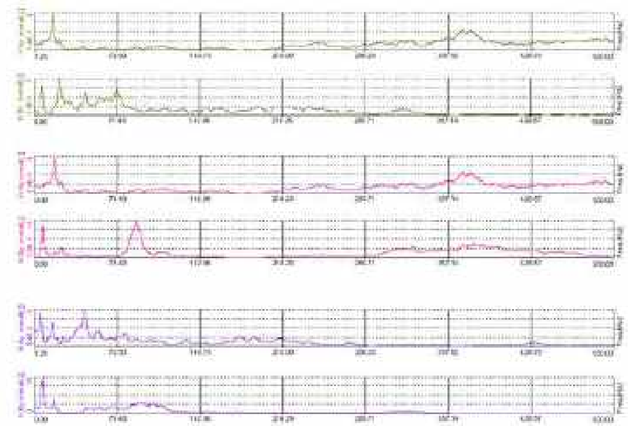
$$\begin{bmatrix} H_{AA} & H_{BA} & H_{CA} \\ H_{AB} & H_{BB} & H_{CB} \\ H_{AC} & H_{BC} & H_{CC} \end{bmatrix}$$

The H function was calculated using math instruments present in Dewesoft X2. This part of data elaboration was executed after the completions of a single run of measure.

Post analysis with X2

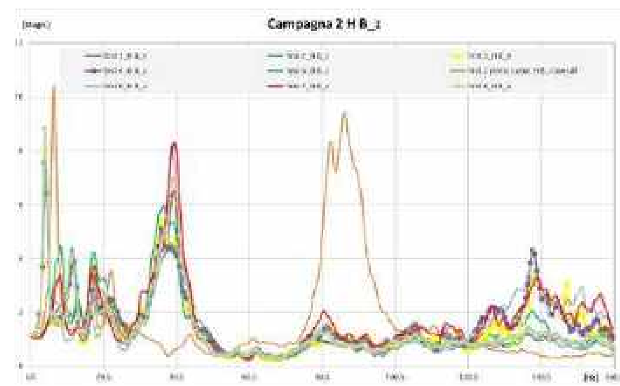
RESULTS

For each measuring run a set of H(s) functions was calculated for B and C points (rotation pin and antenna positions respectively) for X, Y, and Z direction:



Transfer functions by X2

After that, to evaluate the performances of different dumping solutions, for each measuring point and for each direction, all the H(s) functions were gathered together in an Excel® sheet & graph in terms of magnitude:



All transfer functions – Z axis, point B second campaign

The solutions tested show various behaviours along the frequency range. No solution tested is efficient on the entire spectrum. Many solutions are efficient at low frequencies but not around the value of 40 Hz (characteristic of truck's rotating wheels). Other solutions magnify the response at very low frequencies but are more efficient in the rest of the spectrum. Anyway, the results obtained during the test allowed the customer to make a choice (the one which minimizes magnification at very low frequencies (eg red, Test # 6 and #7)).

FIND THE SOURCE OF NOISE IN CAR
that disturbed the driver and passengers inside

MEASUREMENT SETUP

DATA ACQUISITION SYSTEM

- Dewesoft SIRIUSi Custom slice with 1x ACC, 1x ACC+, 1x CHG, 2x HV, 1x LV and 2x STG
  Sampling rate: 50 kS/s
- Accelerometer: PCB 356B21 Tri-axial accelerometer at the Gear Transmission side
  PCB M353B18 Single accelerometer at the Engine side
- Microphone: PCB 130F20 in the passenger room.

SOFTWARE

- Dewesoft X2 Professional
- DSA Upgrade including Sound level and FFT Analyzer

Microphone and SIRIUSi in the Passenger room

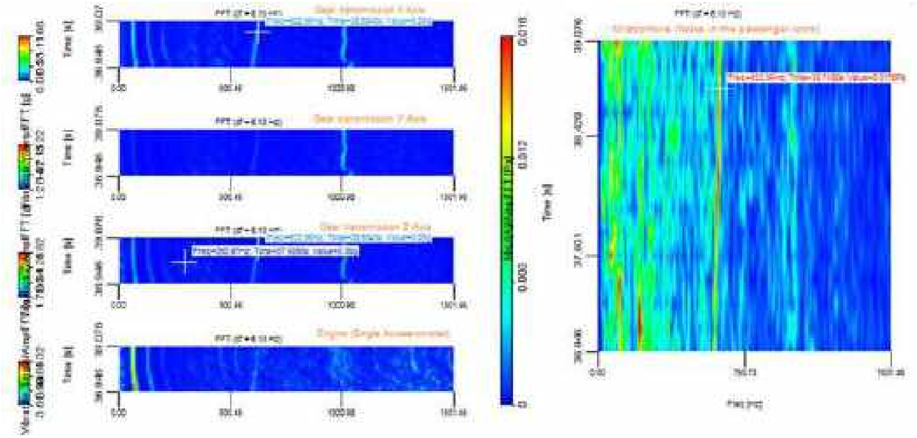
Tri-axial accelerometer on the Gear Transmission (Left)

Single accelerometer on the Engine (Right)

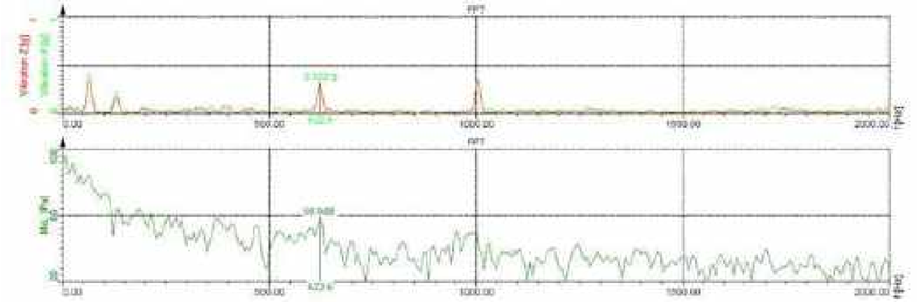
ANALYSIS

ANALYSIS AFTER RUNNING THE TEST ON THE ROAD

We found the noise in the passenger room at a frequency of 622.56 Hz and compared it to the engine room at 2 points. The same frequency (622.56 Hz) was detected at the Gear Transmission side (X axis and Z axis) as the analysis screen shows below.



Analysis Screen (FFT Analyzer, 3D Graph)



Analysis Screen (shows the noise in dB and compares the frequency)

CONCLUSION

The noise that was found is about 58.90 dB at a frequency of 622.65 Hz. The source of noise is the Gear Transmission side.

SOUND POWER ON A WOOD-CHOPPING MACHINERY

INTRODUCTION

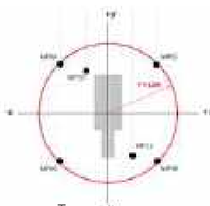
Sound Power is the total power emitted by a source in all directions, it is a characteristic independent of the distance, therefore suitable for comparing various sound sources. Recently, for more and more devices exists a labelling obligation. The Sound Power module in Dewesoft X2 (based on the measurement of sound pressure, according to ISO3744 and ISO3745) is an easy-to-setup tool for quickly achieving accurate and repeatable measurements.

IN-FIELD APPLICATION

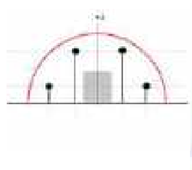
We got the possibility to participate a practical sound measurement at customer site located in Austria. The customer is manufacturing stationary and mobile shredding, composting, screening and separation units, as well as special stone/biomass separators. The machines can deal with wood, green waste, biomass, gravel, soil, etc. in different sizes, depending on the requirement. The chipper we examined is a mobile chopping machinery mounted on a 4-axle-lorry with 350kW power. The operator sits in a height-adjustable cabin, for better overview, while feeding the machine with the crane arm. Various materials can be chopped, but the main usage is for wood.

CUSTOMIZABLE SETUP

At first the setup was defined: According to the standard ISO 3744 (free-field) there is a subclause (Annex F) where you can use a minimum of 6 microphones. The customer used 4 microphones on low, and 2 microphones on high position, in a hemisphere 10m radius setup, placed around the sound source.



Top

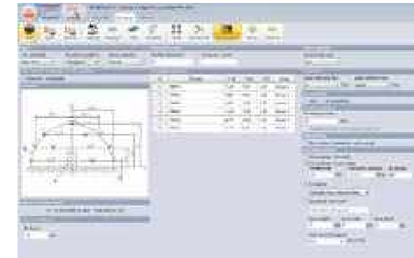


Side

The positions are usually defined by the standard, and automatically calculated by the plugin, but you also have the option to enter custom coordinates. The AD sampling rate was set to 50 kS/s, the CPB third band octave plot was required up to 10 kHz.

All microphones were sequentially put in a handheld reference calibrator (114 dB at 1 kHz), and scaling factors have been applied by one click in Dewesoft. This is a very convenient way; please consider the calibration step is important, as there are long sensor cables.

VARIOUS CORRECTION METHODS



Dewesoft offers different correction methods, to fit to all customer needs. For our measurement C2 and K1 were used.

- C1 and C2 correction (meteorological: temperature, height above sea level)
- K1 background noise correction (by separate measurement, done when sound source is switched off)
- K2 room correction (by mean absorption grade, reverberation time, or entering the table)

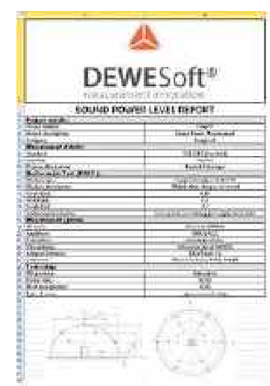
GUIDED MEASUREMENT

The sound power module comes with a prepared screen, showing all relevant information at once. On top you have buttons to interactively start/stop the acquisition of background or sound source, as soon as you are ready. Status messages will be shown (e.g. how long the measurement is running, if background and sound source levels are too close, etc). The six CPB plots on the left side show the microphone sound pressure levels, on the right you see sound power result, sound pressure level and the correction factor vs frequency.

The measurement itself takes a short time, because a minimum duration of only 20 seconds is required by the standard. The machine is switched off, we measure, then start the engine and all moving parts of the vehicle – produce as much sound as possible – for the final sound measurement.

AUTOMATED REPORT GENERATION

The customer was previously exporting the data, and doing the post-analysis in an additional software package. With the Dewesoft X2 software, everything is covered with one package, from the setup to the measurement, and the auto-generated report. Create your template in Excel® or Flexpro, then export the data and all additional informations (data header, mandatory fields according to the standard) into it with one click. Additionally Dewesoft offers the export into various file formats, such as Matlab, Diadem, RPCIII, Text, CSV, etc.



FORMULA STUDENT NOISE MEASUREMENT

INTRODUCTION

In order to pass the technical inspection for the formula student competition, all internal combustion engine cars need to pass a noise measurement procedure. In the unified rulebook it is stated:

IC3.3 MAXIMUM SOUND LEVEL

At idle the maximum permitted sound level is 103 dBC, fast weighting. At all other speeds the maximum permitted sound level is 110 dBC, fast weighting.

IC3.2.1 The sound level will be measured during a static test. Measurements will be made with a free-field microphone placed free from obstructions at the exhaust outlet level, 0.5 m (19.68 inches) from the end of the exhaust outlet, at an angle of forty-five degrees (45°) with the outlet in the horizontal plane. The test will be run with the gearbox in neutral at the engine speed defined below. Where more than one exhaust outlet is present, the test will be repeated for each exhaust and the highest reading will be used.

IC3.2.4 TEST SPEEDS

The maximum test speed for a given engine will be the engine speed that corresponds to an average piston speed of 914.4 m/min (3,000 ft. /min) for automotive or motorcycle engines, and 731.5 m/min (2,400 ft. /min) for "industrial engines". The calculated speed will be rounded to the nearest 500 rpm. The test speeds for typical engines will be published by the organizers.

The test was normally performed by one person using a hand-held sound level meter. Each team needed to have a dash display or a computer connected to show the engine RPM during the test.

MEASUREMENT SETUP

Dewesoft was one of the sponsors of the Formula student Austria 2017 competition at the Red Bull Ring in Spielberg, Germany. The event was also a promotion of the company and as such it was decided to do the noise test at a higher level.

DATA ACQUISITION SYSTEM

• SIRIUS ACC with high dynamic range

SENSORS

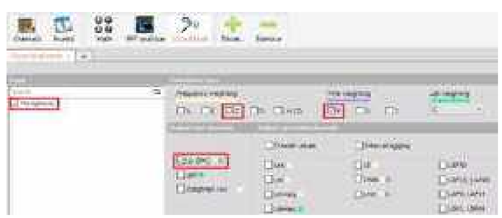
• GRAS microphone (for example GRAS 146AE)

SOFTWARE

• Dewesoft X3
  Sound level meter plugin

SETUP

It is stated in the rulebook that the maximum permitted sound level is 103dBC for fast weighting at idle and 110dBC for fast weighting at maximum RPM. Using the microphone with an ACC input in IEPE mode, the sound pressure in Pa is measured. By using the sound level meter and selecting only the correct frequency and time weighting, the sound pressure level output is created.



The measurement was made more interesting by detecting the engine RPM only by using the microphone. For this, the FFT analyser was used with peak amplitude output. Array function "maxpos" were used to get the exact frequency of the rotating engine. Then this was divided by the number of cylinders, multiplied by two and converted form Hz to RPM.

In some engines, other unwanted frequencies were present which made RPM detection more problematic. An IIR band pass filter solved this problem. Cut-off frequencies needed to be set below idle and above maximum RPM. Caution needs to be taken, since the frequency depends on the number of cylinders in the engine. In the competition only 4-stroke engines are allowed, which have one firing per cylinder every two engine revolutions. If a 4-cylinder engine is measured, there are 2 combustion cycles each engine revolution. This means that at 6000 RPM, the frequency of the engine is 200 Hz (6000*2/60).

There is also an input field in the setup for determining the engine test speed. In the rulebook, chapter IC3.2.4, it is stated that the maximum engine RPM for the test is calculated from the mean piston speed, which depends on the engine stroke.

The setup that was prepared is very simple for the operator. The number of engine cylinders need to be selected, engine stroke entered and then the measurement can start. There are two big indicators showing if the idle and maximum RPM noise levels are exceeded.

CONCLUSION

The Dewesoft noise test raised a lot of interest at the competition and teams were impressed with the capabilities of the hardware and software. Organisers from other events saw a video from the Dewesoft noise test at the competition in Austria and invited Dewesoft to do the same test at the formula student competition in Brazil.

The Formula student event is a good promotion for Dewesoft and a great chance for people to start working in automotive and other areas to get to know Dewesoft. Every team that passed the noise test received a printed report and an USB pen drive with the datafile, software and product catalogues.

EXHAUST SOUND ENGINEERING

ABSTRACT

This appnote shows how an excellent car exhaust sound design can be developed using Dewesoft equipment.

INTRODUCTION

A big european manufacturer of exhaust systems is continuously working on a knowledge database concerning the sound design of their various products.

The inhouse research splits into two departments: CFD Simulation and Test & Measurement. The second one is investigating in the different fields of sound transmission loss, exhaust pressure pulses, vibrations, temperatures, experimental modal analysis, internal and external sound.

MEASUREMENT SETUP

The customer uses a lot of different sensors for strain, temperature, vibrations, sound, all connected to the SIRIUS instrument. The OBDII (CAN) is used for acquiring engine speed, velocity, gas pedal and throttle position from the car engine.

DATA ACQUISITION SYSTEM

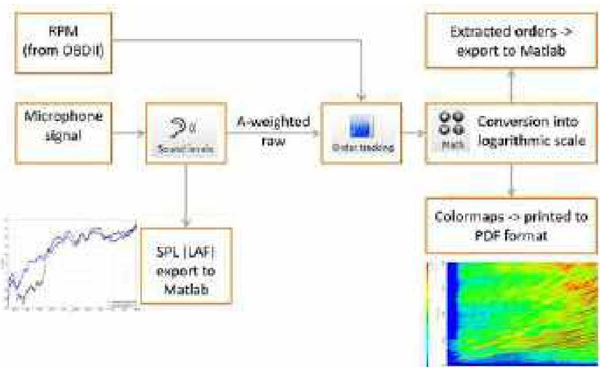
- SIRIUS-6xACC,2xACC+

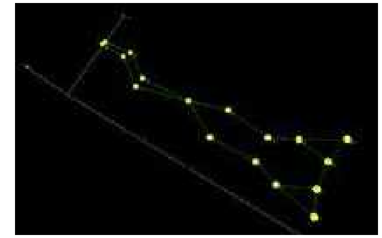
SOFTWARE

- DEWESoft X2
  Software option DSA

The schematic on the right shows the acoustic signal processing done in Dewesoft. The customer is using Ordertracking for getting colormaps as „identity cards" of each exhaust system.

Modal testing is performed by impact hammer to verify the simulation model, and identify the natural frequencies.

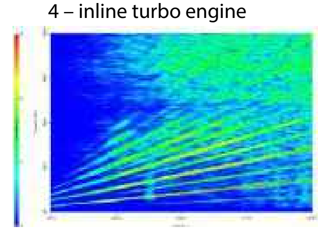




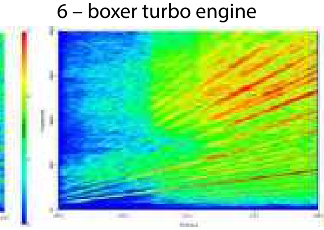
RESULTS

The customer is able to characterise the exhaust system using the scientistic approach. The efficiency of each acoustic element is analysed, disturbing effects (like whistling and drone noise) of the whole system are located, analysed and removed. With his experiencs of data collection and analysis, he is now able to judge a system by the colorplots, understanding the effects of different order contents.

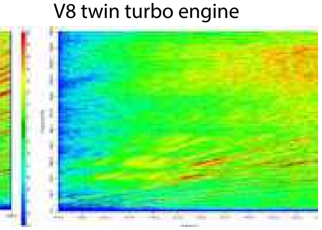
4 – inline turbo engine



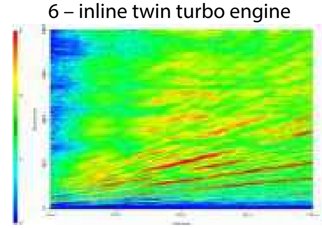
6 – boxer turbo engine



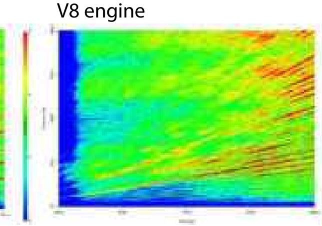
V8 twin turbo engine



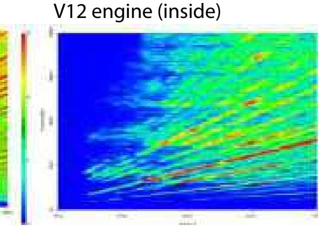
6 – inline twin turbo engine



V8 engine



V12 engine (inside)



CONCLUSION

The DEWESoft system offers a ready-to-use solution, the customer is very satisfied with quickly acquiring data for understanding, improving and customizing the exhaust system to the required needs.

BUS CRASH TEST

ABSTRACT

A crashtest of a bus has been performed in order to evaluate design of deformation zones protecting the driver. The measurement using SIRIUS units with S-BOX included set of strain gages on the bus construction, acceleration sensors in dummies as a driver and passengers, synchronized with fast video and speed measured by GPS. Video post-synchronization was used in Dewesoft to improve interpreting measured values on a driver’s body.

INTRODUCTION

Testing buses or coaches for safety in case of an accident such as rollover test is a standard part of development now. The procedures are focused mostly on passenger safety but in case of a front crash it is the driver who can be injured most because of his/her position in the very front. Therefore one of the bus producers decided to perform a crashtest of a bus skeleton to confirm a construction design that allows controlled deformation of the bus front in order to protect the driver.

MEASUREMENT SETUP

Similar to a standard car crashtest, a bus was sent to hit a concrete barrier with full front contact. Since the focus of the measurement was the construction of the front, only a bus skeleton was used. To get the appropriate weight corresponding to a complete bus the construction was filled with concrete, the impact speed was requested approximately 25-30 km/h. Along with strain gages applied on the important structure components, dummies measuring acceleration inside of the body and head were used as both driver and passengers.

DATA ACQUISITION SYSTEM

For onboard recording 3 slices of SIRIUS 8x STG / STG-S with SBOX were used with GPS antenna fixed on the skeleton.

SENSORS

As additional information source, the DS-CAM, was used to record the crashtest video from outside, independent from the SIRIUS set.

MEASUREMENT

Since it was only one shot to make the measurement, and the actual speed that will be achieved to hit the barrier could not be guaranteed, no trigger was used in Dewesoft. The measurement was started and stopped manually from a remote notebook connected by WiFi.

To make the instant of the bus contact with the concrete barrier more precise, additional resistive strips were placed to the front bumper and connected as one of the inputs.

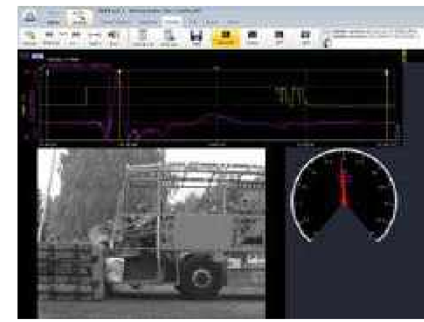
After the measurement, the video recorded using the DS-CAM at 300 fps was post-synchronized with the other data to get better overview of meaning of the data.

ANALYSIS

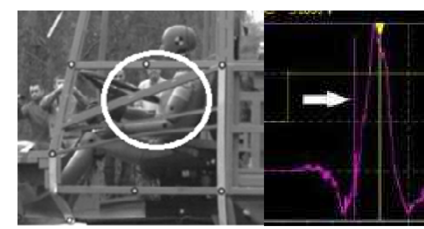
The recorded data was analyzed by different departments according to their focus, either in terms of the bus construction behavior creating a controlled deformation that can make the driver safer by moving the driver seat backwards and up as the bus front collapses, or the acceleration to which the driver and passenger are exposed.

Also all the used equipment has to be able to withstand the shock when the vehicle hits the barrier without compromising the data.

However the high speed camera records can give a lot of information about the crash progress and properties of the whole construction and the recorded values from sensor enable evaluation of the specific component properties, only linking the data with video record can provide information about cause of a specific value that has been measured. An example is shown on the right, where an unexpected sharp peak of acceleration is measured. When a synchronized video linked to the data is available, it is easy to find out the driver was hit by the steering wheel in the chest area.



Recorded data sample with video



Acceleration peak from a chest impact

CONCLUSION

The participation on the crashtest confirmed the hardware is reliable to record data even when it is exposed to an acceleration shock during the crashtest measurement and proved the power of the video record linked with data. This feature along with ease of understanding the data using Dewesoft was appreciated by the participants during data evaluation stage.

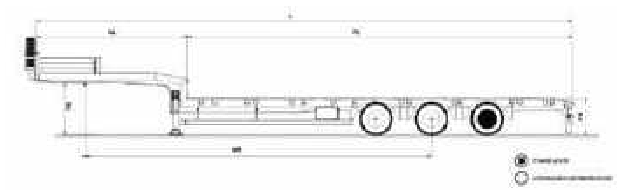
SEMI-TRAILER CHASSIS STRESS DISTRIBUTION

According to Axle Load and Airbag Pressure Changing

AIM OF THE STUDY

- Defining the change of suspension pressure during loading the vehicle to maximum load.
- Analysis of critical location defined from FEA analysis stress distribution during the load vehicle to maximum load.
- Simultaneous measurement of airbag pressure and chassis critical location stress.

5th wheel height	1,250mm
Wheel base	8,120 mm
Overall Length	13,120 mm
Gooseneck length	3,700 mm
Platform length	9,420 mm
Platform height	860 mm
Total Width	2,550 mm



SCOPE OF THE STUDY

TEST CONDITIONS

Investigation of airbag pressure and chassis stress distribution during unloading the concrete blocks, which are totally 40t, from the vehicle.

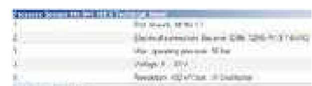
MEASUREMENT SETUP

DATA ACQUISITION SYSTEM

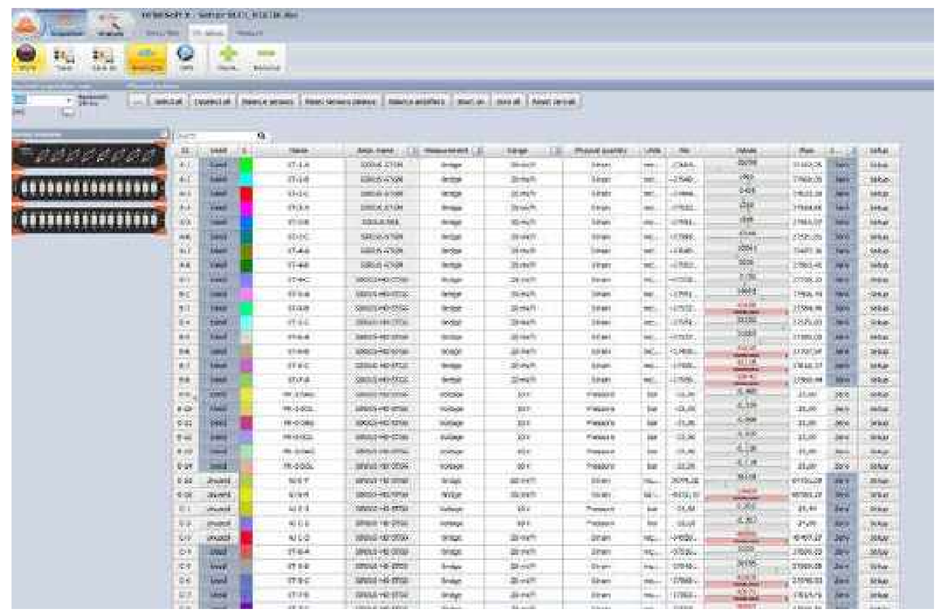
- Datalogger SIRIUS-STGM & SIRIUS-HD

SENSORS

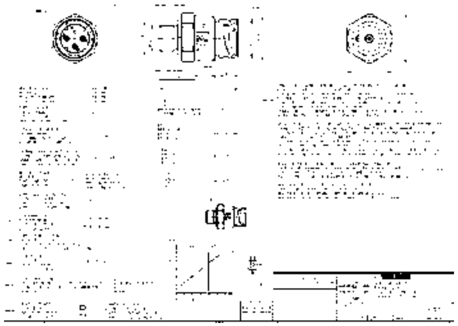
- Straingage Pressure Sensor (Wabco)

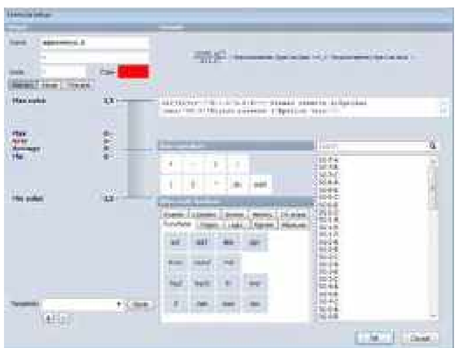


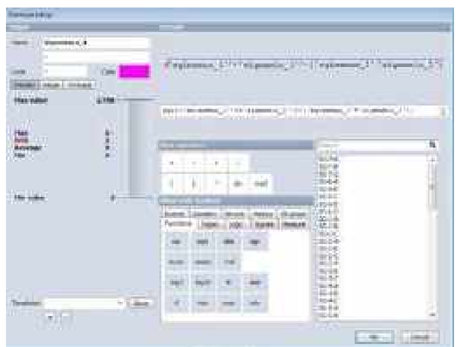
SETUP & RECORDING



SIGNAL PROCESSING

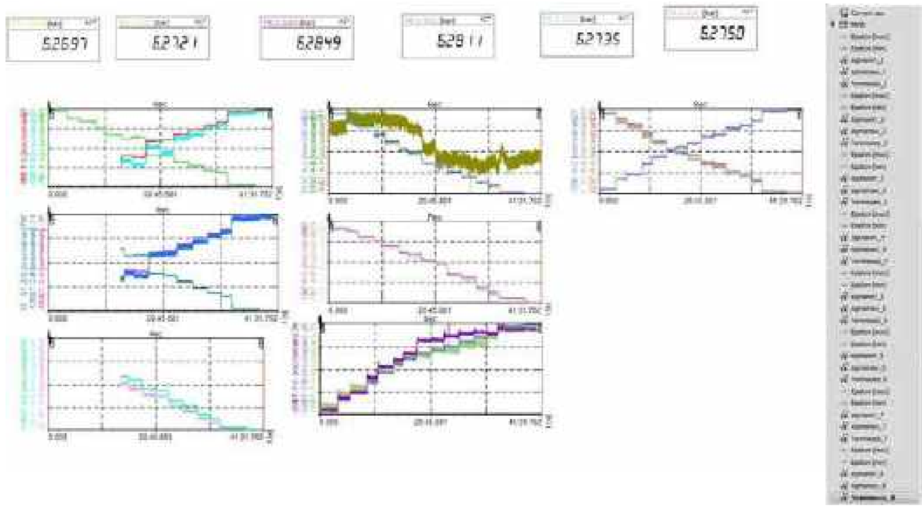






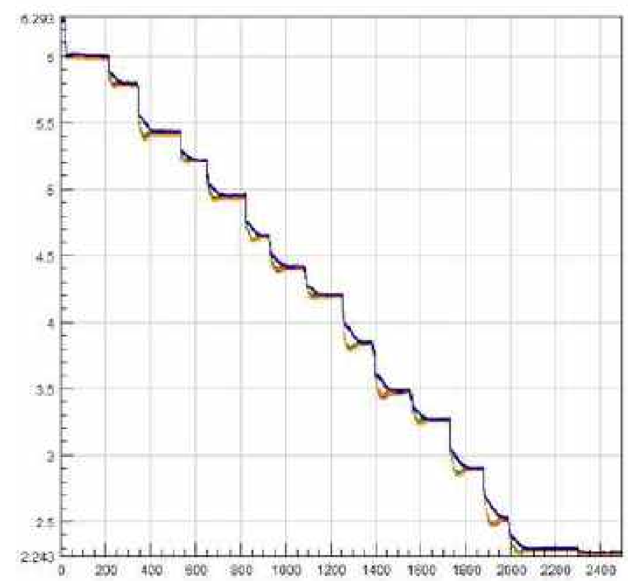
ROSETTES MATH

By the use of the free Rosettes math plugin in DEWESoft, the main strain (stress) direction can be calculated interactively using 3 strain gages. Various configurations are supported.



RESULTS

All data was acquired successfully and can now be further analysed and compared with the simulation.



STRUCTURAL TESTING WITH KRYPTON

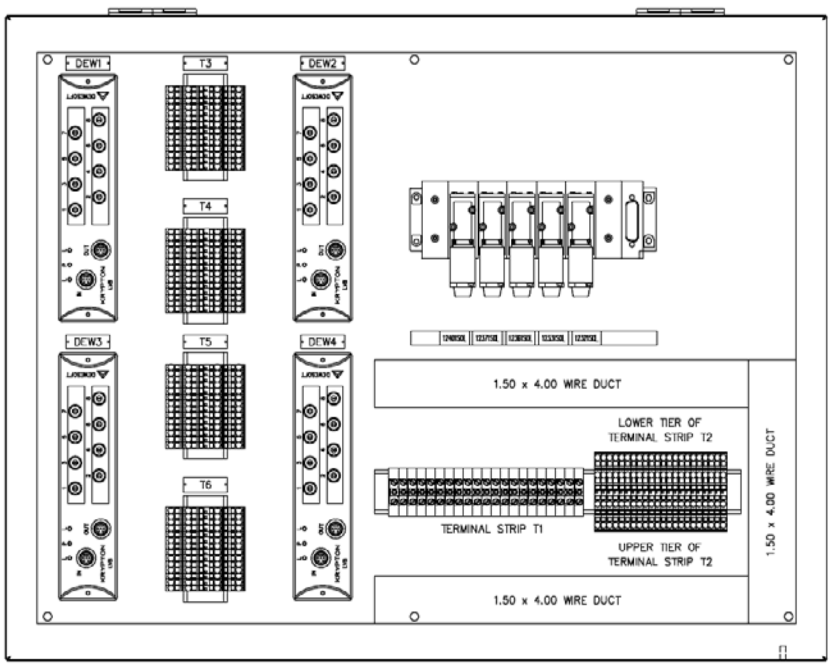
INTRODUCTION

In the test cells & structural lab of a big US car manufacturer, the KRYPTON modules are used for extreme temperature ranges for structural testing.

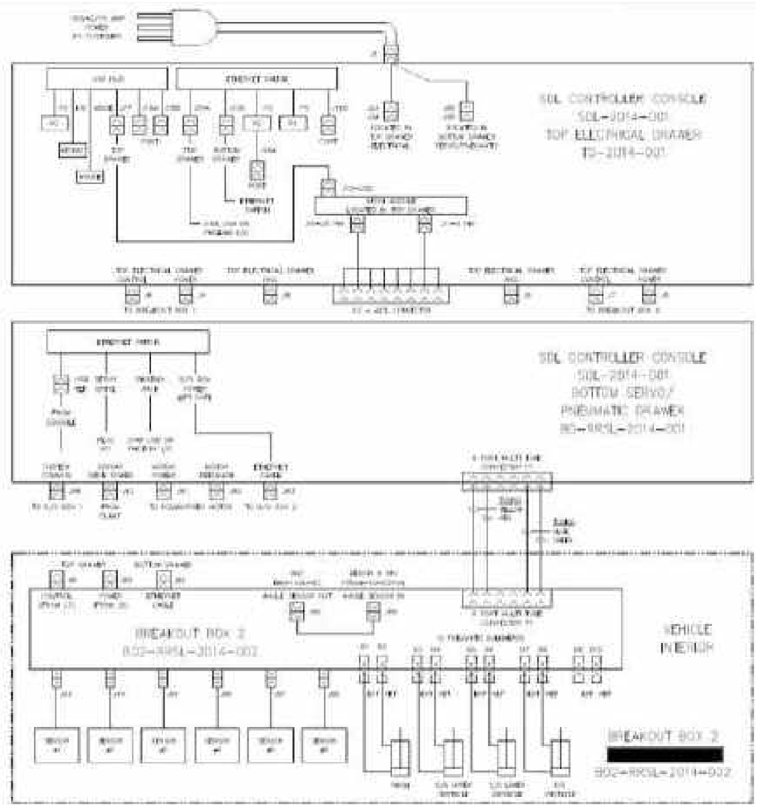
MEASUREMENT SETUP

Vehicle wiring harness will be incorporated into the data collection breakout-box for testing and data collection of body structures. Testing is done at a range of -30 deg C to +85 deg C as well 90% RH. Dewesoft is the main data acquisition system and incorporates into both the vehicle CAN system and the test site controller via the DEWECAN module used as the gateway of the system.

All three units SDL site controller, Vehicle Spy and Dewesoft run through the gateway using an in-house CAN database. The system is capable of emulating missing vehicle modules and components that are not under test and can perform multiple test sequences throughout the test lab.



Breakout-Box

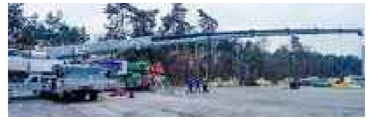


SDL test site controller

ANALYSIS

- Continued Dewesoft integration with existing hardware was a must.
- KRYPTON was needed because of the environmental temperature ranges.

ABSTRACT



This application note shows how Dewesoft products provide an effective solution for a quick validation of crane boom positioning in the field. The mobile measurement instruments and the easy-to-setup software are used for checking position parameters and relative movement of top of the boom on the mobile/truck cranes. Such system is useful in the development and production phase to evaluate the stiffness of cranes boom.

INTRODUCTION

The client, a huge truck-crane manufacturer in Germany, is developing and producing high-load truck cranes for worldwide market. Since material technology has advanced, the crane manufacturer also wants to test new materials to see the limits with the goal to increase length and load capacity of the crane. Two most crucial facts for them are the external environment and the ratio between length and angle of the boom and load on it, at which they allow working with the crane, and at which they do not recommend it, because it's either to high wind or the load is to high.

MEASUREMENT SETUP

DATA ACQUISITION SYSTEM

- VGPS-HS-RTK (100 Hz GNSS receiver with support of GPS/GLONASS and 2 cm position accuracy with Real-time kinematics GNSS technology)
- Additional fixed base station to transmit RTK correction data
- Industrial bluetooth connection to the top of the boom

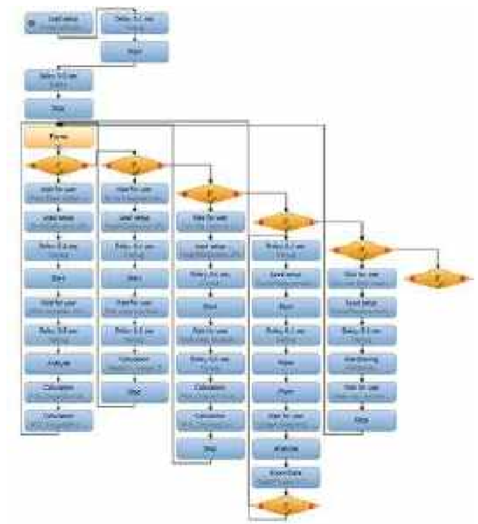
SOFTWARE

- Dewesoft X2
  Special sequence, which includes center calibration procedure

Photo of system installed on the top of the cranes boom, base station inside the factory and first measurement screen, to check bending and relative movement of the boom.

SEQUENCE/POLYGON SETUP

Since the customer wanted a turn-key solution, we had to pack the complete package in an easy-to-use hardware and software. Therefore all the complicated Math, which is needed to calculate relative distance of the movement and bending of the boom is hidden inside the Dewesoft sequencer. With this, the operator has a very easy screen to work with, and is able to perform the measurement in a couple of minutes after mounting the kit.



ANALYSIS

The display on the right was created for easier online indication to the operator, where he can input certain values as for instance load, angle, number of booms used, … All those parameters are saved inside the data file and later on exported to MATLAB® for further development calculations and simulations.

CONCLUSION

Measuring and clarifying the limits is crucial for operation of such a huge truck crane. Since customers of cranes are sometimes walking on the limit of the cranes capabilities, they have to be aware of the limits and in which weather conditions lift the load and in which not, because the consequences can be devastating. With such a system, the manufacturer is able to test the limits of the crane and also compare bending of different designs or different used materials. The complete installation including measurement and calibration (with a prepared sequence) takes around 1 h, which is also a huge improvement, because so far all the tests were performed manually (big possibility of error and accuracy around 1 m).

BRAKING & RUNNING DYNAMIC OF RAILWAYS

ABSTRACT

This application note is about a test measurement campaign to evaluate the braking performance and running dynamic behavior of railway vehicles, in order to guarantee safety against derailment. Thanks to the Dewesoft acquisition system, the signals of accelerations, hydraulic & pneumatic pressures, optical speed sensors and various electrical signals belonging to train equipment were recorded simultaneosly, in order to measure traction and braking performances, running dynamic behavior and track/vehicle interface characteristics.

INTRODUCTION

An Italian railway department performs the braking and running dynamic tests on Light Railway Vehicles. The braking tests have been composed by differents steps: speed increasing, during which the laboratory verify the braking capacity of vehicles, and braking performance in according to EN and UIC applicable. The test campaign of running dynamic can last from a week to approximatively a month, during which the Dewesoft instrumentation is the core of the field laboratory, stably installed on the vehicle.

The assessment mainly concerns the following aspects:

- Running Dynamic Behavior, according to the guidelines of EN14363:2005
- Traction performance, according to UNI11174
- Brake performances, according to EN13452-1, EN13452-2 and the guidelines of UIC544-1 (edition 2013), EN 15595 for the verification of correct integration of the wheel sliding protection (WSP) device.
- Evaluation of the permitted speeds, according to specific requirements of Municipal Authority.

MEASUREMENT SETUP

DATA ACQUISITION SYSTEM

- SIRIUS with 24 channels and I/O ports of an IPC

SENSORS

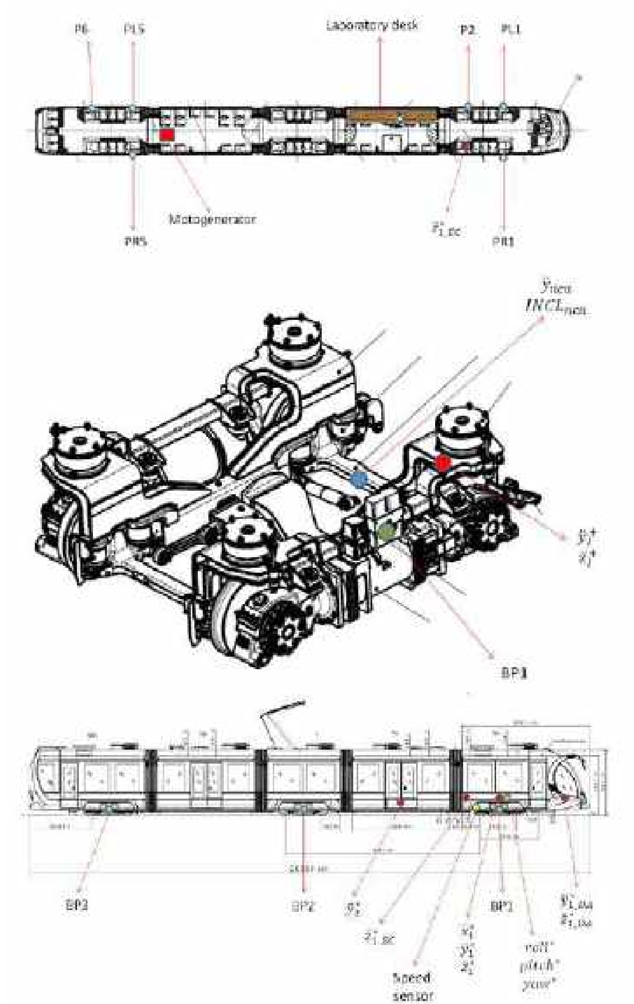
- Voltage sensors
- Distance sensor
- Accelerometers
- Hydraulic and pneumatic pressure sensors

SOFTWARE

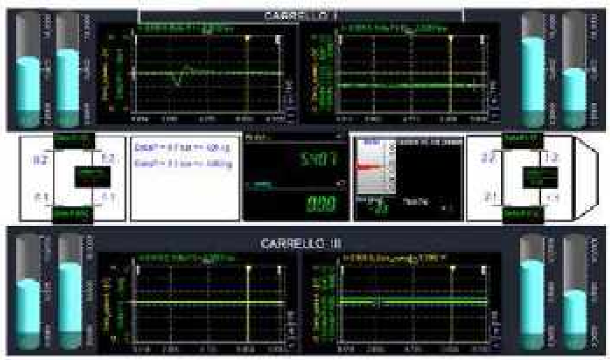
- Dewesoft 7.1 SP3

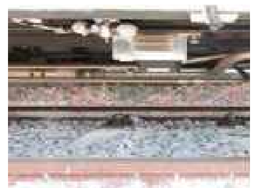
Setup example

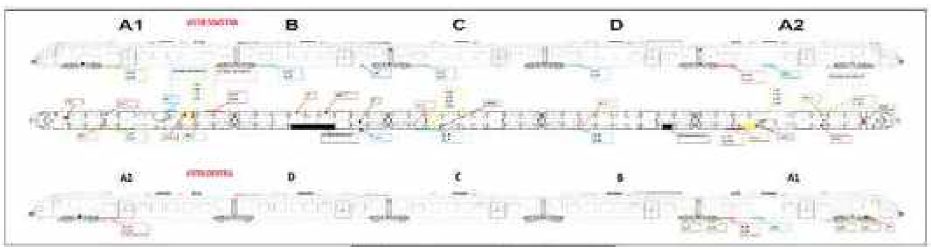
In the following pictures the positions of the sensors throughout the vehicle and the bogie are reported for a specific installation.



Screenshot of the main display built with Dewesoft including some of the main parameters that have to be visualized during the dynamic tests.







The dynamic test campaign is usually composed of two different parts: real time monitoring and post processing.

REAL-TIME MONITORING

By means of Dewesoft software all the required masks related to the relevant parameters and the line-vehicle parameters were built. These masks are useful to display safety relevant parameters (like lateral and vertical bogie accelerations, non-compensated acceleration and brake system status, etc…) and functional variables (like speed, mileage, time, pneumatic pressure of suspensions, etc…).

POST-PROCESSING

All the acquired data can be processed in DEWESoft in order to assess the compliance of the vehicle behavior to the required standards.

The main elaborations consist in

• windowing according to specific triggers

• searching of max, min and average values

• statistic data evaluation including percentiles

• FFT analysis for carbody motions

• Various signal processing calculations according to specific requirements

All the analysis performed are used by the Train Testing Laboratory to produce the final report that would be submitted to the safety authority in order to give the Authorization to Put In Service (APIS) to the vehicle.

All the data is stored and maintained as proof of the safety characteristics achievement.

The braking test is also characterized by further steps:

• Static and dynamic preliminary tests.

• Verification of braking capacity during a preliminary phase of speed increase

• Test finalized to determinate the braking performance of railway vehicle

• Post analys with Dewesoft tool

CONCLUSION

This is an application of Dewewsoft acquisition and post processing system in the railway domain. The tests consist in acquiring various types of analog and digital signals to obtain the authorization to put in service and to evaluate the safety relevant and functional parameters of different railway vehicles.

EVALUATION OF TRAIL DYNAMIC PARAMETERS

ABSTRACT

Since 2000, the fast tilting train EMG 310 (Pendolino or InterCity Slovenia ICS) operates between the stations Maribor – Ljubljana – Koper. At the start of operation the measurements of dynamic parameters of the line were needed due to increased speed. On the routes over which trains with tilting included drive, in accordance with the regulations of the superstructure of lines, the values of the dynamic parameters of forces between wheel and rail have to be measured. The purpose of the project is to carry out measurements of dynamic parameters using a tilting train EMG 310, and in this way to locate possible local bad sectors on the line.

INTRODUCTION

Measurements must be performed in accordance with the local Railway transport regulations for tilting trains. This measurements must be carried out every 12 months. The purpose of the project is to carry out measurements of dynamic parameters, using tilting train and with use of the results increase max. allowed speed on the trail.

In parallel with the measurements of dynamic parameters, the speed and position (location) of a train are also measured with GPS equipment.

One of the most important values during measurement is the ratio between lateral and vertical acceleration (Y / Q), which represents the coefficient of derailment. The ratio Y / Q is important because it indicates the possibility / probability of derailment of the rail vehicle.

MEASUREMENT SETUP

DATA ACQUISITION SYSTEM

- DEWE DAQ system with 32 channels
- DS-CAM-120

SENSORS

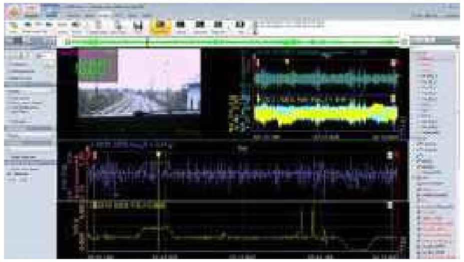
- 2-axis DC accelerometers
- Triaxial IEPE sensor for Human Body Vibration
- GPS 1Hz
- GPS Leica Viva

SOFTWARE

- Dewesoft
  Option Human Body Vibration

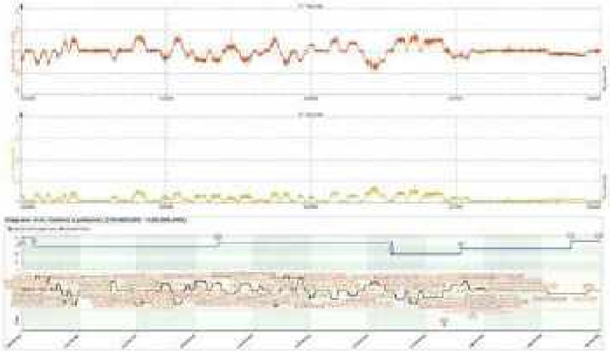
TEST SETUP

The following picture represents a screenshot of the main display built with Dewesoft including some of the main parameters that have to be visualized during the dynamic tests.



ANALYSIS

The results of the measurements are processed by segment of the rail. In addition to the measured speed minimum and maximum measured values of dynamic parameters are shown - the average lateral acceleration, lateral forces and derailment coefficient.



Averaged lateral acceleration, derailment coefficient

CONCLUSION

This is an application of Dewesoft acquisition and post processing system in the railway field. With online math possibilities inside Dewesoft all important parameters are monitored. Customer must take a special care when mounting sensors on the train body and on the roof.

ABSTRACT

Dewesoft allows real time frequency analysis of current and voltage, giving initial results during testing and sometimes replacing post-test analysis in Matlab.

INTRODUCTION

My company is in the business of measuring the power quality of railway systems. We record the current and voltage supplied to trains, and then analyze it for particular frequency content that may affect things like train detection systems, telecommunications and the power supply voltage.

Over the years the recording methods have evolved from ¼" tape, through DAT and AIT tapes, to recording to hard drives using bespoke applications written in LabView. In the last decade we have been using Dewesoft hardware and software with Dewesoft 6, 7 and now X, to make the recordings; but the data is still mostly exported to MATLAB® for detailed frequency analysis.

In the last few years we have started to perform an increasing amount of the frequency analysis using Dewesoft, either during the test to get real time results or by using post math, avoiding export to matlab.

This application notes describes the different frequency analysis methods we have used and our experience of using them with a detailed example of one post test investigation.

MEASUREMENT SETUP

Mostly we use a DEWE-43 (or two synched together) connected to current and voltage sensors via coax cables. Sometimes the cable runs need to be over a 100 m long, but by careful screening, grounding and isolation we can keep the noise levels sufficiently low.

Our current and voltage sensors have to cope with large signal amplitudes from which we have to extract small signals at particular frequencies. This makes the 24-bit ADC of the DEWE-43 very useful. We can achieve noise floors of 10 - 4A with a range of over 1000A.

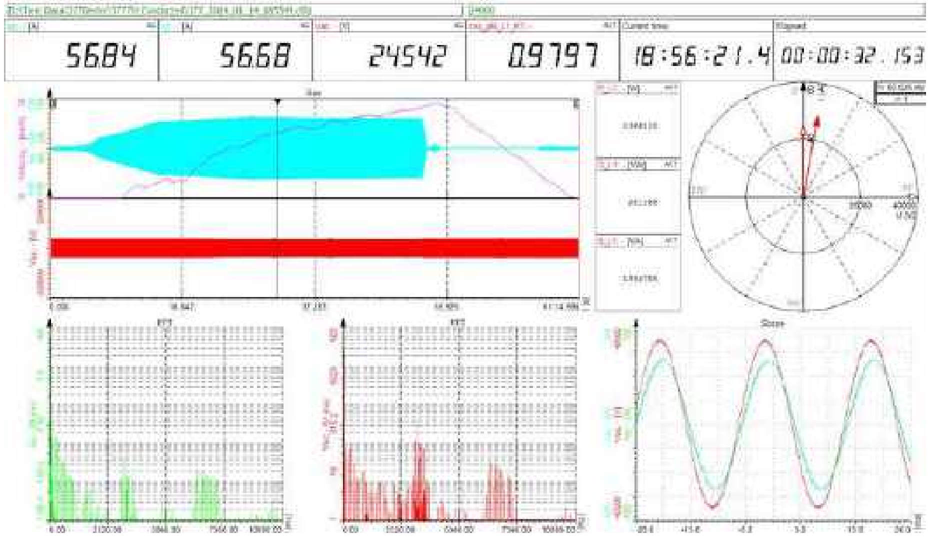
For high frequency testing we have to use a 3 MS/s instrument instead, this one isn't Dewesoft hardware so we have to use Dewesoft 7, but most of the principals are the same.

SETUP FILES

Our setup and measurement display are usually quite simple; traces of current and voltage against time with a spectrum of the supply voltage and current, sometimes compared to a limit.

We can also include "supporting data" like train location and speed and we have a custom Dewesoft plugin that allows acquisition of data directly from the trains' LAN networks.

The example below also includes power factor information from the Power module.



ANALYSIS

Dewesoft provides a number of options for frequency analysis. Our customers are often very prescriptive about how frequency content should be measured, specifying exact frequencies and bandwidths or particular FFT parameters, but a dig around in Dewesoft shows that most measurement requirements can be achieved.

THE STANDARD FFT TOOL

The simplest frequency analysis method is to use the FFT control available on any measurement screen. This provides a good "quick and dirty" view of the frequency spectrum.

The FFT resolution is limited by the restriction to power of 2 FFT block lengths – so we can use block lengths of 256, 512, 1024 etc which at 20kS/s gives frequency resolutions of 39.1Hz, 19.5Hz, 9.75Hz etc.

- We can't choose a particular resolution ie we can't have a resolution of 1Hz.
- We can't choose our own block overlap. Dewesoft overlaps blocks as much as it can within the constraints of calculation time and screen update rate.

We can set a limit curve in Math; and use that to set an "indicator lamp" control whenever the limit is exceeded. But beware, the FFT which is compared to the limit curve is not the one displayed on the screen; you may see a limit exceedance without the displayed FFT crossing the limit and vice versa!

THE USE OF LIMIT CURVES AKA "FREQUENCY DOMAIN REFERENCE CURVES"

Using Math, we can create a set of limits for an FFT (frequency domain reference curves in Math).

Be careful about the limit values – they are in absolute amplitude not in RMS. To create a set of RMS limits you have to multiply the limits by sqrt(2), then on the "measure" screen selecting RMS amplitude will scale both the FFT results and the limits by sqrt(2).

The fft used for comparison with the limits is still available only in power-of-two block lengths, but now we can specify the overlap percentage.

Sadly we can't display the result of the FFT defined by the frequency domain reference curve directly against the reference curve; we can only show the limit curve against the FFT of 3.1, which is derived using a separate FFT with an uncontrolled amount of block overlap.

Plotting the result of the reference curve comparison against time does show when the limit was exceeded, but don't expect it to exactly match what you'd expect from the real time spectrum of 3.1.

CUSTOM FFTS

What if we need to perform spectrum analysis using a particular resolution and overlap. Yes, it can be done. Go into Math functions and select FFT; this tool allows you to select any block overlap and number of lines / resolution you like (within limits: at 8kS/s the smallest resolution available is 0.16Hz = 25000 lines).

So, we can have an exactly 1Hz resolution FFT with 50% overlap.

To show the result of the custom FFT you have to plot it in a 2d graph window. This does not allow you to plot a frequency domain reference curve over the top.

INDIVIDUAL FREQUENCIES AGAINST TIME

A really useful function, which is little documented, is the facility to plot a single frequency bin from an FFT against time.

Back into the Math functions, and you can write a formula as follows:

384Hz_Current = 'Current/AmplFFT'[384]

This finds the nearest frequency to 384 in the FFT results and extracts the bin amplitude as a vector in the time domain.

Alternatively: 384Hz_Current = 'Current/AmplFFT'(385), plots the 385th bin, which is the 384Hz component of my 1Hz resolution spectrum from 3.3.

If you recorded current and voltage, you can plot the 384Hz voltage against the 384Hz current to get an impedance locus; fantastic!

SPECTROGRAMS

If you want to see the whole frequency spectrum against time, you can plot the result of the custom FFT of 3.3 in a 3d graph window – you will get a colour scaled plot of current (or whatever) against both time and frequency, aka a spectrogram.

This control is, frankly, still a little flaky. We can only get a few blocks of data displayed at once (10 to 20 blocks, normally, which with the 50% overlap and 1Hz resolution is 5 to 10 seconds of data). And what appears on the display is not always quite what's happening in real time, or (in analysis mode) what's happening where the time cursor has been placed. This is one piece of analysis I'd normally do off line in MATLAB® ….. but hey, it looks impressive if your tests are being witnessed!

DIGITAL FILTERS

Pretty much all of the analysis described in this paper can be done using digital filters – there are advantages and disadvantages.

- FFTs give you the results at many frequencies at once using a single calculation; but there is limited control of centre frequencies, bandwidth, band pass shape etc, and the impulse response is always finite.
- Digital filters allow precise control of centre frequency, bandwidth and time response for a small number of frequencies. But you have to create a different channel for each frequency of interest and you have to post process the filter output (eg with RMS) to get a useful output.

Dewesoft quickly creates a wide range of nicely stable filters based on simple parameters. You can even create more complex filters in matlab's Signal Processing Tool and type in the coefficients; one day I hope we'll be able to import digital filter objects from MATLAB® and save on all the typing … but meanwhile the built in filters are usually adequate.

AND FINALLY ... THE APPLICATION NOTE!

Here is an example of a recent measurement and analysis task. My client's new train had a new design of pantograph (the thing that picks up power from the 25kV overhead wire) and they wanted to know if the power pickup had been degraded; particularly if there were any currents generated in the band between 350Hz and 450Hz, which is used by train control equipment.

We equipped a train with current and voltage sensors along with GPS, to track train speed and location, then ran it on the main line for several night time test runs, collecting many GB of data.

The entire data set was later exported to MATLAB® and processed, looking for currents in the frequency band of interest. Whenever the current is above the required limits, the time and severity of the exceedance are automatically written to a spreadsheet. This tells us when we have an exceedance and how bad it was, but not why.

During the actual tests we had displayed a basic FFT of the line current and line voltage, but during a long test period the test operator can't be expected to watch the screen all the time; furthermore, saving a lot of maths channels during testing creates a huge data set which sucks up disk space on the recording laptop. We recorded the bare minimum and then performed analysis "as required" by throwing some post Maths at the sections of data containing exceedances.

At the end of this paper is displayed a screen shot of the full post math analysis (for the sake of this paper, it is admittedly rather more than I'd normally do).

The numbers of the following paragraphs relate to items on the screen shot.

❶ Here is the basic real time "FFT tool" with a block length of 4096 samples to get close to a 1Hz resolution; the 8kS/s sample rate gives us a resolution of 0.9765625Hz which shows the contents of bins at 383.79Hz and 384.77Hz, but not AT 384Hz.

A limit curve has been superimposed over the FFT, using a "number of lines" = 8192 which gives a block length of 4096 and a resolution of 0.977Hz, like the FFT over which it is superimposed. But the overlaps are (probably) different.

It would be good (Dewesoft people) if the FFT Options listed in the FFT limit curve Math function used the same parameters as the real time FFT tool. Being able to directly select resolution (instead of block length or number of lines) in both tools would be even better.

❷ Here is an FFT derived using the FFT tool in the Math functions. Exactly 1Hz resolution has been chosen to give bins exactly centred on (eg) 384Hz. You can see the difference in amplitude measured by the 1Hz resolution FFT (0.67A at 384.0Hz) from that measured by the 0.977Hz FFT derived in 1 (0.53A at 383.8Hz).

Unfortunately the limit line comparison can't use this exact FFT and the limit line cannot be plotted in the 2d chart used for display of the spectrum. That would be a good thing to have.

❸ Here is the FFT limit line comparison plotted against time; a handy tool to show when the current exceeds the limits; though it's only approximate as the comparison is with the "wrong" FFT for our needs.

❹ Here is the 384Hz FFT bin of the voltage spectrum plotted against time …

❺ and here is the 384Hz FFT bin of the current spectrum plotted against time

It's clear from these pictures that the voltage and current go up and down together. For the exceedance shown here, the 384Hz current is due to 384Hz in the supply voltage.

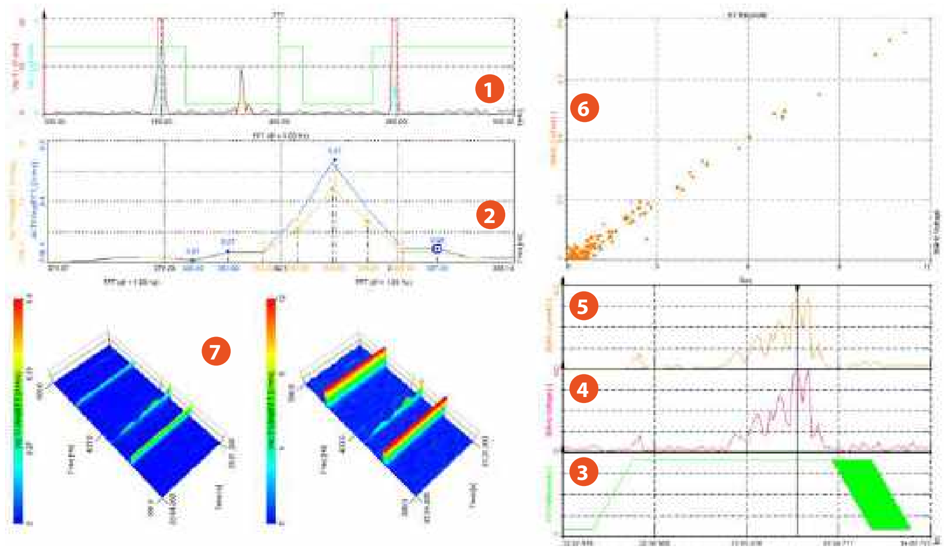
NB: There is some plotting functionality in Dewesoft here which limits the resolution of the plot – even though our high resolution screen could show the details of the changing current and voltage, Dewesoft only shows an envelope of maximum and minimum values; I'd like this to be something I could customize or turn off.

❻ Here is the amplitude of the 384Hz bin of the current spectrum plotted against that of the voltage. It's easy to see that the 384Hz current and voltage not only go up and down together but are proportionally related (ie by a constant impedance).

NB: This particular graphic does not copy well using "copy screen image to clipboard" … I think it is still drawing the dots when the clipboard copy is made and you often end up with a blank axis in your MS Word® report. However, "copy group image to clipboard" does the trick.

❼ And here are spectrograms of the voltage and current showing the 384Hz component to be the only one present (apart from power harmonics) and showing them changing together. This is more for show than information, but I have to say, it does look good.

There are only 18 blocks (9s) of data shown (more would be good) and as I aligned the cursor on the moment of peak current, that peak current and voltage event is at the extreme edge of the spectrogram; the display shows blocks leading up to the cursor position rather than around the cursor position, which would be even better.



CONCLUSION

We have shown a wealth of FFT analysis and display possibilities in Dewesoft X; these are convenient to use directly on the data either in post maths or in real time, saving the time and bother of exporting to MATLAB® and the writing of custom analysis routines.

There are a few pit falls to be aware of – eg the slightly different results that arise from the different FFT tools, and the way that certain parameters have to be entered differently into different tools to get the same result.

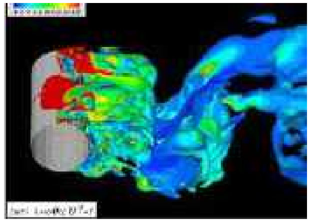
Though Dewesoft has yet to make MATLAB® redundant as a post-test signal processing tool, there is a lot that can be done in maths and post maths functions to give us the frequency analysis data we need.

Comment of DEWESoft factory: Due to continuous improvement and listening to our customers, the most recent DEWESoft X already contains some of the wished features, such as being able to set the exact FFT line resolution (e.g. 1 Hz, 2 Hz, 0.5 Hz), and directly entering the bandwidth instead of the sampling rate! More features built in, please visit our website.

MARINE RESEARCH

INTRODUCTION

An institute of the Italian Council of Research makes numerical and experimental research on naval hydrodynamic and marine engineering, performing tests of new marine vessels, renewable energy devices, propellers, etc.



EXPERIMENTAL FACILITIES

Towing tank n. 1, among the largest in the world (470 x 13.5 X 6.5 m)

Towing tank n. 2, equipped with a wavemaker (220 x 9 X 3.8 m)

Testing facility at a lake for manoeuvring tests

Free surface circulating channel depressurizable

(test section 3.5 x 2.5 x 10m)

Smaller facilities for basic research

(turbulence, drag reduction, sloshing, wave breaking, internal waves)

MEASUREMENT SETUP

DATA ACQUISITION SYSTEM

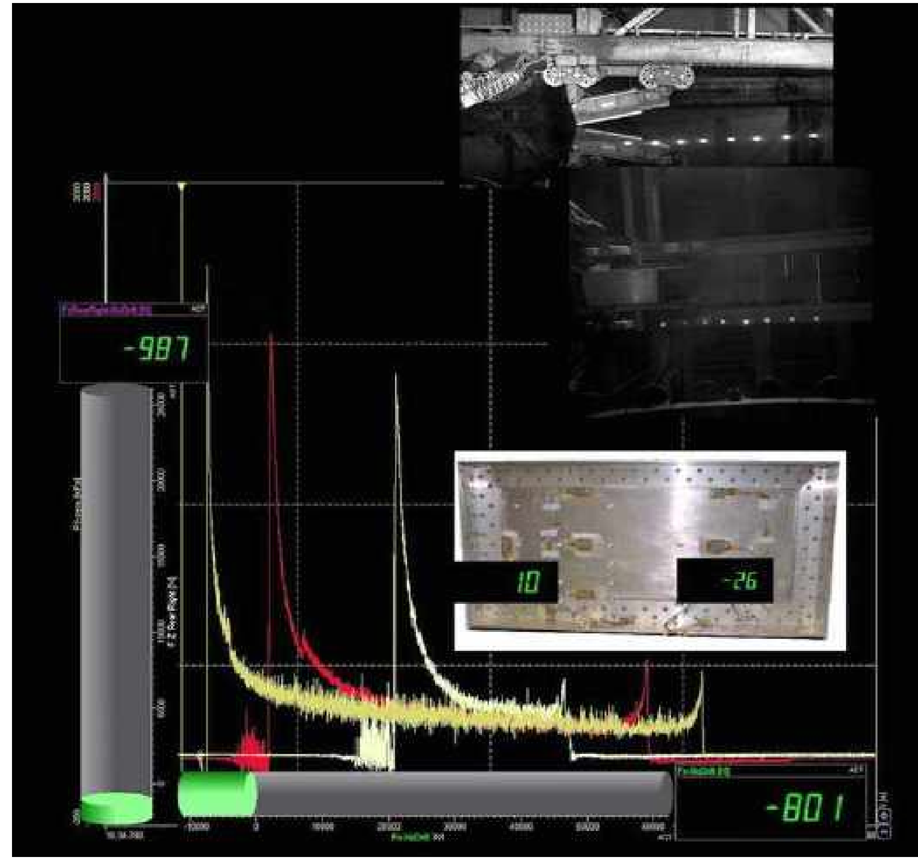
On board devices:

- 4 SIRIUS
- 1 DEWE-43
- 1 SBOX PC

Sample rate: up to 200 000 Hz

SENSORS

- 6 biaxial Strain Gauges
- 18 Pressure sensors
- 4 Load cells
- 6 accelerometers


-987
10
-26
-801

“Mystery creates wonder and wonder is the basis of man’s desire to understand.”

-Neil Armstrong

AEROSPACE


DEWESoft®
SIRIUS-R8DB

TURRET TESTING

INTRODUCTION

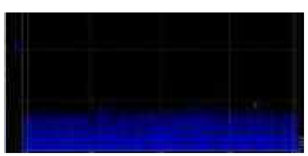
A United States Army facility Proving Ground - one of the largest military installations in the world. The Proving Grounds are used mainly to test Military vehicles. This application note encompasses a certain test on these Grounds, because of the vehicle we were unable to get the name of the tank. We were able to see the test preformed and get several data files.

GPS

Global Positioning is essential for accurate vehicle testing in today's testing world. Rarely is there a test at the proving ground preformed without GPS being utilized on the vehicle and surrounding vehicles as well.

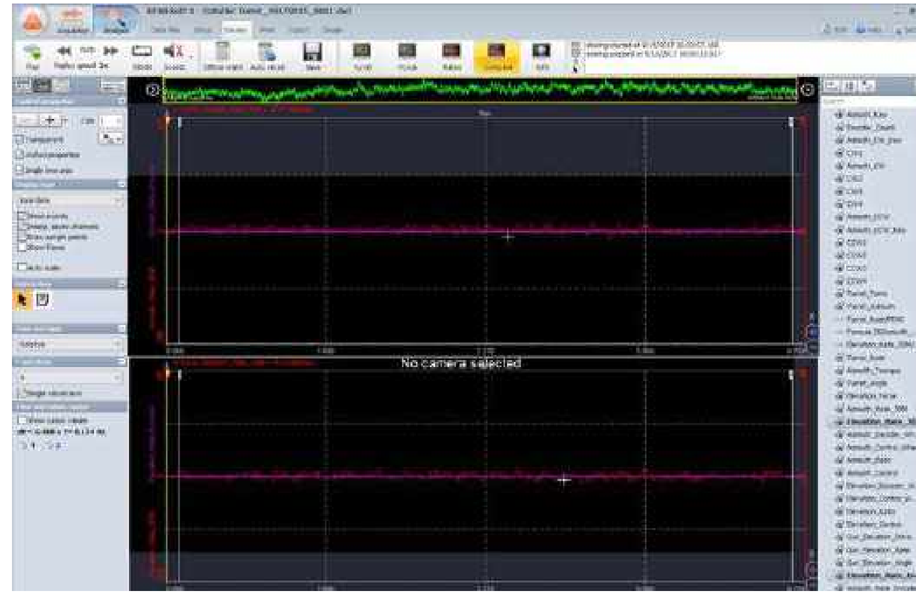
FORCE

Full Force measurements were taken on multiple points of the Turret. These were taken in conjunction with Torque and Vibration measurements. These were taken to monitor the Turret's torque as well as the cannons vibration in comparison.



Turret Rate Degrees per Second in Harmonics.

COMPARISON



Comparison data in the Turret Elevation rate as well as 360 ° Rate comparison.

CONCLUSION

Using Dewesoft and its capabilities our customer was able to compare and successfully test a valuable piece of US military equipment. The customer said "We love Dewesoft ease of use and ability to give us everything in 1 software and hardware package!"

MISSILE AND ROCKET ENGINE TEST BENCH

ABSTRACT

1000+ channel modular DAQ system with real-time output to EtherCAT® control system.

Dewesoft R8 instruments connected into a network present the go-to solution for large aerospace, defense and automotive test benches. Each R8 can hold up to 64 SIRIUS amplifiers and output real-time data to EtherCAT® in parallel with local storing and sending the data over TCP/IP network to the central unit.

INTRODUCTION

Testing of missile and rocket engines presents a great challenge for system engineers because there must be no humans in the close proximity of the measurement during the test. Due to high cost of a test, large number of channels and high sample rates are necessary. Therefore the overall data rate is high and the distance between the measurement and the operator is large. This must not jeopardise the reliability of the measurement, data storage and test bench control.

Dewesoft joined forces with an established aerospace system integrator to lay out a system architecture that not only meets the reliability criteria but also presents an easy-to-use DAQ system. The simplicity for the user is almost the same as if a single 8-channel SIRIUS slice was plugged into a laptop.

SYSTEM ARCHITECTURE

Figure 1 shows the overall system architecture. The following key functionalities were used or developed to meet the needs of the measurement system:

- All measurement channels use the Dewesoft SIRIUS STG amplifier: Isolated 24 bit DualCoreADC® with 160 dB dynamic range, 200 kS/s sample rate, that can interface to almost any sensor due to highly programmable front end, four measurement ranges, wide range voltage/current excitation and TEDS support.
- Dewesoft R8 instrument presents a modular building block consisting of a powerful SBOX PC (Intel i7 processor, 1 TB SSD) and up to 8 SIRIUSire-STG slices (each having 8 STG amplifiers) that can be swapped between different R8 instruments.
- Dewesoft software is running on each R8 to store data locally and send it over the Dewesoft NET network to the central master client and additional view clients. Network configuration allows many R8 instruments to be distributed over a large area. Storing all the data locally and on the central client ensures the system redundancy.
- IRIG synchronization ensures that all of the measurement channels are synchronized down to 1 microsecond, independent of the location of the unit, as long as IRIG signal is available.
- Trigger information is multicast over the whole network, allowing an analog trigger from a remote R8 to trigger the rest of the system to a precision of a single data sample.
- Measurement channel configuration on each connected R8 can be accessed and controlled from the central master client. With sensor scaling, amplifier configuration, channel name etc. all stored in TEDS memory on each sensor there is a very small chance for user error during configuration.
- R8 instrument also comes in a real-time version, called R8rt. It has the EtherCAT® bus on the backplane that allows real-time data output from each SIRIUS slice directly to the EtherCAT® bus. In this way, the same amplifiers can be used for data acquisition and as control system inputs.

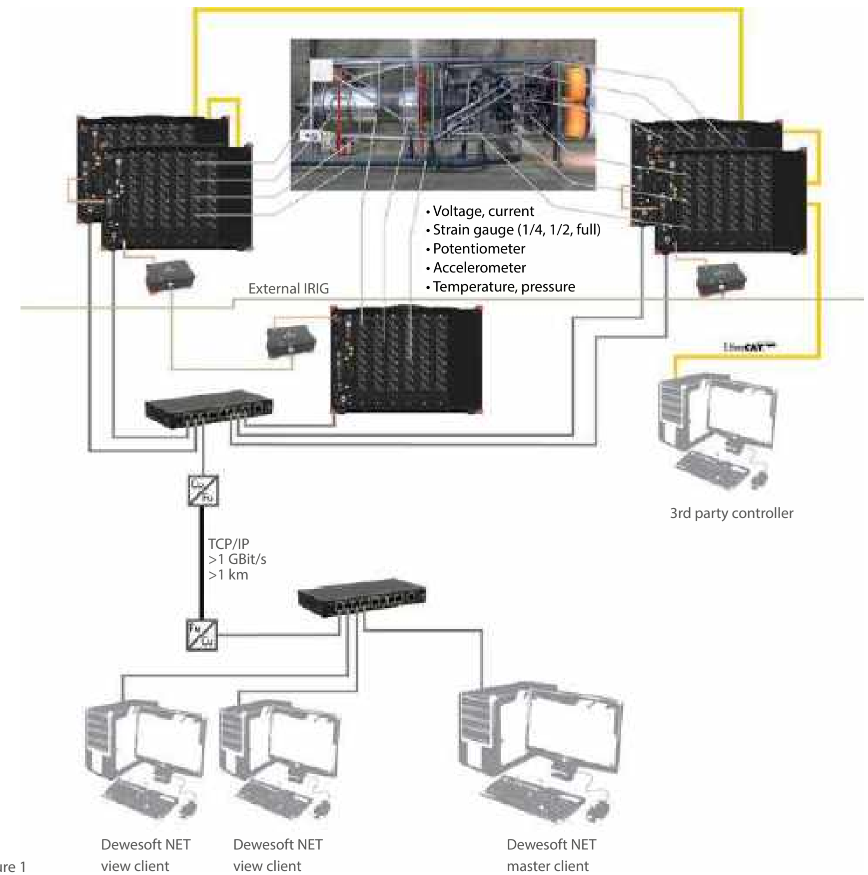


Figure 1

NETWORK - DEWESOFT NET

As seen in Figure 1, Dewesoft NET allows flexible configurations of measurement units, view clients and a master client. Each member of Dewesoft NET must be running an instance of Dewesoft. In case of R8 instruments, Windows® with Dewesoft is running on the included SBOX. Each R8 can transmit all the acquired data to the Dewesoft NET even if 68 channels are running at 200 kS/s sample rate. The total data rate on the master client, receiving the data from many R8 instruments, is up to 2.5 GBit/s in this application.

External copper to optical ethernet converters allow the distances from an individual R8 to the network switch to be in the range of kilometres.

AMPLIFIER CONFIGURATION

Each amplifier in the system can be configured from the central NET master client. Channel setup on the master client displays all the channels which makes the setup procedure for the user the same as if a local setup was performed. In this specific application the customer is using the TEDS functionality to the maximum. Besides standard TEDS data Dewesoft also supports Dewesoft-specific templates that allow the user to completely set the SIRIUS STG amplifier from TEDS memory. This prevents operator configuration errors and removes the need to connect the right sensor to the specific input connector – any channel is automatically set according to the connected TEDS sensor.

SIRIUS-STG hardware can read TEDS data over up to 200 m of cable, allowing further distribution between the amplifiers and sensors.

CROSSTRIGGER

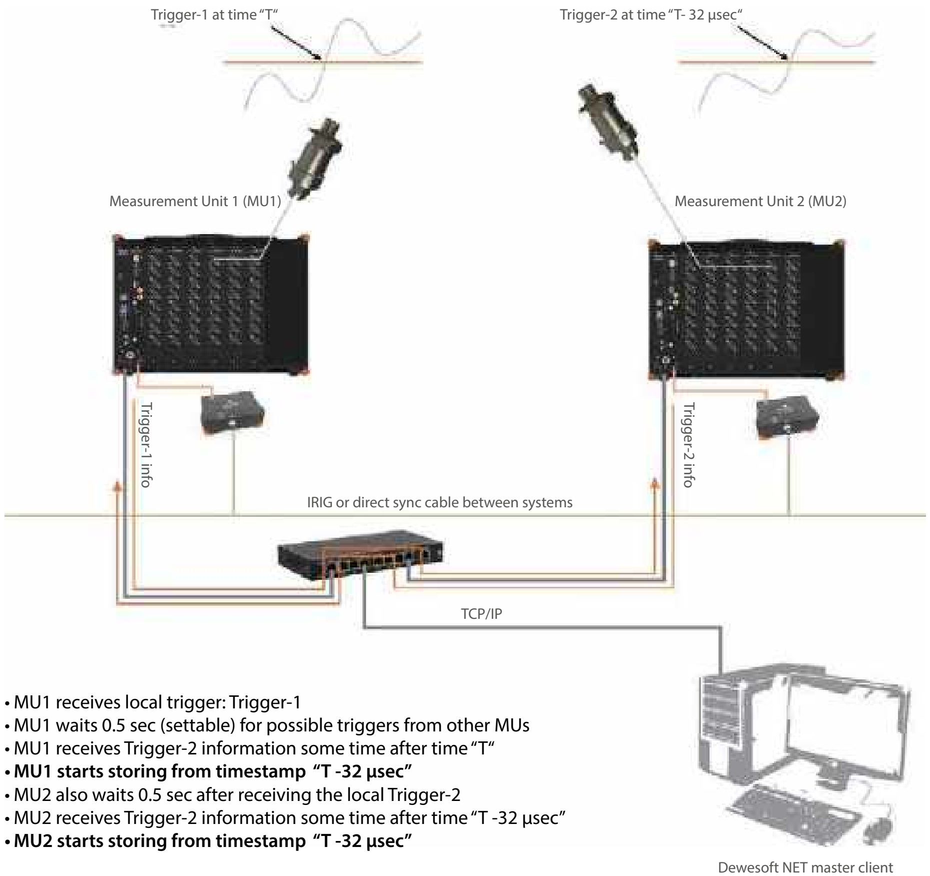
Global network triggering - Crosstrigger

Another challenge of having multiple measurement units separated by large distance and connected in a network is the triggering. In many cases the user wants to start storing the data from the same data sample on all measurement units, like in the following case:

- The test lasts for more than 10 days. The point of interest is an event occuring at a random time during the test. The event needs to be recorded at full speed with many channels on different measurement units.
- Due to disk size limits it is impractical to store the data at full speed for the whole test. Therefore the storing-on-trigger must be used.
- Trigger can come from any of the numerous sensors/conditions, distributed over multiple measuremnt units (i.e., it is not practical to analogously wire the trigger signals to each measurement unit).

The solution is to send the trigger information over the network. This can be problematic since TCP/IP is not a real-time protocol and it is not possible to predict what time it will take for the information to reach all measurement units.

Dewesoft developed a solution that sends the trigger information (with exact absolute timestamp) as multicast messages. All the measurement units (MUs) that join the same multicast groups receive the trigger information from other MUs. After receiving trigger information (locally or from the network) the MU waits for a certain settable period of time (~0.5 sec) to ensure that no other trigger has occured sooner. The MU is then triggered from the earliest timestamp, which is possible thanks to large enough sliding buffers that temporary save data for long enough period of time.



Schematic of the crosstrigger function

ETHERCAT OUTPUT

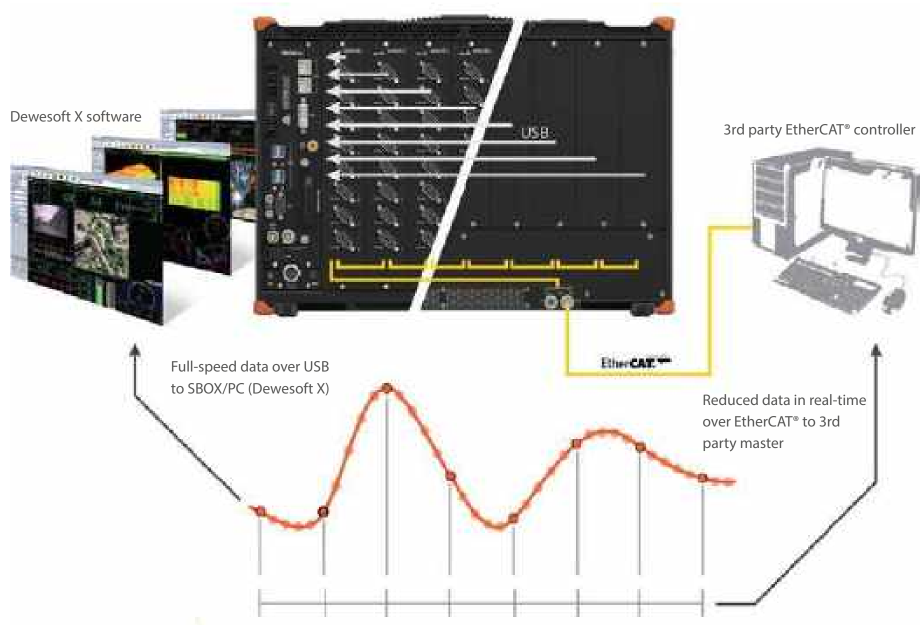
Real-time EtherCAT® output – Dual mode

SIRIUSe instruments can use EtherCAT® and USB interfaces to provide real-time data to a 3rd party control system and full-speed data to Dewesoft X software in parallel. R8rt (version with EtherCAT® backplane) can host up to 8 SIRIUS EtherCAT® rack slices a 3rd party control system can access the data from SIRIUS slices in real-time:

- 100 microseconds worst-case delay and
- Minimum EtherCAT® cycle time of 100 µs can be achieved with appropriate EtherCAT® master configuration and performance.

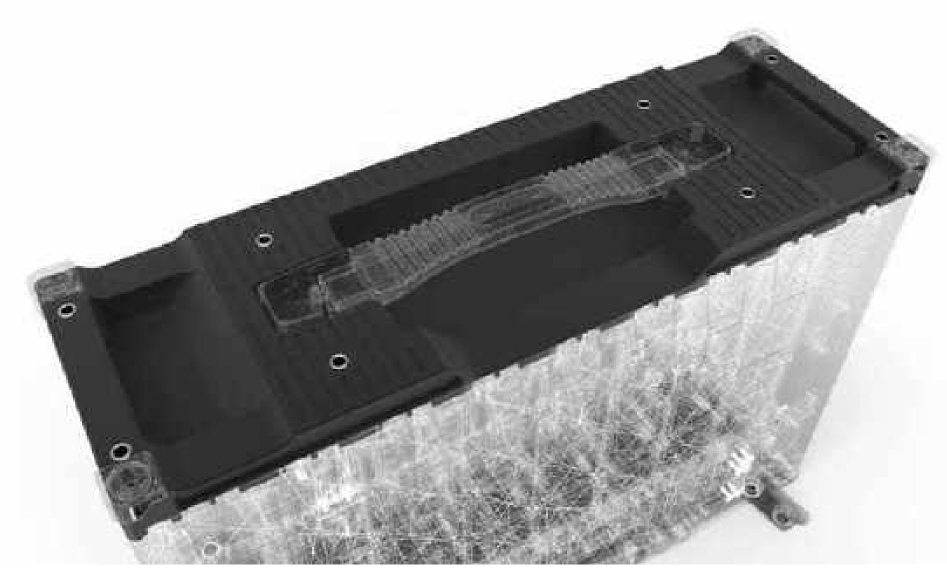
On a missile test bench the R8rt is used to perform the usual signal conditioning and data acquisition task and at the same time provide test-critical data to a control system. This has two main advantages:

- There is no need for special control system amplifiers since the same temperature, pressure or strain sensors can be used for data recording and test control and
- The data used for test control can be analysed with the same powerful hardware/software capabilities as the data from regular data acquisition channels.



VIBRATION RESISTANCE

R8 instruments can be ordered with special mechanical enhancements that allow the systems to sustain 3 grms random vibration for 30 minutes in each direction. This specific vibration profile was chosen to represent the vibration environment in the launch towers of missile and rocket launchpads.



R8 can sustain 3 grms random vibration 30 minutes in each axis (on request)

NAVAL AND LAND SYSTEMS

INTRODUCTION

Turkish MBT – ALTAY

The work reported in this paper tries to explain the facts and findings of data acquisition processes in military projects, mainly based on naval and land systems.

In our practical world, mechanical systems rarely expose failure under static loading. Mostly they are excited by dynamic loads. These loads need not necessarily stress the components above the yield point to cause mechanical failure, if enough cycles are applied on the component, there will be fatigue failure [1]. Mechanical systems running dependent on electronical devices also expose failure or mostly malfunction due to the vibration and shock which effects the electronical setup. In this study acquisition of data from the integration platforms is explained.

Land platform tests in this study are performed on the prototoype MBT (Main Battle Tank) ALTAY (Figure-1) of the Turkish Land Forces. Naval tests are performed on KILIC CLASS Fast Patrol Boats (Figure-2).

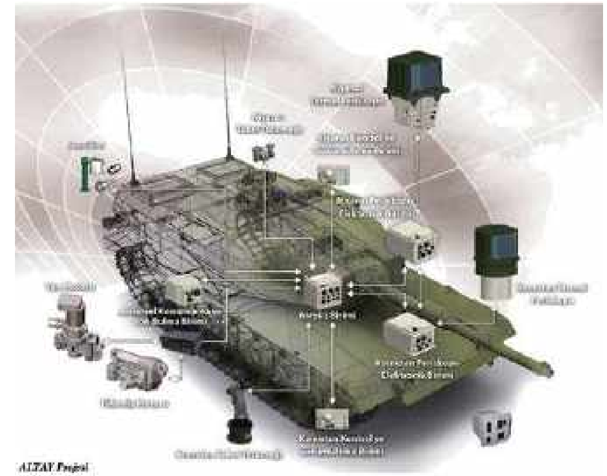
ALTAY MBT consists of many electronical equipments as shown in Figure equipments and sensors are sensitive to vibration during the movement of the tank and shock during gunfire. These systems must be tested during the design and prototyping phases. Platform data is needed for the vibration and shock input. The customer has many equipments designed specific to ALTAY. Mechanical Design Directorate (MTD) conducted all these pl tests for road and gunfire data.

High seas operations are vital for any fleet. During these operations away from the homeland, KILIÇ Class fast patrol boats required a new stabilized platform for the safety of the operations. Any stabilized device over a harshly moving platform need platform orientation, shock and vibration data during the design phase. HBT-MTD conducted sea trials for data acquisition processes.

KILIÇ Class Fast Patrol Boat

References: [1] Murat Aykan, Mehmet Çelik, Vibration fatigue analysis and multi-axial effect in testing of aerospace structures, Mechanical Systems and Signal ProcessingVol.23, 2009, pp.897-907.

MEASUREMENT SETUP



ALTAY Project Electronical Equipment

ALTAY TESTS

Live fire tests (stationary and during movement) are conducted only with specialized personnel inside the tank. Some tests are even done without any personnel inside. One must prepare the data acquisition setup for reliable operation and long duration power need.

Taking the power from the platform is a risky business, since at any time, power can be cut off for the sake of the tests. BB2590 batteries are used as power source for the tests. These batteries are the main battery for the manpack radio sets of the army also shoulder fired anti-tank missiles etc. It can be found in any military installation, so logistics of this battery is easy. For the sake of the battery life, once the configuration was set, screen was plugged of. Screen seems to be a major power consumptions source.

Accelerometers were used for data collection. Previous gunfire experience of our personnel for different platforms helped us to choose the type of accelerometers.

Grounding of the Minitaur Chassis is also a must because too many electronical devices for test purposes existed inside.

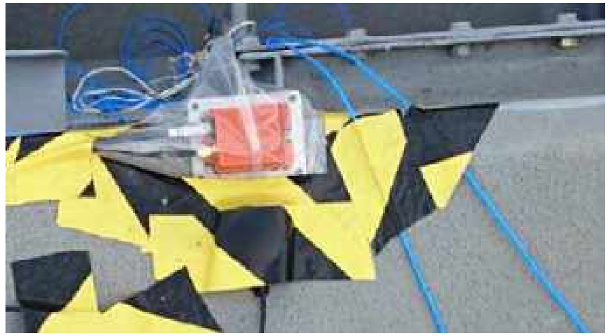
Inside the tank it is a living atmosphere. Since it is a prototype tank, there are many devices which will not be there in the serial production. Dewesoft Minitaur-1R rugged system was placedin the tank with all the battery and accelerometer connections. During the tests MTD personnel is not allowed to get in the tank. After the tests, it is found out that ammo shells fall over the Minitaur chassis. Some hydraulic fluid leaked over it during a cleaning process. Under these conditions data can be collected without any problem.

Minitaur-1R and Screen for the fire tests

ALTAY Stationary Fire Tests

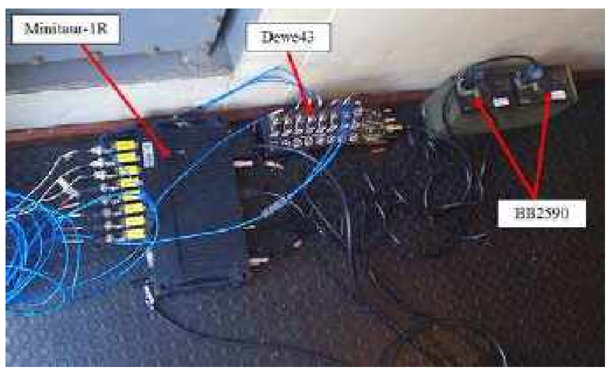
KILIÇ TESTS

Kılıç tests were performed while docked to the harbor and on the open sea. The place where the installation of the new system is planned is prepared for sensor placement. While the main and auxillary motors were working on idle, vibration data is collected in the harbor. sensor was also placed with the accelerometers on the platform for the detection of yaw, pitch and roll movements for open sea trials. The sea and weather condition may change during the trials, so all the sensors are covered for water protection.



Sensors were covered for weather protection

Minitaur-1R and Dewe43 were synchronized for the tests because of the high amount of channel needs. Two BB2590 batteries were used and it lasted for the whole day.

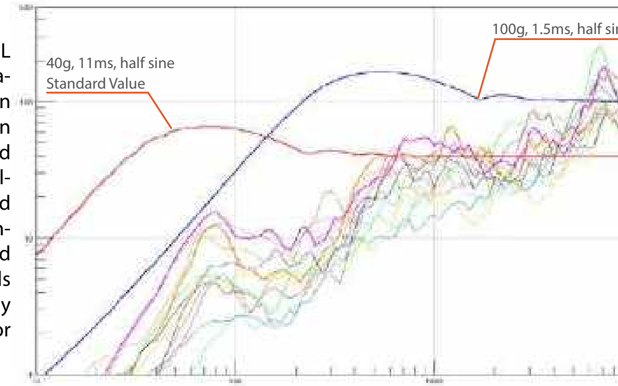


Test equipment

ANALYSIS

ALTAY TESTS

Military standards, especially MIL-STD-810 gives general information about shock and vibration data of the military platforms. In the standard it is recommended that if platform data is not available, the values in the standard may be used and tailoring is essential. When collected data is plotted it is seen that military standards either do not cover the necessary requirements or are over-safe for this specific case (Figure-9).

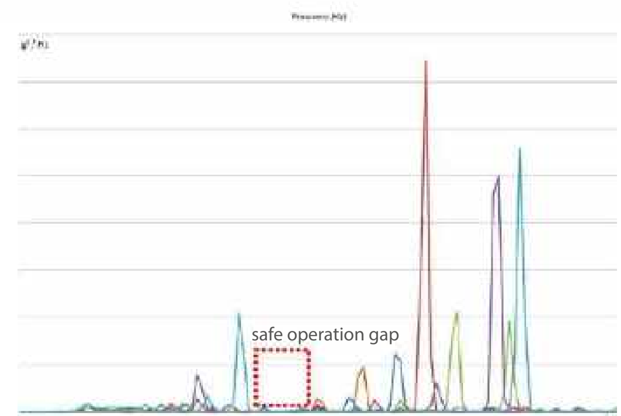


Comparison of standard and collected data

KILIÇ TESTS

Yaw, pitch and roll data are collected and processed for the specific requirements of the stabilization project. The design highly depends on the ground position and its velocity of change. The necessary equipments are selected or designed specifically for this class of ships.

Vibration data is processed and it is seen that for specific frequencies there is a gap where safe operation is possible (Figure-10). This data is shared with the design department, for the safety of the design and the design of the foundation.



PSD graph for the integration point

CONCLUSION

In military platforms where operational efficiency is vital, platform data should be collected. Military standards may not cover some specific purposes. Without the data collection phase, the new equipment on Kılıç Class Patrol Boats may not work well because of the ground noise, which is very high for some frequencies as can be seen above. Also some values on the standards may lead to over-safe designs where designers end up with very heavy, expensive final product.

AVIATION POWER TEST

INTRODUCTION

This application note is used for Aviation Power test, all the test is according to US standard MIL-STD-704F.

The US Department of Defense released a standard called MIL-STD-704F to establish the requirements and characteristics of aircraft electric power provided at the input terminals of electric utilization equipment. MIL-HDBK-704-1 through -8 defines test methods and procedures for determining airborne utilization equipment compliance with the standard MIL-STD-704F. In China we have the similar standards GJB 181A-2003 and GJB 5189-2003.

Besides the basic electrical parameters, the top five tests that the customer cares are shown below:
- Envelope of normal 400(60) Hz and variable frequency AC voltage transient
- Limits for 400(60) Hz and variable frequency AC overvoltage or undervoltage
- Envelope of normal 400(60) Hz AC frequency transient
- Limits for 400(60) Hz AC overfrequency or underfrequency
- Maximum distortion spectrum of 400(60) Hz and variable frequency AC voltage

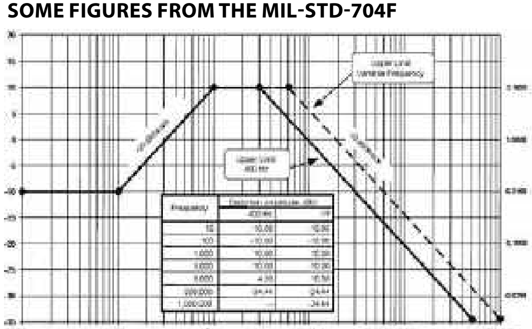
MEASUREMENT SETUP

DATA ACQUISITION SYSTEM

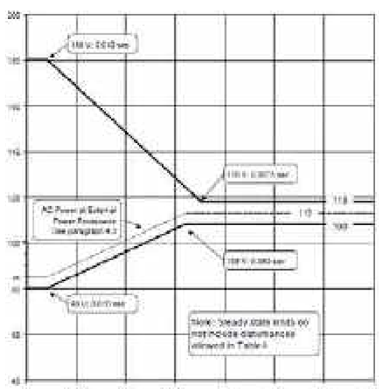
Two sets of SIRIUS-R8D with:
- 6 x SIRIUSir-HS 8xHV
- 6 x SIRIUSir-HS 8xLV
- 4 x SIRIUSr 8xACC

HV and LV modules are used for Voltage and Current measurement, and ACC modules are used for Vibration test.

SOME FIGURES FROM THE MIL-STD-704F



Maximum distortion spectrum of 400 Hz and variable frequency AC voltage

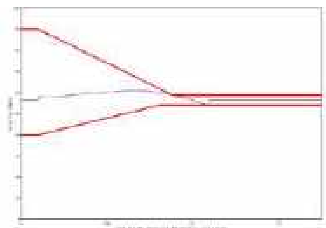


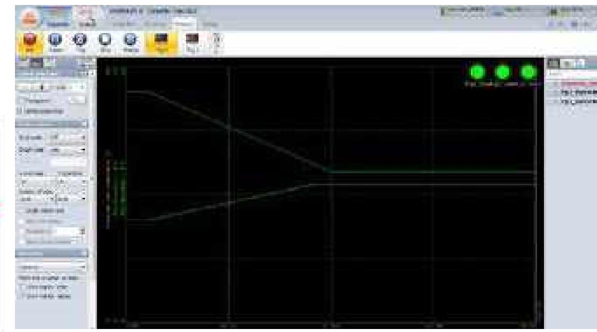
Envelope of Normal AC voltage transient

ANALYSIS

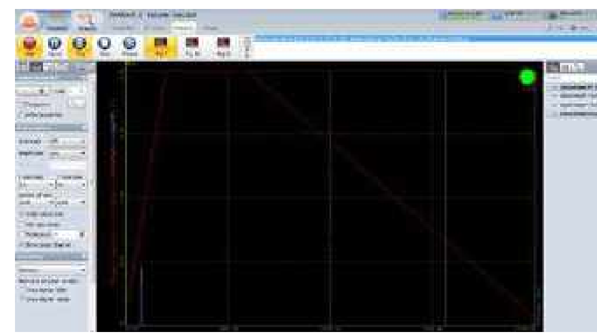
We made some test setups for different test procedures.

Envelope of normal AC voltage transients





Maximum distortion spectrum of AC voltage



CONCLUSION

We could make the special setups for such test methods to fulfill the test procedures for MIL-HDBK-704-1 through -8. The next step could be a special plugin for such particular application.

References:
[1] US Department of Defense interface standard. Aircraft electric power characteristics.MIL-STD-704F.12 March 2004.
[2] US Department of Defense handbook.MIL-HDBK-704-1 through -8.9 April 2004.

ORDERTRACKING OF GAS TURBINES

ABSTRACT

Under the European research project ESPOSA (Efficient Systems and Propulsion for Small Aircraft (https://cordis.europa.eu/project/rcn/100644_en.html), for which our customer is a partner, the aim was to develop and integrate a novel design and manufacture technologies for a range of small gas turbine engines up to approximatively 1000 kW to provide aircraft manufacturers with better choice of modern propulsion units. There were also researches made for engine related systems which contribute to the overall propulsion unit efficiency, safety and pilot workload reduction, in this case the gear-box. As a producer a turbine motors, our customer came into this project with projecting, simulations and measurements for the transmission gear-box with a multiplication factor of 26. Our customer has to project, simulate and test for this assembly. Among the tests made for the fault detection, an Order Tracking analysis was performed.

INTRODUCTION

This Turbine Engines Research and Development Institute in Romania is working in development and integration of scientific research, constructive and technological design, manufacturing, experimentation, testing, technological transfer and innovation in the field of aviation turbine engines, gas turbine industrial machines and high speed blade machines.

For testing procedures, the turbine engine was build on a special stand, on which the gears were brought to running speed. With 8 accelerometers placed axial and transversal to the axis of transmission, the signal was transformed from time domain to the angular domain. The technique of Order Tracking was applied for bringing the asynchronous signals to a single sampled signal of the reference shaft, this resampling being actually an interpolation. The FFT of the angular domain signal is defined as an order and represents a fraction of the angular velocity of the reference shaft. These orders make it possible to identify the frequencies which are related with angular speed and those which are different and which are a result of the structural vibration of the transmission gear-box.

MEASUREMENT SETUP

For an order tracking analysis it was used 8 analog channels for acceleration measurement and a laser counter for measuring RPM. One channel is defined as alternatively RPM determination from FFT acceleration spectrum.

As an encoder for measuring the velocity it was used a non-contact laser system with black-white marks on the shaft. For finding the natural frequencies related with angular speed, the Campbell diagram was plotted as a vibration response spectrum as a function of the shaft rotation speed.

DATA ACQUISITION SYSTEM

- SIRIUS 8x ACC, SIRIUS 8x STG with 8 DSI-ACC converters
- SBOXfe computer
- Battery

SENSORS AND TRANSDUCERS

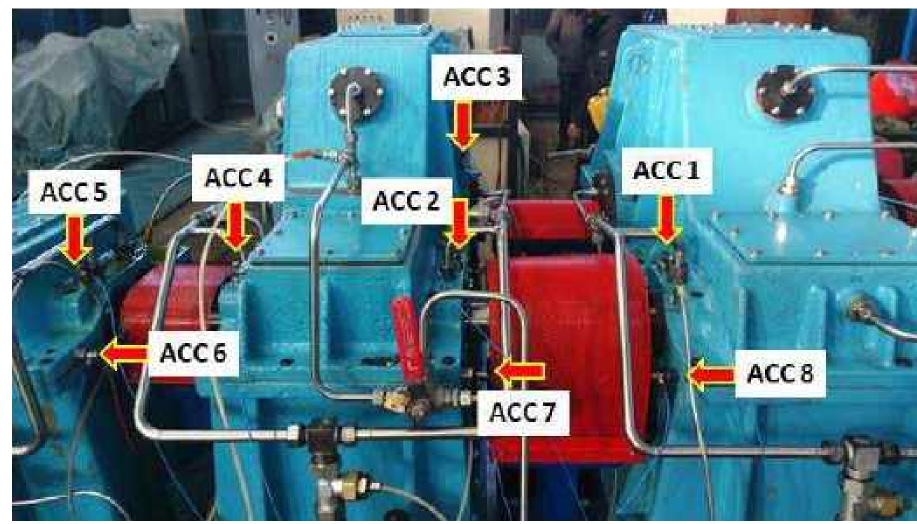
- 8 Bruel&Kjaer Single axis accelerometers
- Laser

SOFTWARE

- Dewesoft-X-DSA (OT and FFT)

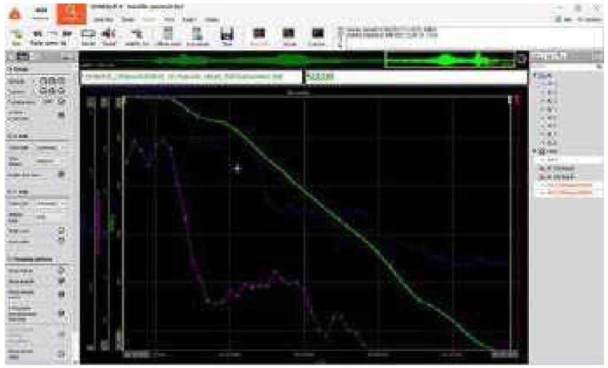
TEST SETUP

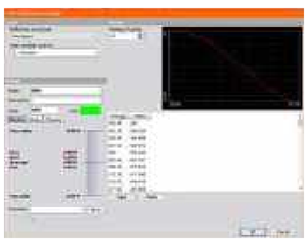
For setting up the channels, 8 channels for accelerometers and one channel for acquisition of the angular speed or rotation per minute have been used. Alternatively, the RPM was acquired from the FFT spectrum of one accelerometer.

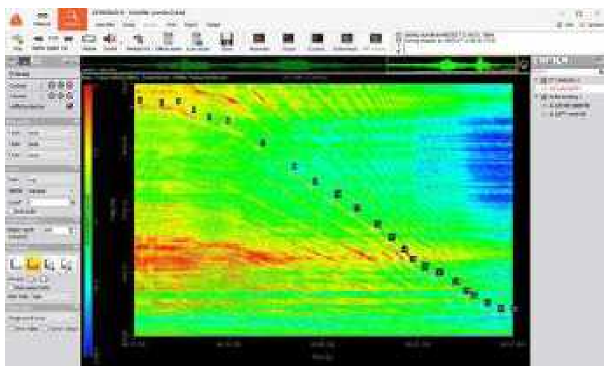


ANALYSIS

The regimes of the gear-box running on different angular speeds were found during the order tracking analysis with Dewesoft. Using Dewesoft OT module, the time domain data was resampled in order tracking way. FFT spectrum and Campbell diagram were plotted. The angular speed was taken alternatively directly from the acceleration spectrum and from laser encoder and obtained similar results.


Time domain data


Reference curve


3D waterfall diagram

CONCLUSION

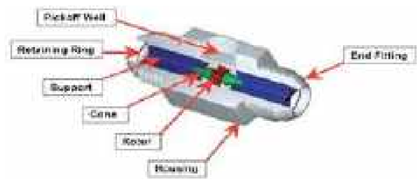
Topic of this analysis was to define the possible errors or faults in the ensemble of the gear-box which might come from unbalancing, bearing faults, gearing imprecisions, eccentricity or assembling faults. Unbalancing was searched on the first order, eccentricity on the second order and different upper orders for bearings faults.

INTRODUCTION

Precision Turbine meters are used in Test and Measurement applications in the Automotive and Aerospace Industries to measure fluids such as fuel and oil. They are selected because of size, repeatability, wide rangeability, resolution, cost and ruggedness. They are however, viscosity sensitive. They are also a volumetric device. A Mass measurement would be even more accurate.

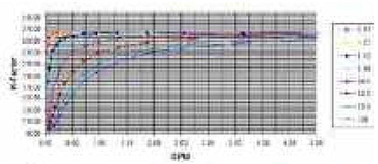
Many test departments own hundreds of these meters.

Many of these companies own flow calibrators and calibrate in house. Others send them out. Many suffer inaccuracies from not correcting for viscosity and density or even non-linearity. Others write in house algorithms based on history. Expensive flow computers can also be purchased from the flow meter manufacturers.

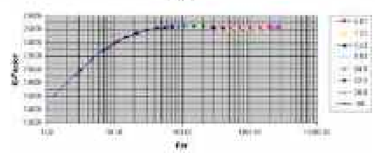


ESTABLISHING A REYNOLDS NUMBER

The chart on the right shows an inaccuracy of 8% in a 10 cSt fluid at 1/10th max flow. The thicker the fluid or lower in the flow range, the greater the accuracy loss (loss of rotation per volumetric unit) or "slippage"



The next chart shows a how considering the relationship of velocity to shear stresses can be plotted in a curve, known as a Universal Viscosity Curve or Strouhal-Rohsko Curve.



A Reynolds Number establishes a measure of laminar or turbulent nature of the flow. It is defined as:

$$Re = \frac{\rho V D}{\mu}$$ where

ρ - Fluid density
V - Fluid velocity
D - Diameter of pipe
μ - Absolute velocity

CALIBRATION CURVE

$$Re = \frac{\rho V D}{\mu}$$ where

ρ - Fluid density
V - Fluid velocity
D - Diameter of pipe
μ - Absolute velocity

$$\nu = \frac{\mu}{\rho}$$

The ratio of Absolute Viscosity to Density can be expressed by the Greek letter nu (v) and is known as Kinemetic Viscosity.

The Velocity can be measured by measured by counting the rotor blade and calibrating the at various flow rates. The Frequency (Hz) of the rotor blades is proportional to Velocity. The Diameter of the pipe inside the flow meter is constant.

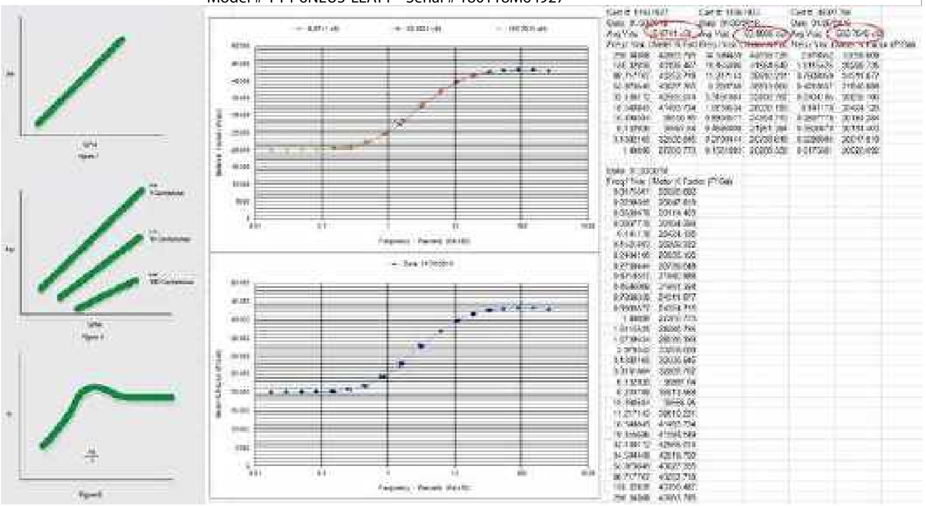
Therefore Re = Hz/v

The sensitivity of the rotor is commonly known as a K factor. It is derived from calibration data as follows: K = Hz X 60 / LPM (or GPM) or pulses / volumetric unit.

In the case of a Reynolds Number Curve (aka Universal Viscosity Curve), the meter is often calibrated at a minimum of 10 different flow rate points in one or more kinemetic Viscosity covering the thinnest and thickest extremes of the fluid. 3 Viscosities would Require 30 calibration points.

TYPICAL 3 KINEMETIC VISCOSITY CALIBRATION CURVE PROVIDED IN EXCEL® BY CALIBRATION LABORATORY

UVC Plot and UVC Historical Calibration Report
Model # FT4-6NEU3-LEAT1 Serial # 180118M64927



FINDING AN ACCURATE VOLUMETRIC FLOW RATE USING DEWESOFT - STEP 1

- STEP 1 – Determine the output Frequency (Hz)

Theory:

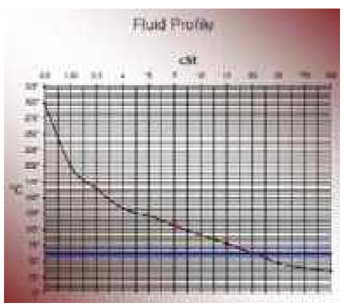
Rotational speed of the rotor is directly proportional to fluid velocity.
The rotor speed is detected via Mag or RF pickoff.

FINDING AN ACCURATE VOLUMETRIC FLOW RATE USING DEWESOFT - STEP 2

- STEP 2 Measure temperature to determine kinematic viscosity

ASTM D341

From the MSDS sheet enter the value of 40 deg C and 100 deg C



- STEP 3 - Calculate Hz/V
- STEP 4 – Find Viscosity Corrected K factor
- STEP 5 - Establish Volumetric flow rate K = Hz X 60 / LPM (or GPM) or pulses / volumetric unit
- STEP 6 – Repeat the steps using a Temperature to Density Look up Table
- STEP 7 – Infer Mass – Volumetric Flow Rate X Density = Mass Flow Rate

SATELLITE ATTITUDE CONTROLLER TEST

INTRODUCTION

This application note is used for attitude controller test of satellite, it is a long life monitoring test.

The attitude controller test of satellite - Gyroscope is the core components, so how to guarantee it working well in a long time is so important. Most of the customers do this test underground in a simulated environment.

KEY POINTS:

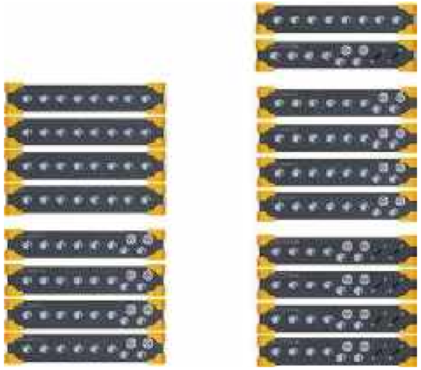
- The Gyroscope will be always running in the simulated environment.
- It is really long time monitoring---about 7~8 years.
- There is at least 4 signals form Gyroscope--- Rotor speed, Vibration, Noise and Temperature.
- Normally the system will store the low speed data(statistics),but when one signal is exceeding the default value, it will send an alarm and store the data fast.

MEASUREMENT SETUP

DATA ACQUISITION SYSTEM

18 sets of SIRIUS module with:

- 4*SIRIUS-8xACC
- 4*SIRIUS-6xACC-2xACC+
- 4*SIRIUS custom
- 4*SIRIUSi-6xACC-2xACC+
- 1*4*SIRIUSi-8xACC
- 1*SIRIUSi custom



COMPUTER

There is 20 test beds in one test chamber, each test bed works with one SIRIUS system. The hard disk of computer should be 4 TB - for long time data storing. The SIRIUS with computer should continue to work at least 1 year.

DEWESOFT SETUP

We just set it to " fast on trigger, slow otherwise" mode, and then set the trigger conditions, also we can set it to X days one file.

ANALYSIS

The customer will reload one-year-data by Dewesoft and analyze the tendency of temperature, vibration, noise and rotor speed.

Even when the amplitude of the signal exceeds the default value, the SIRIUS system continues to store the data until the measured object is really broken.

CONCLUSION

The customer did the real test before they bought our SIRIUS systems and they proved our SIRIUS systems are stable for long time monitoring.

AERODYNAMIC OF STRUCTURE OF AEROPLANE
in Wind Tunnel

INTRODUCTION

Some components of the model under test are equipped with 6-wire strain gauges, with only 1 pair of excitation inputs in each structure. The customer tests the model up to extreme conditions, so the DAQ system needs to be able to acquire the data, process them by math functions and to send the output signal to control the model. The system also has a safety feature that it monitors the limits the model can take. When exceeding the limits, the system sends a signal to shut down the wind tunnel.

MEASUREMENT SETUP

DATA ACQUISITION SYSTEM

- SIRIUS- R8
- SIRIUS-STGx3
- SIRIUS-STGMx1
- SIRIUS-HD-LVx2

CONCLUSION

We have proved that we can power the strain gauge in the model, and able to acquire the data and process the data through maths function in Dewesoft and output the wind tunnel control system. (Data and actual test of current tests cannot be disclosed)

ABSTRACT

Dewesoft Software was used for the flight instrumentation station processor on the past space mission and selected in April 2015 for the mission set to launch 2018. The crew module is being developed by American space station for the future of manned space exploration beyond Low Earth Orbit.

INTRODUCTION

Dewesoft supported agency's first Experimental Flight Test of the Module. In the module development and test phase Dewesoft was used for laboratory real-time, post-test and postmission of Developmental Flight Instrumentation (DFI) telemetry data. This data is currently being reviewed by agency engineers and scientists to continue the development towards the next unmanned test launch of the rocket on agency's Launch System rocket. Dewesoft played a critical role in acquiring and analyzing data in what could only be described as a text book test flight.

The first mission was the first space test flight of the new multipurpose exploration module. The mission was a four-hour, two-orbit test of the crew module featuring a high apogee on the second orbit and concluding with a high-energy re-entry at around 20,000 miles per hour (32,000 km/h; 8,900 m/s). This mission was designed to validate flight control systems and heat shield integrity at re-entry conditions.

MEASUREMENT SETUP

No special hardware was required for this mission. Using standard computers running Dewesoft X1 with the Chapter 10 Plugin, PCM Plugin and NET Option, engineers were able to capture and analyze all data required.

Dewesoft was setup to receive Chapter10 data from Ethernet and recorded data files. The Chapter 10 source contained 6 PCM streams which Dewesoft decommutated on a single computer. Dewesoft in post flight testing was looking at over 2,000 parameters being processed from a single measurement unit.

ANALYSIS

During the buildup of the crew module, Dewesoft performed outstandingly processing Telemetry data. Then after the flight portion of the mission, Dewesoft provided the post analysis processing of the DFI Mission Data.

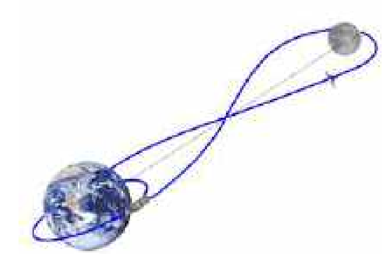
After the Module splashed down in the Pacific Ocean flight engineers downloaded the DFI Telemetry data while the module waited for the US Navy to retrieve it. This Telemetry data was then de-commutated at multiple sites; American global aerospace company in Denver, CO along with at space center in Florida.

The flexibility and ease of use of Dewesoft software was able to eliminate many manhours and ultimately save the agency expenses. The role that Dewesoft played during the mission is a significant one.

CONCLUSION

Partially based on the outstanding performance of the Dewesoft Telemetry Software Ground Station we were offered a bid on the next phase of the agency manned space flight Exploration Mission. We worked many hours, answering many questions of the engineers as they whittled down the candidates for this contract.

Through all of our hard work Dewesoft was awarded in April 2015 the contract as the DFI Ground Station Processing software for the Crew Module that is set to launch in 2018 atop SLS Rocket. This mission is planned to be a 7 day mission to orbit the moon and return safely. The Crew Module for this mission is already under development and testing using Dewesoft. We at Dewesoft are excited to continue our role in helping progress Manned Space Exploration.



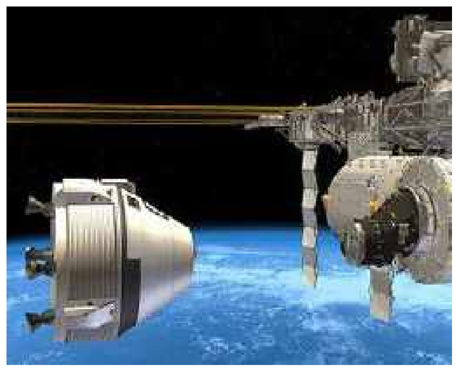
COMMERCIAL CREW CAPSULE

ABSTRACT

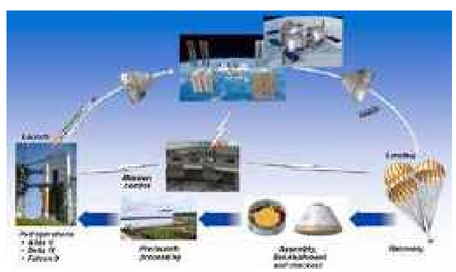
A large plane manufacturer from USA in cooperation with an American space technology startup company has been awarded a contract from Americal space agency to participate in the Commercial Crew Development program. The aim of this program is to supply the agency with commercially developed space craft to ferry astronauts to and from Low Earth Orbit specifically the International Space Station. Dewesoft has been selected by several facilities from a large American plane manufacturer for use in development of their Commercial Space Transport vehicle.

INTRODUCTION

The Commercial Crew Development program of the agency is a multi-phase program with the aim of achieving privately developed spacecraft to transport humans from Earth to Low-Earth Orbit (LEO) and back. Large plane manufacturer from USA was awarded a portion of this contract to develop their Commercial Space Transport capsule which they call CST-100. The CST-100 is currently being engineered and tested in California. The next phase of development will see the CST-100 moved to Florida for further testing and launch aboard a rocket. After all necessary milestones are achieved, the CST-100 will enter into production and begin ferrying astronauts to and from the International Space Station (ISS).



In Huntington Beach, CA Dewesoft hardware and software are helping with the Capsule PCM Encoder integration with pulling real time data from the encoder for testing. In addition, our software is handling post playback checks of the onboard Telemetry recorders for DFI data. The CST-100 will be fully integrated at agency's Space Center in the building known as OPF3, where an Orbiter used to live. Plane manufacturers engineers are currently working in this building to run hundreds of sensor cables throughout the capsule to their data processing machines. A 96 channel Dewesoft SIRIUS System is being used here for checking cables and a future plan to be used for sensor calibration checks and preflight testing.



MEASUREMENT SETUP

In Huntington Beach California for Capsule development – Currently have a standalone computer for DFI Telemetry processing using

- Dewesoft Professional with
  - Chapter 10 Plugin
  - Telemetry Video Plugin
  - PCM Plugin
- SIRIUS Frame Sync box to help with troubleshooting of PCM Encoder
- Also using DEWE-43 for trouble shooting of sensors and PCM Encoder

At KSC Florida for Capsule Integration and Checkout – Currently have

- Dewesoft Professional with
- Two SIRIUS-HD-16xSTGS
- Three SIRIUS-8xSTG
- Two SIRIUS-HD-16xACC
- KRYPTON-8xTH
- USB hub and accessories for sensor integration and checkout on capsule.

Will receive all Dewesoft Telemetry equipment from CA closer to launch.

ANALYSIS

In California the Telemetry team is able to use multiple aspects of their Dewesoft System to troubleshoot all specifications of the capsule DFI system. This has allowed the plane manufacturer to use one power platform to replace an entire rack of equipment in a ground station. This will transition to allowing the Florida team to take control of the Telemetry system once the capsule is ready. The Florida team is able to now work with the same platform to conduct cable harness checkouts.

This allows for a single system to measure basic signals but then grow providing high end signal conditioning to the sensors for calibration of the sensors on the capsule itself. This then allows for an easy transition for the team for when they integrate the PCM Encoder into the capsule to measure all the sensors on board.

CONCLUSION

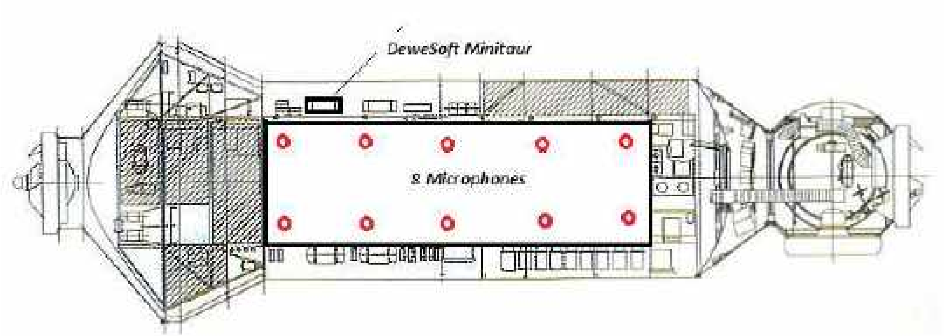
Dewesoft solution is allowing the plane manufacturer to easily complete their testing because of the ease of use of the software. Along with the powerful processing capabilities on a single computer from real time telemetry processing to processing 96 channels of SIRIUS to a single laptop computer. The ability to have a flexible platform as SIRIUS, engineers were able to invest in a large DAQ system that will be able to grow and support them in multiple assets of their testing as the program progresses. Dewesoft is the solution throughout the life cycle of the CST-100; from development to production/mission. The elimination of the need to learn multiple platforms saves money on many man-hours.

LOCALIZATION OF METEOROIDS IMPACT POINT

INTRODUCTION

The Dewesoft DS-Minitaur data acquisition system and 8 microphones are used for the localization of the meteoroids impact points.

During the experiment "breakdown" onboard the Space Station the coordinates of the meteoroids breakdown were determined. The impact of the meteorid causes an acoustic pulse due to the loss of sealing compartment, that can be registered. The coordinates are determined by triangulation method based on time delay measurement of the acoustic pulse.



Placing instrumentation at a Space Station modules

Dewesoft Minitaur inside the instrument module.

Microphone 4958 in protective cover

MEASUREMENT SETUP

During the experiment, the acoustic pulses were simulated by a special pneumatic device, and recorded by the microphones. The measurement of the time delay and the calculation of the coordinates of the meteoroids impact were made with the Dewesoft Minitaur data acquisition system

Elena Serova with the pneumatic simulator of acoustic impulse

CONCLUSION

In accordance with the program of the space experiment "breakdown" «Testing elements of the prototype onboard system for operational positioning of breakdown points at the Space Station, because of meteoroids or space debris impacts» accuracy of determining the point of breakdown in uncluttered areas of the module should be between 0.05 to 0.3 m. In other areas - from 0.4 to 0.7 m.

In near future experiments will be continued with the new generation of Dewesoft's data acquisition systems – SIRIUS.

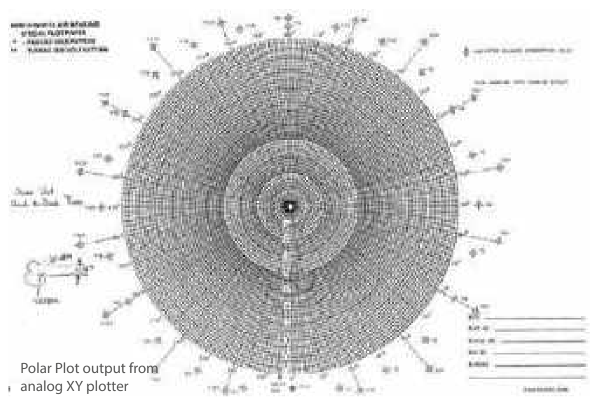
XY PLOTTER REPLACEMENT

ABSTRACT

Utilizing Dewesoft's built-in displays, a US Aerospace company has begun a large scale replacement effort of existing analog XY plotters in their turbine assembly balance cells. Specifically, by using the built-in order tracking, XY display and orbital plot in a single setup, they obviated two analog XY plotters in a single test cell.

The result is increased measurement resolution on the plot as well as the ability to plot changes at a higher shaft speeds, beyond 90,000 RPM. Prior to the digital representations, the resolution of plots were subject to the response of the analog plotter as well as the width of the felt tip pen used to record the data.

INTRODUCTION



Polar Plot output from analog XY plotter

Balancing takes place in test cells where an operator is responsible for controlling the speed run-up of the assembly (upwards of 90k RPM) as well as monitoring the live data to check for flagrant errors or inconsistencies in the data.

A unit is passed or failed based on the balance cell data. Thus, the balancing procedure has a direct impact on production and facility profitability. Per Federal Aviation Administration regulations, the assembly can only be rebalanced slightly, after the initial balancing is performed, before the unit is considered scrap.

XY plotters, while historically reliable for a variety of plotting applications in various industries, are subject to various mechanical limitations including, but not limited to: slewing speed, peak acceleration in the x&y axis and overshoot. In short, the response of an XY plotter is limited. Image 2 shows the output from an XY plotter in the form a 'polar plot.'

With the advent of and widespread availability of digital 'recorders', more and more Engineering departments, in a variety of industries, continue to replace legacy XY plotting systems. The obvious reasons are that XY plotters are subject to the aforementioned mechanical limitations. In addition, XY plotters are expensive to maintain and repair as a result of decreased supply. Their reliability is subject to mechanical components. As well, the end product from an XY plotter, a paper graph, is archived locally and cannot be easily disseminated for additional analysis amongst Engineering personal in the

MEASUREMENT SETUP

There is a turbine side and fan (compressor) side to the assembly. The displacement of the center shaft is measured on both the turbo and fan sides with a proximity probe. The shaft speed is measured with a one (1) pulse per rev pick up sensor and is input as an analog channel in the DEWE-43A.

Cut away of turbo assembly showing fan and turbine side

EQUIPMENT USED IN BALANCE TEST CELL

- DEWE-43A + DSA for Order Tracking
- 1 Pulse per second pickup sensor – used as AI reference signal in OT
- 1 proximity probe for tracking displacement of fan or turbine side – data signal

ANALYSIS

Two distinct measurements within the balance cell were previously recorded on two separate XY plotters. The first, a speed versus amplitude measurement, is quite elementary and required little effort besides utilizing the basic XY recorder already available in Dewesoft. The second measurement involved replacing what is the polar plot.

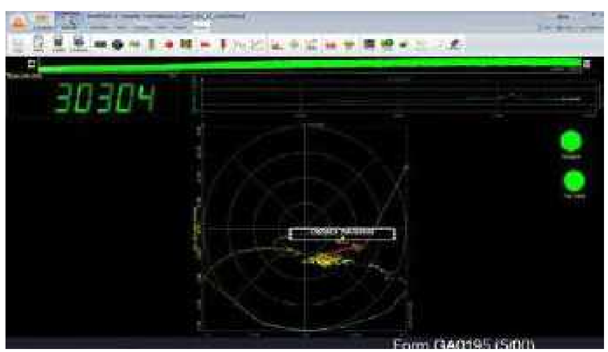
The polar plot is in essence a phase measurement calculation between the reference and data signal. The measurement though is made from a measurement of the physical distance between the beginning and end of the measurement. Currently, the phase angle is tracked by an analog tracking filter based on the reference and data signals. The output are sinusoidal representations of the input signals including phase information.

In order to meet this requirement, a few improvements were implemented in Dewesoft to meet the application. Specifically, the following were required to meet the application:

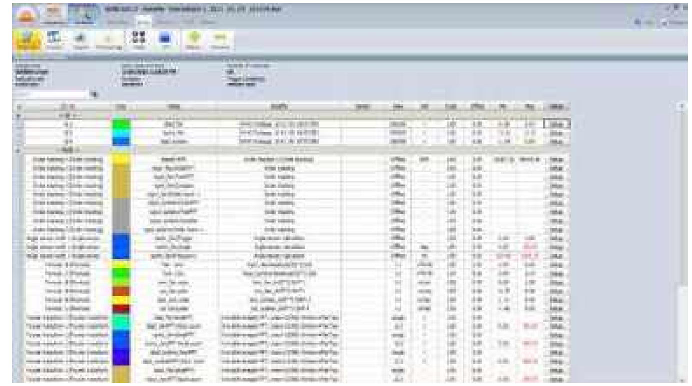
- Implementing specific math into the setup in order to replicate the output of the other instrument
- Measuring a distance between end and beginning points on their polar paper
- Implemented delta cursor measurement feature
- The images illustrate an example of measurement output using Dewesoft.

User display screen during live balancing measurement

User display screen during live balancing measurement – Turbo side



Arrow showing required distance calculation


Channel Setup from data file showing math

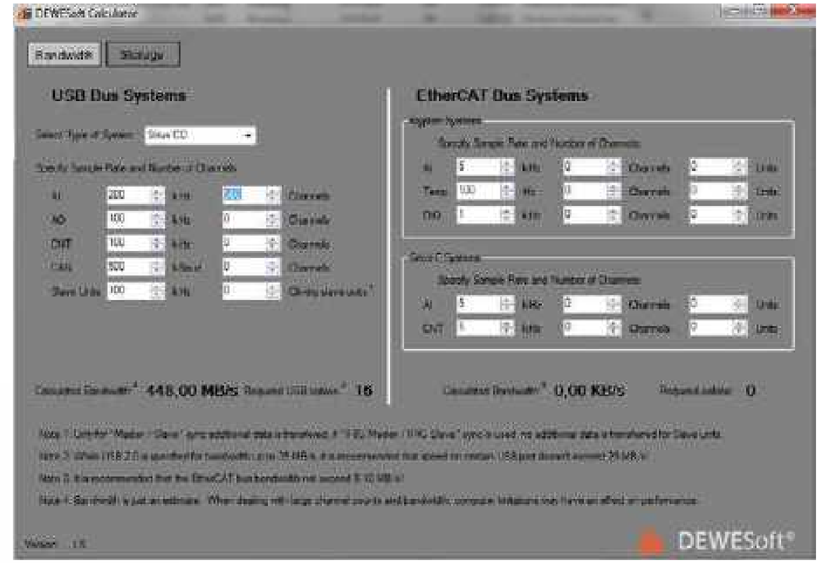
CONCLUSION

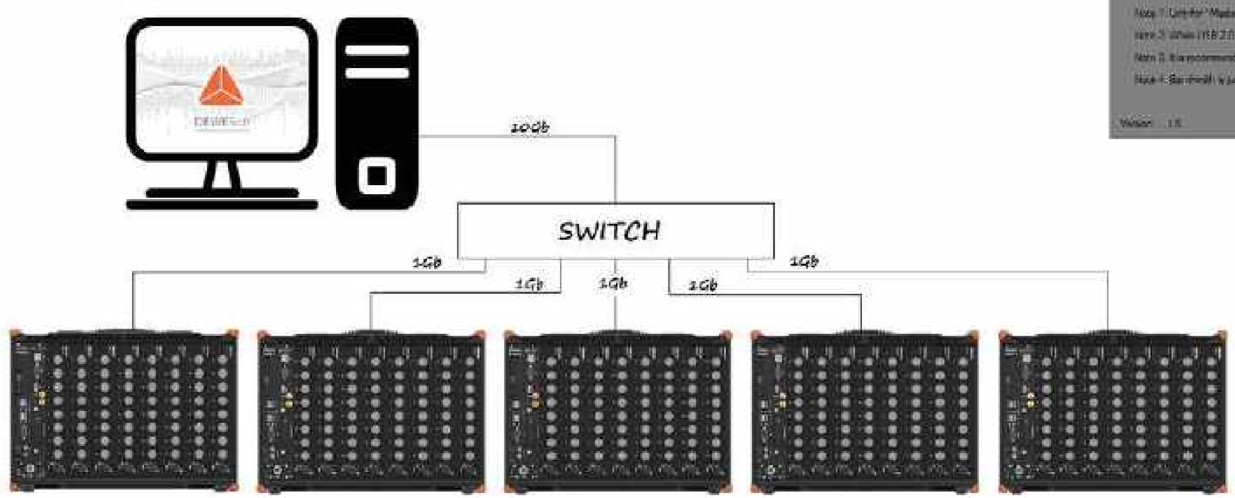
Dewesoft is clearly a suitable and capable replacement for the existing analog XY plotters still in wide use throughout a number of test cells in the facility. The primary hurdle to wide-spread implementation of Dewesoft in the test cells is two-fold. First, additional data from measurement output in Dewesoft must be compared to the polar plot. There will ideally be 100% correlation although minor discrepancies will inevitably exist. In the case of differences, the sources should be identified and determined how to proceed. Secondly, senior test operators who have worked with the analog XY plotters are still adapting to using a digital representation. Most operators have been using the traditional XY plotters for well over a decade. Time and continued training using Dewesoft will go a long way towards getting 'comfortable' with the software and hence promoting trust.

DEWESOFT SPEED RECORD

DEWESOFT SPEED RECORD

With the latest Dewesoft X2, we wanted to know what are the capabilities of our software and hardware. We have decided to build a big system which would help us evaluate our software. For the master client PC with Windows 10 operating system, two solid-state drives in RAID0 configuration and a 10Gbit network card were used. We operated five Dewesoft R8 units with 64 analog and counter channels, each as slave measurement unit. For the synchronisation, standard sync cables were utilized, with Dewesoft in IRIG-B-DC mode. The network switch provided 1Gbit Ethernet and a 10Gbit optical port. The slave measurement units were connected to the switch with 1Gbit Ethernet cables and the master client with 10Gbit optical cable. With this configuration we were able to achieve outstanding 450MB/s total data transfer rate (continuously streaming!), which corresponds to 560 analog channels at 200kHz.





"Get the habit of analysis - analysis will in time enable synthesis to become your habit of mind."

-Frank Lloyd Wright

CIVIL ENGINEERING


KRYPTON
6xSTG
KRYPTON
KRYPTONi
2xCAN-USB
CAN1
CAN2
SYNC
USB
KRYPTON

LTPP (LONG-TERM PAVEMENT PERFORMANCE)

INTRODUCTION

The customer is working for KICT (Korea Institute of Civil Engineering and Building Technology). KICT is a government organization, who does various tests related to roads and buildings, such as construction policies and techniques for comfortable and safe land environments.

This system measures the load (dynamic) by each vehicle passing on the road, and it also measures strain (static) of the road for several years. There are a couple of measurement points, constructed by different methods of pavement, on the road. They compare the data to figure out which method is better than others. Furthermore, the speed of each vehicle is calculated by the peaks of strain as a reference.

MEASUREMENT SETUP

DATA ACQUISITION SYSTEM

- SIRIUS-STG 24CH + SBOX + DS-BP2i

SENSORS

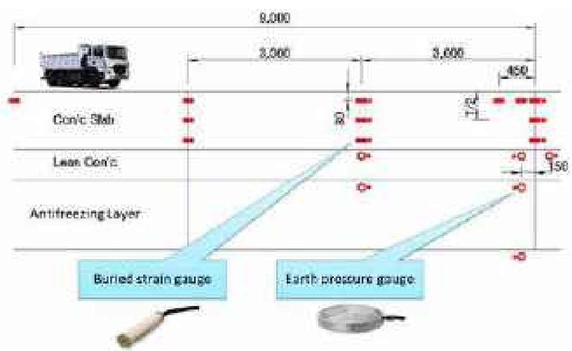
- Sensor: buried strain gauges, earth pressure gauges
- Installation of sensors

DEVICE

- Webcam: Only for a pre-test, video of the vehicles was recorded, to know the vehicle types (truck, passenger car, etc) because judging the vehicle type by only graphs causes errors.
- Wireless bridge modules: Control the system even at the opposite side of the road (up to 3 km)

ACCESSORIES

- Panel for multi channels: Fast and easy connection (to connect and disconnect 24 channels in 10 seconds)



SOFTWARE SETUP

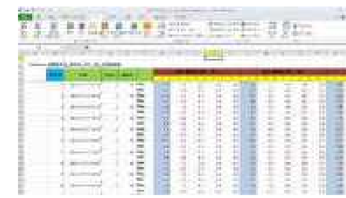
Storing: Trigger storing by slope because the values gradually change (increase or decrease) / one data file has signals of 50 vehicles.

Installation of the system beside a real road

ANALYSIS

Measurement screen

Analysis screen (Excel® macro, post-processing)

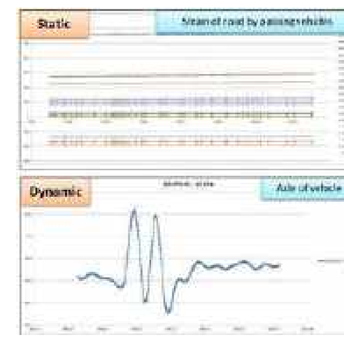


Export multiple data files to Excel® files and load multiple Excel® files by Excel® macro for calculating and sorting

There are two sections for analysis:

Static: Permanent change by the load of vehicles

Dynamic: Momentary change by a vehicle passing on the road



CONCLUSION

The Dewesoft system has a couple of strong points regarding this project. The customer wants to measure small changes of the road condition (static), and he also wants to measure big changes by passing vehicles. High dynamic range is the best solution for this project (from accurate measurement of small values to wide measurement for big values). What's more, the compact all-in-one system (SBOX+SIRIUS+DS-BP2i) is a good point, because of the narrow space and unstable power supply. The customer also likes easy video recording by a webcam and easy setting of trigger storing.

One of the important points was how to sort and analyse the vast data. Exporting multiple data files in Dewesoft and the Excel® macro were very helpful for easy and fast analysis.

SCAFFOLDING TESTING

INTRODUCTION

Each commercial scaffolding has to pass a certification (according to ISO written by the Italian Institute for the insurance against work accidents (INAIL)) before being introduced to the market. Also any structural change in a commercial scaffolding that has already passed certification, avoids the certificate, so the scaffolding needs to be tested again.

To test the scaffolding the same load in every arch has to be applied and the scaffolding is tested up to implosion.

TESTING ENVIRONMENT

The scaffolding architecture for testing purposes is composed by 4 arches and stands on 5 couples of feet (5 on the front and 5 on the rear). The feet stand on a metallic structure and underneath of each couple of feet the is an Hydraulic Piston.

The piston is connected via 2 strong iron cables to the top of the scaffolding so when a pressure is applied to the piston the weight is like applied from the top.

The test is performed up to collapse and each arch has to withstand at least 8000 kg without collapsing. The more the better. To do so, the same pressure is applied on each of the four hydraulic pistons so they will push the scaffolding arches at the same way.

1

2

3

Workers installing Pistons and Tensioning Cables

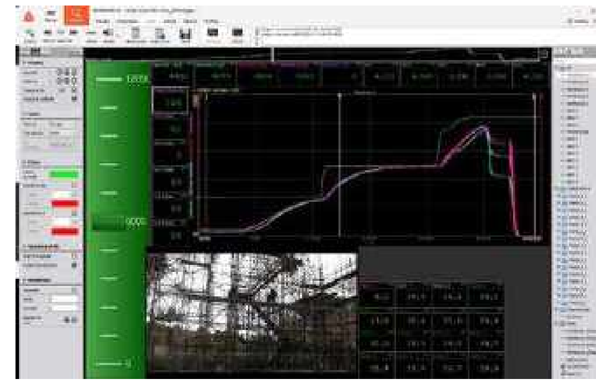
DEWESOFT SOLUTION

To test the system, a Hydraulic pump, driven by a complete Dewesoft solution, is supplied. This includes 2x SIRIUSi-8xSTG + 8AO. In the 16 channels unit, 5 loadcells and 5 pressure sensors are configured and recorded. The 8x AO (Analog Out) are used to control the Hydraulic proportional valves. Dewesoft PID math is used.

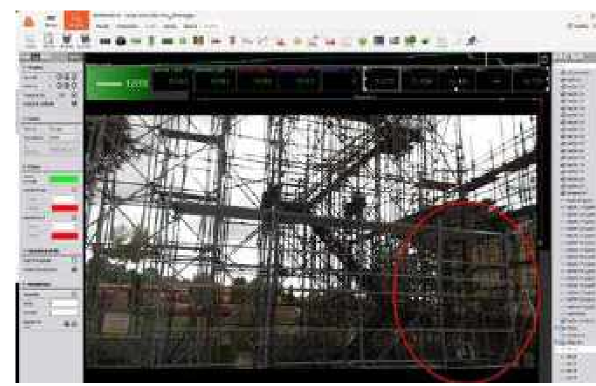
The system works in such a way:

On top of each hydraulic jack a loadcell has been applied that will be used as feedback to drive the proportional valve that will partialize the Hydraulic system on that specific jack. To be sure that the same load is applied on each jack, Dewesoft PID math is used. The PID reads the input coming from the jack loadcell, reads the setpoint and will adjust the analog output to drive the proportional Hydraulic valve.

In such a way automatic load steps can be performed, or using the slider on the left. Here you see the Dewesoft Control screen, with the "Control Channel" you can control the load manually.



The test will end when the scaffolding collapses and it passes specification if it withstands at least 8000 kg on each foot.



CONCLUSION

Happy customer, happy testing!

STADIUM ROOFING TEST

INTRODUCTION

Our customer is working in the NDT (non-destructive testing) business for civil field. The company ist manufacturing NDT equipment. In the civil field the applications are endless, and very often it is needed to collect different types of data at the same time.

Until now to do these kinds of test, a different equipment was used, and the result was achieved in post processing analysis. Thanks to the new equipment DaTa 500 (based on the DEWE-43 PCB board) and Dewesoft X software, many tests can be done in place in real time and just with one equipment.

DATA 500

The DaTa 500 can acquire data from a lot of different sensors as:

- Displacement
- Slope indicator
- Strain gauge
- Pressure transducer
- IEPE accelerometer
- Wire sensors
- and many many others...

It can be used in place, thanks to its internal battery operating for 8 hours.

The functionality can be extended with Dewesoft and virtual Math channels, to get results directly during the test.

MAIN APPLICATION

STADIUM ROOFING TEST

Our client should assess the strain of the tie-beam of the roofing of the stadium in Turin.

He measures following data:

- Oil pressure
- Displacement
- Strain
- Load (load cell)

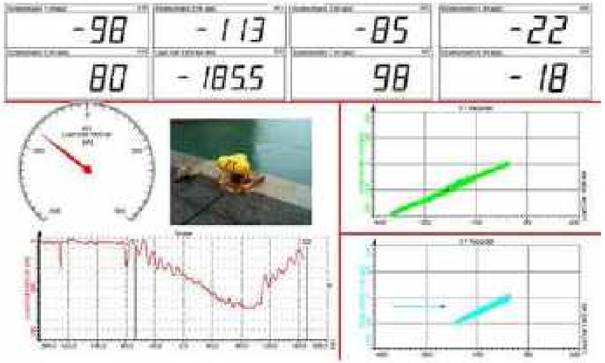
BOLLARD STRENGTH AND LOAD CAPACITY

Our client should assess the strength and load capacity of bollards in Venice.

Sensor connected are:

- Strain gauge
- Intensity and direction of wind
- Load
  (rope connect to the towboat)

At the end of the test, their client asked to arrange a monitoring for a long time to keep under control the bollard during standard activities. That was done thanks to DaTa 500 and Dewesoft. Monitoring is still in progress.



SHEAR TEST ON MASONRY

SHEAR TEST ON MASONRY

Our client had to test masonry walls to see the shear strength.

Measurement was done using displacement and pressure sensors.

LOAD TEST OF BUILDINGS

LOAD TEST

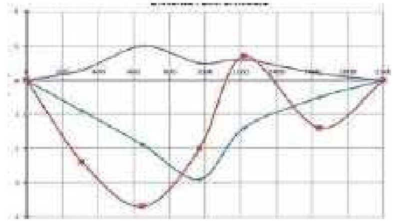
Our client had to measure displacement of the roof and/or ceiling under load.

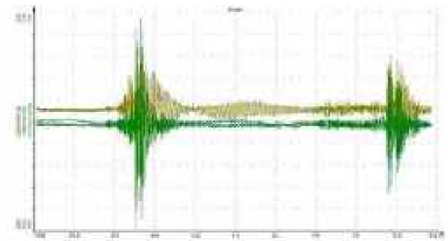
BRIDGE TEST

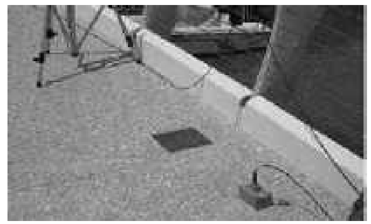
BRIDGE TEST

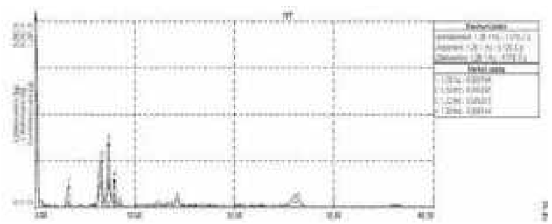
The test had to assess vibration, load, strength and displacement.

With DaTa 500 and Dewesoft X it was possible to acquire all data of different sensors just with one equipment.



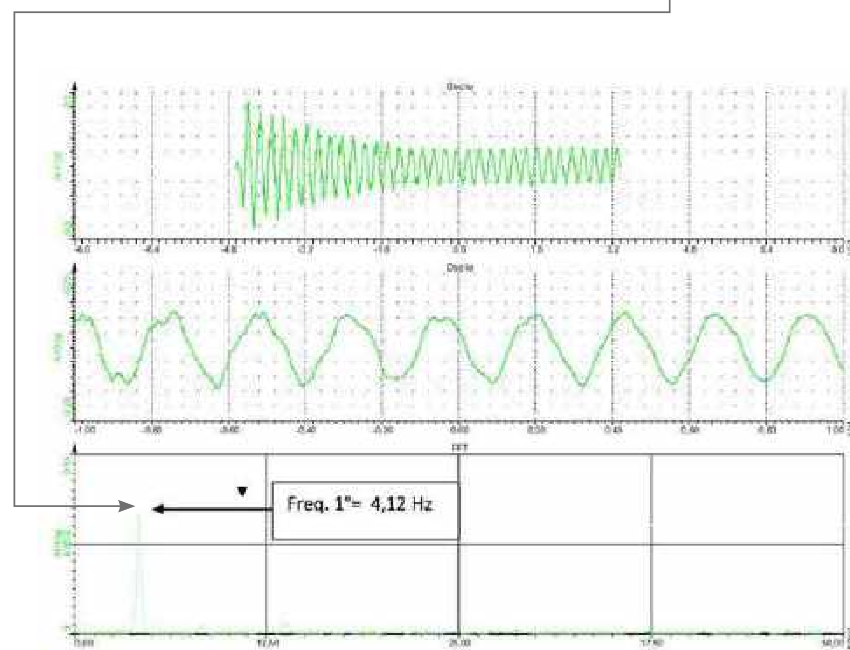






CHAIN TENSION

Another task successfully completed with the mentioned equipment.



INTRODUCTION

The client wanted an acquisition chain system which can measure current, voltage, resistance and which can protect data.

Furthermore the simultaneous acquisition of 250 voltage and 175 resistance measurements was required, without degradation of the system characteristics. The system must be able to acquire 400 measurement channels at a rate of 1 second over a period of 12 months without any limitation of bandwidth, dead band or filter.

That's where the KRYPTON-LV and -RTD took place.

SPECIFICATIONS

Voltage	
Precision	±0.03% ±5mV
Sensibility	<8 mV
Scale	0.1, 1, 10, 20, 200

Current	
Precision	±0.01% *calibrated
Sensibility	<0.012mA

Resistance RTD	
Type of meas.	100 Ohm
Sensibility	<±1.02 Ohm
Resolution	<0.001°Ohm

Resistance PT100	
Range	-20 to 350°C
Precision	±0.375°C on the range
Resolution	<0.01°C

MEASUREMENT SETUP

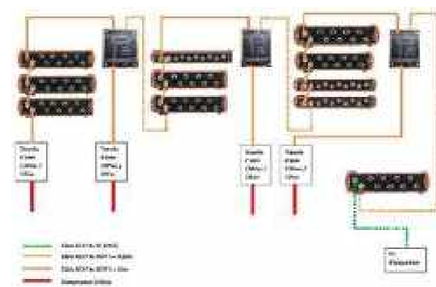
DATA ACQUISITION SYSTEM

- 18 KRYPTONi-8xLV for tension measurement
- 21 KRYPTONi-8xRTD for resistance measurement
- 5 ECAT-POWER-INJECTOR for an additional power supply

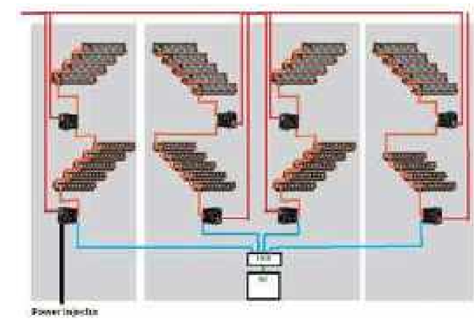
SOFTWARE

- Dewesoft X3 with PLUGIN-ODE option for exporting Dewesoft's data during the storage directly to a data base SQL and/or .csv

Only one chain of the mounting



Final mounting



For the assembly line we used EtherCAT® junction because the customer wanted to connect all the chain to only one computer. This device permits to join up several branches at a particular point. The EtherCAT® junction is connected via RJ45 sockets.

We have checked the compatibility of the HUB with Dewesoft X3.

CU1128 EtherCAT® junction

ANALYSIS

The measurement campaign is still in progress so far. The data is not accessible yet though. We'll be able to take a look at it when the campaign will be over. But what we can say is that the mounting is working so far, with no unexpected disconnection or issues of any kind. The Dewesoft equipment is of confidence.

CONCLUSION

Thanks to Dewesoft software and hardware, we have answered all of the needs required by the customer. We have adapted our mounting with another device (EtherCAT® junction) and shown the flexibility of Dewesoft to adapt its system to the different environment he has to face.

"The only constant in the technology industry is change."

-Marc Benioff

INDUSTRIAL


IOLITE

SIMPLIFIED CONTROL

ABSTRACT

This application note shows how Dewesoft solutions can be safely and easily used with servo motors, stepper motors, etc. in conjunction with actuators, torque fixtures or other automation devices for control-type projects. The combination of Dewesoft X3 software along with an analog output device allows the user to easily control the forcing function of the test fixture while simultaneously measuring signals and inputs from the instrumented part. This configuration makes tasks such as File Playback possible where the user collects field data then brings the part back to a laboratory environment where the field data can be replayed and simulated for many cycles.

INTRODUCTION

In the early days of Programmable Logic Controllers (PLC's), the technology was revolutionary, simplifying millions of projects, replacing hundreds of relays and timers per project, speeding up various processes and making once time-consuming tasks a breeze. Many universities, regardless of the program thrived on teaching students the basics to circuits along with the industries advancements in PLC's. In recent years, modern universities have taken a much more focused approach and degrees and are much more specialized in their own areas of interest with only a few degrees reaching detailed discussions and education in the topic of PLC's.

Younger test engineers and technicians have a great deal of knowledge in many aspects of test and measurement including 3D modeling, material properties, advanced calculations, etc.; however, they lack the experience in traditional test setups such as the use of PLC's. The industry is moving to stand alone solutions with easy and intuitive Graphical User Interfaces (GUI's).

With the increases in demand for productivity in the test and measurement industry, more test engineers and technicians are looking to set up control projects but would rather not go back to learning the basics and yet another software to control a traditional PLC. This application note goes through a simple way to use Dewesoft's X3 software - which many test engineers and technicians are already familiar with - and applies that knowledge to perform control projects in a safe and timely manner.

HARDWARE SETUP

AUTOMATION FIXTURE

The first step is designing and building a test fixture in which to perform the test. For this example, we have designed and built a small load frame out of anodized extruded aluminum to house a linear actuator and servo motor. In this example we used a Tolomatic ERD20/BNM05/SM154.2/LMI actuator along with a Tolomatic ACSI34-1Q1-B servo motor to apply our forcing function and a Futek LCM325 load cell to measure load in our part which could also be used at the feedback for PID Control.

ANALOG OUTPUT DEVICE

Any SIRIUS unit with Analog Output (AO) and the function generator software upgrade can be to send the control signal to the servo motor. In this case we used a SIRIUSi mixed configuration (3xHV, 1xACC+, 2xACC, 1xMULTI, 1xSTG) unit. In this test, we used the MULTI-channel for the AO, and the STG-channel for the Load Cell.

SIRIUS WATCHDOG

The SIRIUS Watchdog can also be used at a safety precaution. With the SIRIUS Analog Output, the user can look for a heartbeat from Dewesoft throughout the test. If the heartbeat is missing, the SIRIUS Watchdog can be programmed to send a digital message to the motor stopping or coasting to stop motion.

SOFTWARE SETUP

ANALOG INPUTS SETUP

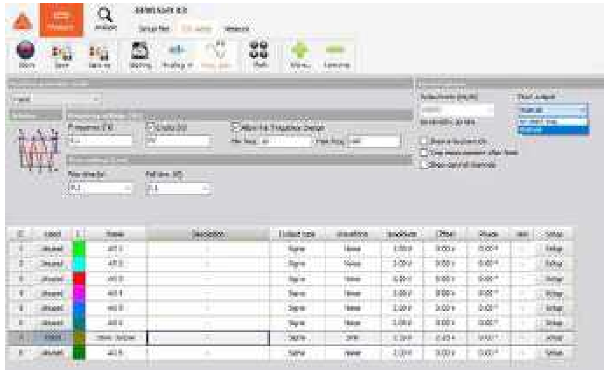
The analog input channels need to be configured based on the sensors used for the test. The Simple Measurement Using Dewesoft Pro training is a great resource to setting up your analog inputs.

https://www.dewesoft.com/pro/course/simple-measurement-using-dewesoft-hardware-12

FUNCTION GENERATOR

The function generator is an additional software package in which the user can define the analog output signal. Using your analog channel as "Signal Output" and creating either a Sine, Triangle, or Arbitrary waveform will be the most practical. The following image shows a user defined arbitrary waveform to program the actuator to perform a specific task. In the arbitrary waveform setting, old data could also be copied to simulate data that has already been collected.

In addition to configuring the waveform, the frequency, number of cycles, and output initiation should also be set. In this case we have set our frequency in a manner where the waveform will repeat itself every 10 seconds (frequency of 0.1Hz) and will be performed for 50 cycles. We have also programmed this analog output to have a manual start once we are in measurement mode.



SIRIUS WATCHDOG

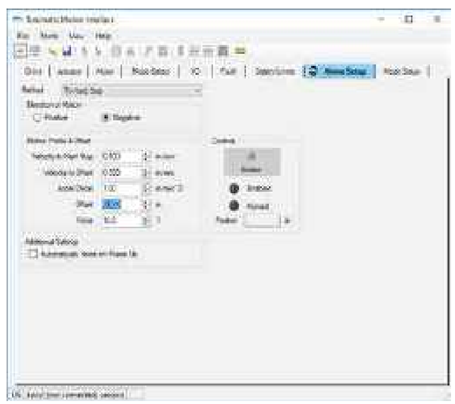
If the SIRIUS Watchdog is to be used, it will also need to be programmed and can be done so following the user's manual at the link below.

https://www.dewesoft.com/download?file=Watchdog_user_guide_v1.2.pdf

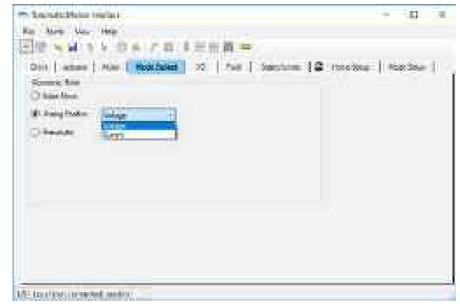
THIRD PARTY SETUP

During the first test for a new setup, a few parameters must be programmed into the automation system so that the system knows what to do upon startup and how to interpret the analog output from the SIRIUS System as well as the digital output from the SIRIUS Watchdog if the SIRIUS Watchdog is used.

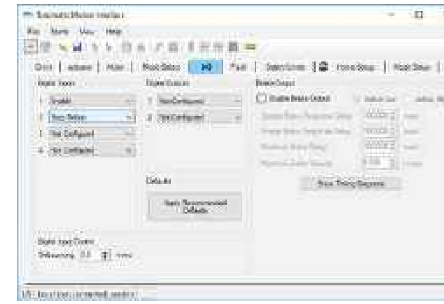
"Home Position" must be selected. In this example I programmed my motor to retract to actuator until its hard-stop (at 10% load) then extends 0.5 inches.



Analog Input must be defined. First, we select that we want to operate in Analog Position mode then select that we want voltage to define position for a stroke-controlled application.



Digital Input must be defined. Finally, we select that we want one of the digital channels to "stop motion". This selection must match how the user has wired in the digital signal as there are 4 conductors to digital inputs in this case.



AUTOMATED MEASUREMENT

Once your hardware and software has been programmed, you can go to measurement mode to begin running your automated test. If the function generator was configured to start "manually", the user will have to go to the control tab and select "Start Output". From this point forward, the test will be conducted just as the user has programmed. Once the test in initialized, the user can watch the test perform while data is being collected from the same

CONCLUSION

Previously users have had to use multiple systems to perform the forcing function and the Data Acquisition or have had to make the choice between the stability of a PLC with limited options in terms of Data Acquisition and post processing; or flexibility in terms of DAQ and post processing with the susceptibility from the control aspect. By using a combination of Dewesoft's hardware and software in conjunction with Tolomatic's easy to use programmable motors, the user can get the stability of a PLC but also the flexibility and GUI offered by Dewesoft's powerful hardware/software combination.

CONVEYOR BELT PRODUCTION

THE PROBLEM

Conveyor belts for industrial plants are manufactured with high-performance rubber materials, such as to guarantee durability in harsh conditions, as commonly found in steel plants, mines, foundries, electric plants, tunnel constructions, waste transport and recycling, sand quarries.

The integration of the various parts of the belt is performed through hot vulcanization, a process invented in 1844. Vulcanization allows to obtain chemical bonds in the rubber at molecular level when the rubber undergoes a given pressure and temperature profile over time. The limitation of current vulcanization cycles is that the temperature of the rubber is monitored through probes placed on the molds, i.e. externally with respect to the rubber. The actual temperature inside the rubber is therefore still not strictly known, due to the interaction of various factors (thermal inertia, ambient temperature, different rubber blends,…). The actual indirect monitoring systems are therefore not suited for modifying the production cycle according to the variable conditions experienced inside the actual part being produced, such as variable dimensions, different blends, mold inertia, abnormal functioning of the machinery.

OUR SOLUTION

In collaboration with a conveyor belt manufacturer, a company developed an innovative industrial solution, stemming from the vision of the Industrial Internet and consisting in the insertion of wireless and batteryless RFID sensors inside the elastomeric blend of the conveyor belt. They started by characterizing the electromagnetic response of elastomeric blends, which helped later in understanding the most suitable typology, the correct materials and the optimal technique for the sensor insertion into the rubber. Such sensors, when interrogated by an ad-hoc radiosystem, can transmit wirelessly the temperature value as recorded inside the object, hence constantly optimizing the vulcanization process with the help of a user-friendly interface and data analysis tool developed in Dewesoft.

The infrastructure of the sensing network is external to the production machinery, hence perfectly suited to retrofit existing machinery and simplifying the adoption of the new technology.

The developed system is therefore capable of monitoring the vulcanization cycle from the very inside of the object under production, enabling to strictly follow the optimal temperature-pressure profile. The products exiting the machinery will provide higher quality and improved product life.

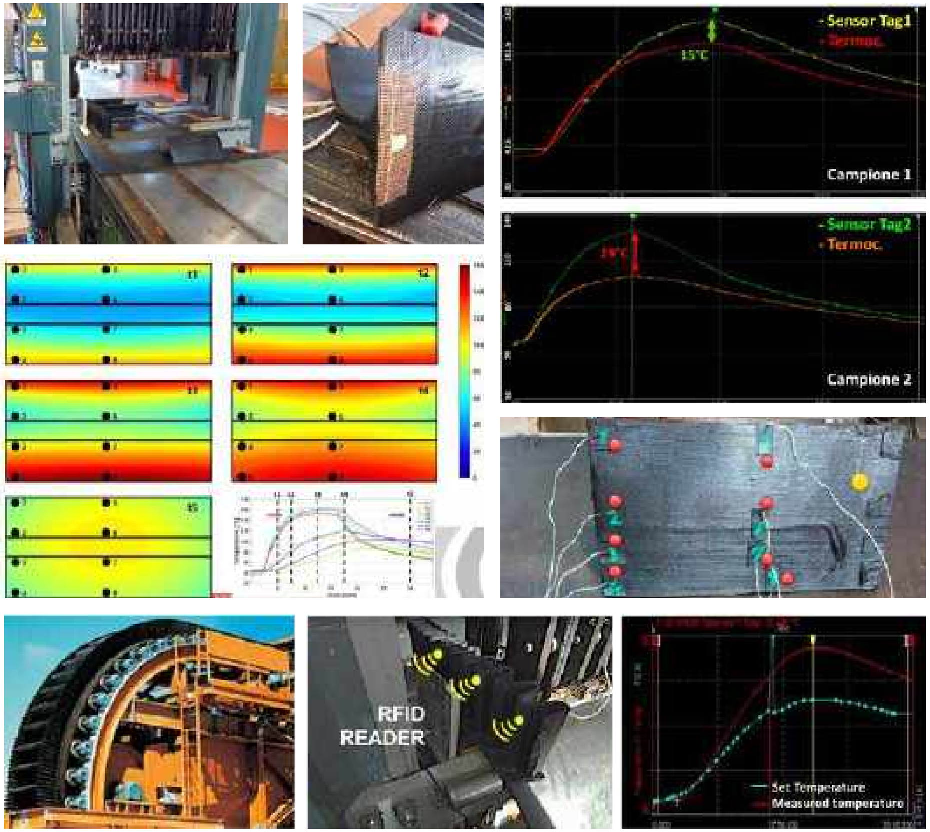
EXPECTED BENEFITS

The production process will be deeply transformed, as it will be possible to produce ad-hoc products following the customers' wishes in a more effective way, without the need for costly trial-and-error tuning process of the vulcanization cycle. The product itself will "communicate" to the machinery which cycle to adopt for optimal results.

A clear benefit is therefore a substantial drop in production problems and in production delays, due to erroneous vulcanization cycle setups or to the non-adequate vulcanization of parts of the belt: the sensor itself will be able to sense if all product parts have correctly undergone vulcanization.

This will moreover allow reducing energy costs with respect to the current situation, where over-vulcanization is often performed to minimize the possibility of having non-vulcanized areas.

Finally, once inside the final product, the sensor can be used to implement improved strategies for warehouse management, logistics and planned maintenance of the conveyor belts once in use.

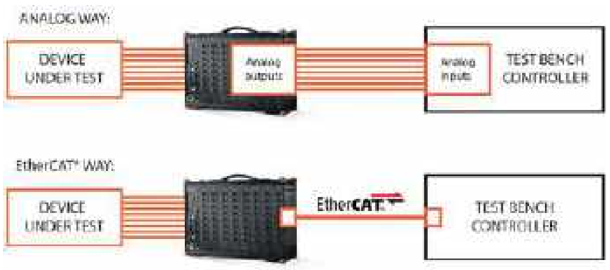


EtherCAT® REAL-TIME DATA OUTPUT

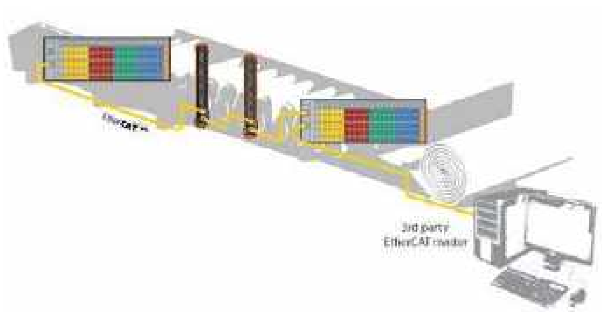
NEW APPLICATION AREA: ETHERCAT® INTERFACE TO 3RD PARTY SYSTEMS

SIRIUSe and KRYPTON® instruments are compatible with 3rd party EtherCAT® masters. This allows many new applications such as:

- Control system front-end
- Real-time data output with minimum latency directly from the SIRIUS or KRYPTON® hardware to the EtherCAT® bus hosted by a 3rd party real-time EtherCAT® master.
- **Application example**
- SIRIUSre slices in the R8rt (more info below) are used as signal conditioners in a rocket test control system, providing real-time data from analog sensors directly to the EtherCAT® bus for the 3rd party control system. In parallel, the SIRIUSre slices also provide data over USB to Dewesoft X software for recording.



- Digital interface to 3rd party test benches
- Instead of acting as an AD/DA signal conditioner with low level analog input and high level analog output, SIRIUSe and KRYPTON® instruments can provide acquired samples in digital form to the test bench control and DAQ system if it supports EtherCAT®. This reduces cost for the customer by requiring only a single cable from the SIRIUSe/KRYPTON® chain to the test bench controller. This eliminates the need for a high level analog input stage on the controller side.
- **Application example**: SIRIUSre slices in the R8rt (more info below) are used to acquire the response of a specimen on an automotive road-load data test bench. Data with constant delay from approximately 100 channels is sent to the test bench controller over EtherCAT® providing the feedback for drive profile generation.



- High-end signal conditioning for a PLC
- High-end signal conditioning for a PLC EtherCAT® is a backbone of many industrial PLC systems, forming a long chain of EtherCAT® slave devices to control a production or test process. SIRIUSe and KRYPTON® instruments can be used in any EtherCAT®, providing the system integrators with unmatched signal conditioning capabilities in the PLC world.
- **Application example:** KRYPTON® instruments are used in temperature chambers of a test facility to provide high-accuracy temperature measurements to a 3rd party PLC system. The levels of accuracy, drift and isolation of the KRYTPON® modules are unique in the PLC market.

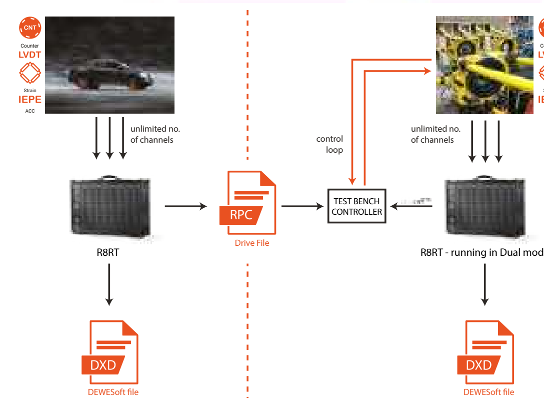
R8RT

- **A special version of R8 with EtherCAT® backplane**
- **For 3rd party EtherCAT® master interface**

R8rt (rt for real-time) includes a backplane EtherCAT® port. The port is a direct gateway to the SIRIUSre slices, bypassing the SBOX. Real-time data from SIRIUS hardware can be transmitted on this port to the 3rd party EtherCAT® master.

EtherCAT® backplane brings the versatility of the R8 even further as it can be used in many ways:

- High channel count test bench data acquisition
- Real-time signal processing for 3rd party controller feedback (over EtherCAT®) and
- Compact size high performance data logger for in-vehicle use.



*Same R8RT instrument can be used for measurement on proving ground and on the test bed for real-time data stream to the controller.
* Dual mode - Data samples from SIRIUS slices are transmitted in real-time over EtherCAT to the 3rd party controller at up to 10 kS/s and at the same time recorded in DEWESoft software at up to 200 kS/s

EtherCAT® REAL-TIME DATA OUTPUT

When purchasing the R8rt instrument keep in mind the following technical details:

- The front side EtherCAT® port on the SBOXre is a master-side connector; additional KRYPTON® or SIRIUSe slices can be connected to this port for accessing the data in Dewesoft on the SBOX, not in real-time
- The backside EtherCAT® port is a slave port (hence IN and OUT connectors), allowing real-time data feed from the SIRIUSre slices inside the r8rt to the 3rd party EtherCAT® master
- There is no physical connection inside the R8rt between the front and back side EtherCAT® ports and they are not meant to be connected together by a cable
- In order to be accessed by the backside EtherCAT® slave port, the SIRIUS slice has to be an EtherCAT® rack slice, designated SIRIUSre; those slices do not have a CAN port
- R8rt is not a real-time controller; it can be a real-time front end of the control system

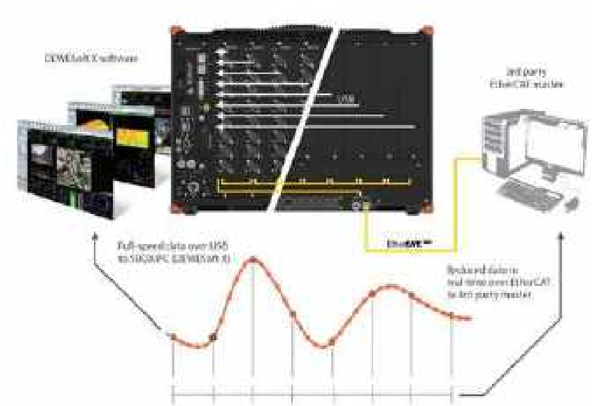
DUAL MODE

SIRIUSe instruments can use EtherCAT® and USB interfaces to provide real-time data to a 3rd party control system and full-speed data to Dewesoft X software in parallel. This makes the SIRIUSe a unique instrument that can be used in the control loop and as a DAQ recording device at the same time, saving enormous cost for the customer and providing detailed insight into the process data.

Typical Dewesoft Dual Mode applications include:

- SIRIUSe as an analog-to-EtherCAT® interface on a test bench with 3rd party EtherCAT® master and DAQ device for recording the data in Dewesoft X software
- SIRIUSe as an analog-to-EtherCAT® interface in a PLC configuration and condition monitoring device with high frequency dynamic analysis in Dewesoft X software

At the moment, only SIRIUSre slices in R8rt configuration support Dual Mode. Single slices will have Dual Mode support from October 2017 (only firmware and software update will be necessary, hardware of all SIRIUSe devices on the market is already prepared for this mode)



SO WHY USE THE NEW R8RT?

- EtherCAT® solution will save you cost on cables and analog controller stage
- R8 has the advantage of being a portable all-in-one instrument that you can take in the car or use at the test bench
- Dewesoft software allows simple EtherCAT® configuration export which is otherwise done with a third party software - as always the software solution is easy to use
- the total solution of SIRIUS instruments and R8 with EtherCAT® output allows the application of dual mode: data acquired at full speed in Dewesoft software and data output in real time over the EtherCAT® bus to the third party controller software

ICE-CREAM PRODUCTION

INTRODUCTION

Did you notice that choccolate ice cream this summer tastes better than ever?

Believe it or not, the manufacturer has now optimized its production process using Dewesoft technology.

The process manager and the automation engineer (Italy) had a clear focus in their mind: the production process needed to be just perfect in order to guarantee the best taste, quality and stability of icecream products, whilst minimizing waste…which is a winning combination!

It was clear since the beginning that these targets could be achieved only by introducing and embedding Industry 4.0 concepts in their manufacturing process and Dewesoft was the best partner to achieve that.

The customer stated "This is a great example of how R&D, supply chain, factory teams and key suppliers like Dewesoft can work together to deliver Industry 4.0 solutions that help deliver improvements in operability and line performance."

Our KRYPTON extreme product line allowed us to distribute acquisition along the production process, integrating modules in existing electric cabinets, exactly where needed, in order to reduce analog signal cable length and improve the signal quality. It also reduced installation cost while ensuring perfect synchronization among all channels.

These units' high protection grade (IP67) and wide temperature range (-40...+85°C) led them to be chosen by the experienced automation engineers to be placed into these harsh environments.

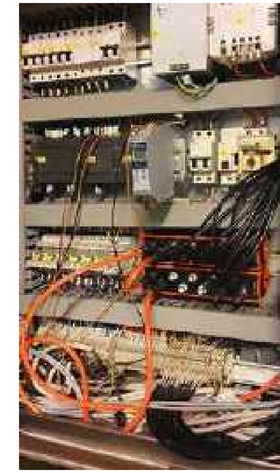
The customer required a deep integration of the Dewesoft system with the already existing control systems.

We thank our developers who made a smooth integration possible, with five different control systems for a total of 220 process parameters transferred using Siemens S7 native protocols, integrated with analog and digital values acquired by Dewesoft KRYPTON frontends.

Acting as global supervisor, Dewesoft created a complete picture by gathering data coming from different parts of the production line and from various sources. Dewesoft tools then calculated complex algorithms in order to give useful indication to the operators and feed both the PLC control system set-points and the internal tools for statistics.

A red light alarm system instigates as soon as just a single parameter goes out of control within the production process. In such a case, the operators are advised to manually adjust valves if the control system cannot directly operate them.

This application proves that Dewesoft is not only a tool for acquisition and online analysis of data in industrial processes but also a comprehensive supervisor with a competitive price and fast reaction time.



ANALYSIS OF CONTINUOUS PRODUCTION

ABSTRACT

Online analysis of continuous productions is becoming an important task to ensure production quality and reduce wasted products. Production managers are called to improve lines efficiency, but leaving production parameters to manual setup may lead to wrong settings and wasted production.

This application is an example how to constantly keep the most important production parameters under control and suggest settings for modification to the production manager, according to the currently used raw material specifications.

INTRODUCTION

Continuous production consumes flows of row materials. These materials are manufactured according to agreed standards and defined tolerances; production lines need to be fine tuned in order to minimize wasted products and optimize product quality.

What happens when a stock of raw material finishes and a new flow from a different stock is then used?

Depending on the raw material specification some parameters (like density) may vary and the production line may request a new tuning to assure the same products quality as before. Production managers have great experience on these tasks and by looking at the production results they can easily figure out what handle should be turned and how many turns. If the line responsible is looking right at the production during the raw material change, just few seconds of production may be wasted before everything will be correctly set again.

But what happen if the manager was busy on another task?

It is clear that this procedures links quality on human experience and reliability... the idea is to have a system continuously monitoring the production and notifying the managers about needed changes on the line settings well before the production starts to drift.

MEASUREMENT SETUP

Fortunately only fundamental parameters need to be acquired along the production line. Most of the measurements are performed by means of transducers installed on the line (like pressure transducers, temperature transducers, density transducers, etc..), sometimes other special (virtual) sensors are needed.

The product quality shall be defined in a measurable way, for example by shape, dimension, color, and so on.

The most important quality parameter for the ice cream was "crispiness" so we needed a crispiness sensor. The customer has a deep knowledge how to predict if the ice cream will be crispy or not and we developed a virtual crispiness sensor starting from visual inspection at a certain production stage.

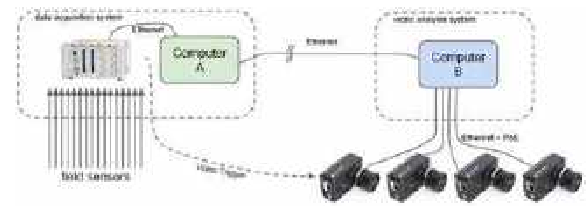
This time video was not "simply" integrated with Dewesoft but a processing algorithm was developed to give a crispiness prediction together with the image.

DATA ACQUISITION SYSTEM

- DS-NET for sensor monitoring (24 voltage channels)

SENSORS

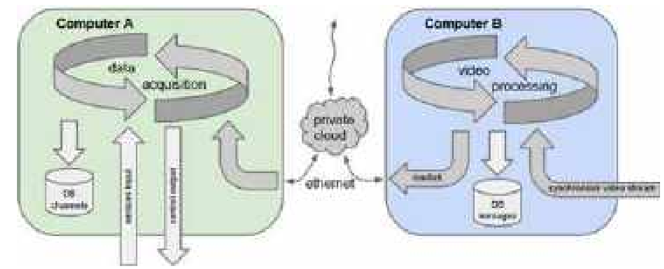
- pressure, position, angle, density, temperature
- DS-CAM + Custom processing software

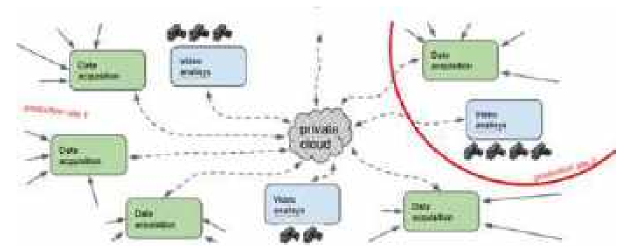


All transducers are acquired dynamically to detect peaks during the production cycle (about 1 seconds) but just the aggregate data from basic statistics channels are used for online analysis.

ANALYSIS

R&D engineers perform a manual statistical analysis on the acquired data. They typically look at cycles peaks, averages, deviations and aggregate these parameters via classification.





CONCLUSION

This method allows continuous productions to be monitored and tuned, to reduce wasted products or increase quality and final user experience, theoretically regardless the presence and the experience of the production manager. By observing the data along the time, several issues in the production were discovered and fixed by the R&D. They confirmed the validity of the method to improve the product quality, production costs and product stability.

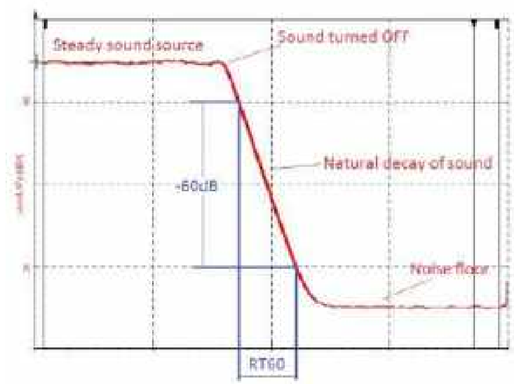
RT60 AND ALPHA COEFFICIENT MEASUREMENT

INTRODUCTION

Reverberation time is the time required for sound to decay 60 Decibels from its initial level.

Reverberation time is measured in narrow bands and differs depending on the frequency band being measured. For precision, it is important to know what ranges of frequencies are being described by a reverberation time measurement.

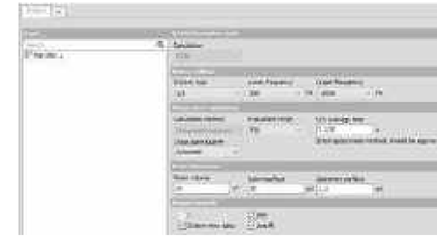
Reverberation effects are often used in studios to add depth to sounds. Reverberation changes the perceived spectral structure of a sound, but does not alter the pitch.



A customer is producing acoustic fillers for car interiors. The reverberation time is measured with and without the test specimen mounted in the alpha chamber.

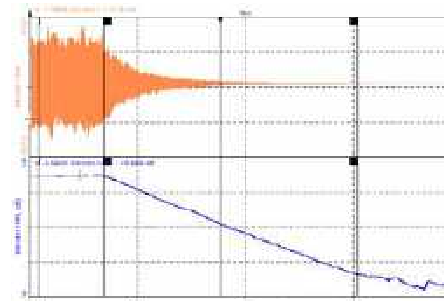
The customer is using a DEWE-43 with MSI-BR-ACC adapter and a microphone. The reverberation time is calculated with the RT60 plugin and the absorption coefficient is calculated with the Excel® template. They are performing the measurement in the alpha chamber, which is a room with steel walls that fully reflects the sound. In the picture below, there is a test specimen in the test chamber, two loudspeakers, and sound reflectors to disperse the sound in all directions.

REVERBERATION TIME MEASUREMENT



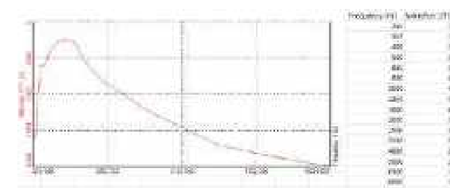
The customer wants to calculate the reverberation time from 250Hz to 10000Hz. Because they cannot achieve a drop in the sound pressure level for more than 75dB, they are using the T20 evaluation range. For this evaluation range, only a 35 dB fall in each frequency band is required.

For the sound source, they are using a pink noise that is played on two loudspeakers placed inside the chamber. Pink noise is being played on the speaker, and after a couple of seconds the sound is turned off.

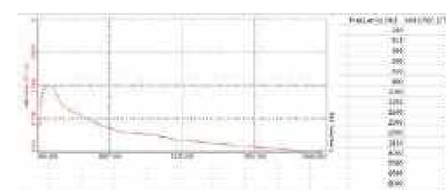


In the picture on the right, we can see how the sound pressure level falls. The blue curve is the sound pressure level in Decibels and the orange curve is the sound pressure from the microphone in Pascals.

The first cursor is locked at the beginning of the SPL fall, and the second cursor is placed at the position where the SPL level already reaches noise floor level.



The first measurement is an empty room measurement, where they acquire the reverberation time for an empty alpha chamber. The result is reverberation time T1 for each frequency band.



The second measurement is done with the test specimen inside the chamber. This test specimen is a foam that absorbs the sound in the doors of a car.

RT60 AND ALPHA COEFFICIENT MEASUREMENT

MEASUREMENT SETUP

ALPHA COEFFICIENT CALCULATION

The Alpha Coefficient is a calculation using a formula in which both reverberation times are important parameters.

They use an Excel® template that stores all the formulas. The important parameter is the surface area of a test specimen.

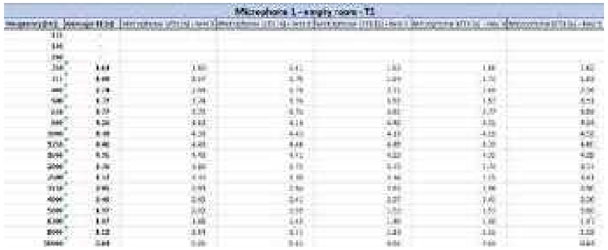
Conditions - empty room	
Temperature [°C]	22
Humidity [%]	20
Attenuation coefficient [dB/m]	
Speed of sound [m/s]	344.60248

Room	
Length [m]	
Width [m]	
Height [m]	
Volume [m^3]	[illegible]
Area [m^2]	[illegible]

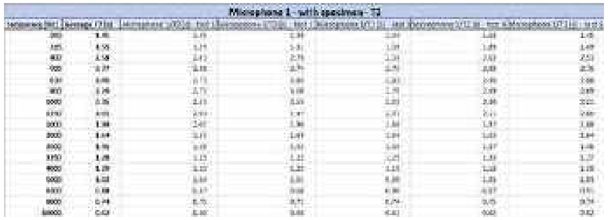
Conditions - room with specimen	
Temperature [°C]	22
Humidity [%]	20
Attenuation coefficient [dB/m]	
Speed of sound [m/s]	344.60248
Deviation [%]	2

Tested specimen	
Specimen area [m^2]	[illegible]

The data for reverberation time T1 (in an empty room) is copied into Excel® template. The customer performs the measurement five times and the reverberation times are averaged in Excel.



The measurement with the test specimen in the alpha chamber is also done five times. The frequency band data for reverberation time are averaged in the template.



RESULT AND REPORT

This section in the Excel® template is dedicated to reporting. The Alpha Coefficient is calculated from reverberation times (T1, T2) and other parameters that have to be entered (e.g. surface area of a test specimen, speed of sound).

Testing laboratory:	DEWESoft
Report number:	524
Date of test:	21.07.2017
Tested by:	DEWESoft
Test ordered by:	DEWESoft
Product:	
Manufacturer:	
Purpose of test:	
Place of test:	
Standard:	
Ambient humidity [%]	20
Ambient temperature [°C]	22

Frequency [Hz]	Average alpha
250	0.16
315	0.11
400	0.05
500	0.20
630	0.18
800	0.29
1000	0.41
1250	0.58
1600	0.61
2000	0.74
2500	0.83
3150	0.94
4000	0.91
5000	1.01
6300	0.97
8000	0.97
10000	0.92

The customer is comparing the Alpha Coefficient in each frequency band with the required values from the car manufacturer.

Each absorbing material has its own alpha characteristics, but most of them are built to fully absorb high frequencies.

SOUND POWER MEASUREMENT

INTRODUCTION

This application note shows how to perform a sound power measurement with Dewesoft.

The object under test was a standard notebook, the measurement was done according to ISO 3744 in a semi-anechoic chamber.

The following are our test categories:

IDLE

- Minimum: minimum noise emission while laptop is idle (Windows power plan: "Energy Saving"
- Medium: Average noise emission recorded while laptop is idle (Power Plan: "Energy Saving")
- Maximum: Highest noise emission measured while the laptop is idle (Power Plan: "High Performance")

HIGH SYSTEM USE

- Medium: Average noise emission while the computer is running at high level of system use. (3D Mark 2006, Power plan: Power Plan: "High Performance")
- Maximum: Highest possible noise emission while the system is under heavy load (Power Plan: "High Performance", 100% CPU and GPU usage - for the test tools such as Prime95 and Furmark load the CPU)

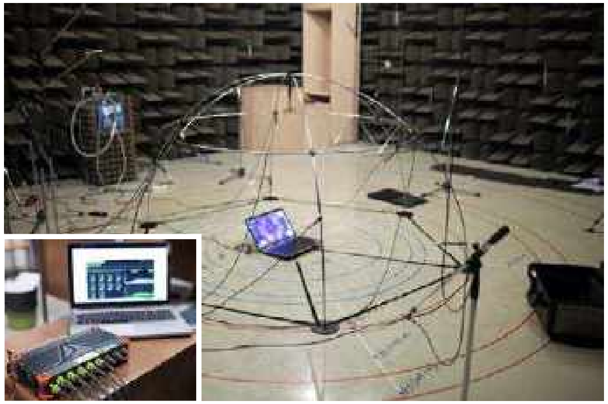
CONSIDERATIONS

In a quiet room, the human ear can hear background noise, which should amount to around 28 dB. A conversation at a normal volume ranges at 60 dB. All these values are dependent on the distance from the source of the noise. This is why we fix our gauge into place at a constant distance from our test models. This allows us to get clear results which can be compared with each other. The measurements are presented graphically and can be judged subjectively:

- **Under 30 dB:** Barely audible
- **Up to 35 dB:** Audible but not distracting.

  Ideal level of noise emission for a laptop running office programs.
- **Up to 40 dB:** Clearly audible, and might be distracting after a while.
- **Up to 45 dB:** Might disturb the user if s/he is in a quiet room. Still acceptable while playing games.
- **Over 50 dB:** Notebook emissions over this level are uncomfortably loud

MEASUREMENT SETUP



DATA ACQUISITION SYSTEM

- SIRIUSi-HD-16xACC, USB-based 16 channel IEPE/Voltage unit

SENSORS

- 10 microphones G.R.A.S Type 26CA (scaling: -40/-55 mV/Pa)
- G.R.A.S. 67HA 1m CCP hemisphere kit (diagonal: 2716 mm, height: 1283 mm)
- 10 BNC cables (10 meters)
- **SOFTWARE**
- DEWESoft X2
  DSA package
  Sound Power plugin

HEMISPHERE KIT SETUP

We used the hemisphere kit from G.R.A.S. with 10 microphones and a radius of 1.36 meters. The distance from the sound source to the microphones was 1 meter. The grid is very simple to assemble if you follow the attached instruction manual. It took us approximately 30 minutes to prepare everything.

First we had to put together the metal sticks and attached them together, to get a nice hemisphere structure. The next step was to put the microphones in the right positions according to the standards. The grid supports 10 or 20 microphones, so we had to select the right position for microphone mounting. The positions had to be the same as in standards and they are already predefined with small screws of different colors.

MICROPHONES

We used 10 BNC cables that were 10 meters long, so that the measurement equipment was outside of the semi-anechoic room. This is very important for reducing background noise to minimum. The microphones had TEDS chips, so the DEWESoft system automatically read the calibration factors after plugging in.

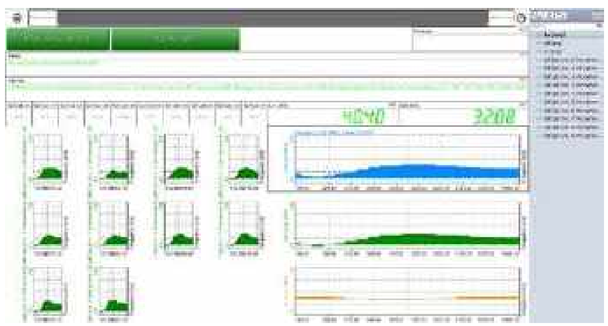
The whole data acquisition process took us approximately 10 minutes. We measured the laptop in three different states, the minimum measurement time for one measurement was 20 seconds (according to standard).

SOUND POWER SETUP

The according setup was chosen from the dropdown menu (ISO 3744, hemisphere), 10 microphones are mounted around the sound source in 1m radius, in the table you see the exact positions (x, y, z). Barometric pressure was measured and entered, the K1 (background measurement) correction method was additionally selected.

MEASUREMENT SCREEN

The SoundPower-Plugin in Dewesoft guides us through the procedure. At first the background noise measurement is done, with sound source (laptop) switched off. Then the laptop is switched on, configured to "idle mode" or "high system use", and the measurement is performed. According to the standard, data has to be collected for at least 20 seconds for each step. The green action buttons allow interaction (Acquire background, start acquisition). The text boxes below show status messages and warnings.



On the left side there are the 10 octave plots of all microphones, on the right you see the three graphs of the result: on top, most important: Sound Power, followed by Sound Level and the correction data.

RESULT AND REPORT

The noise levels of the 17-inch notebook are very good. It is always audible because the fan never stops spinning. The noise is very low during **idle** at **32 db(A)**. In this scenario, the fan speed is more or less constant and therefore very convenient for office use. The **hard drive** can be a bit disturbing with the clatter of the read/write heads, we measured **37.6 db (A)** during high activity.

When we demand the **highest performance** of the 17R, the noise rises up to **40.4 db (A)** (stress test CPU+GPU-FurMark). When we just play a game or run 3DMark 2006, we measured a moderate **36.4 db (A)**. In these cases the speed of the fan is also **constant** and there is no annoying pulsating.

Weather:	sunny
Temperature [°C]:	22
Pressure [kPa]:	1000
Relative humidity [%]:	45

Measurement duration [s]:	20

K1 [dB]:	1,30
K2 [dB]:	0,00

Sound Power Level [dB(A)]:	40,4

Frequency [Hz]	Lw (avg) [dBA]
100	11,4
125	6,14
160	4,81
200	7,65
250	11,18
315	15,58
400	20,47
500	26,84
630	30,07
800	29,52
1000	31,89
1250	32,22
1600	31,56
2000	29,73
2500	29,51
3150	27,51
4000	25,69
5000	24,95
6300	23,99
8000	23,28
10000	22,7

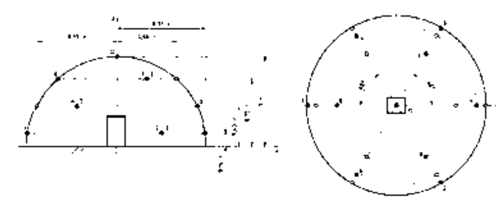
SOUND POWER LEVEL REPORT

Project number:	000002
Project description:	SPL of laptop with power supply
Date of measurement:	14.7.2015
Company:	Dewesoft d.o.o.
Report version:	1.0

Standard:	ISO 3744
Location of measurement:	[redacted]
Responsible person:	Dewesoft

Machine type:	Laptop
Machine description:	[redacted]
Length [m]:	0.27
Width [m]:	0.028
Height [m]:	0.41
Fan speed [RPM]:	3963,00
Additional information:	Laptop was running under performance test FurMark 1.16.0.0 (same as in Appendix A)
High-precision sound power meter:	Dewesoft
Measuring amplifiers:	Sirius ACC
Hemisphere:	G.R.A.S (1 m)
Microphones:	G.R.A.S
Data recording and analysis software:	DEWESoft X2 SP3
Calibrator:	G.R.A.S calibrator

Microphone position:	hemisphere
Radius [m]:	1
Number of microphones:	10
Type of room:	semi-anechoic



HUMAN BODY VIBRATION

INTRODUCTION

The customer, a company dealing with inspection and product certification services in Singapore, shows here some applications related to the effect of vibrations to the human body.

For example when working with a jack-hammer, the human body is exposed to vibrations, which can cause damage to vessels, leading to the white-finger-syndrome called Raynaud's disease. Furthermore, operating a helicopter for years, can cause harm to the spine.

The applicable standards are:

- ISO 2631-1 (1985) – Mechanical vibration - Evaluation of Human Whole Body Vibration
- ISO 2631-1 (1997) – Mechanical vibration - Evaluation of Human Whole Body Vibration
- ISO 5349 (2001)– Mechanical vibration - Evaluation of Human Hand-Arm Vibration
- Directive 2002/44/EC Vibration

ACTION AND LIMIT VALUES

When action values are reached, the company has to take care that periodic measurements ensure the safety of the employee. When limit values are reached, it is not safe any more, and the company has to e.g. reduce the operating hours on the machine / in the vibration environment.

	Action values (m/s²)	Limit Values (m/s²)	Remarks
Whole Body Vibration	0.5	1.15	Standardized to 8-hrs period
Hand Arm Vibration	2.5	5.0	Standardized to 8-hrs period

MEASUREMENT SETUP

DATA ACQUISITION SYSTEM

- SIRIUS-STG with MSI adapters, Battery
- **SENSORS**
- Webcam
- Seat pad sensor

FORKLIFT VIBRATION

There have been complaints about a new seat inside the forklift, the drivers complained about uncomfortable vibrations, and the inspection company was asked to measure and prove it.

For the whole-body measurement according to the standard, a triaxial seat pad sensor was applied on the seat, and another sensor on the floor. As can be seen from the table below, the seat vibration level is always lower as on the floor.

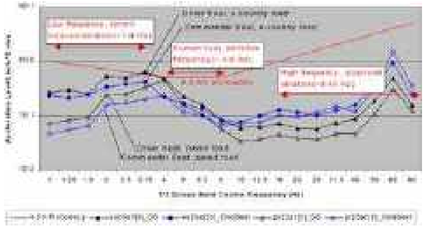
Test Nr	Route Description	Weighted r.m.s. Acceleration Value (m/s²) Floor	Seat
001	Area A + B	1.03	0.99
002	Area C +D	0.88	0.85
003	Area E	0.93	0.9
004	Area F	1.1	1.07

DRIVER SEAT COMFORT

Another similar measurement covers the comfort of car seats. From the measurement the influence of different roads (cross-country, paved road) and the damping behaviour of different seat models (Driver seat, Commander seat) can be compared.

Along with video input the data is then exported and displayed together with the limit line, and in this case an exceedance was found.

Seat pad sensor



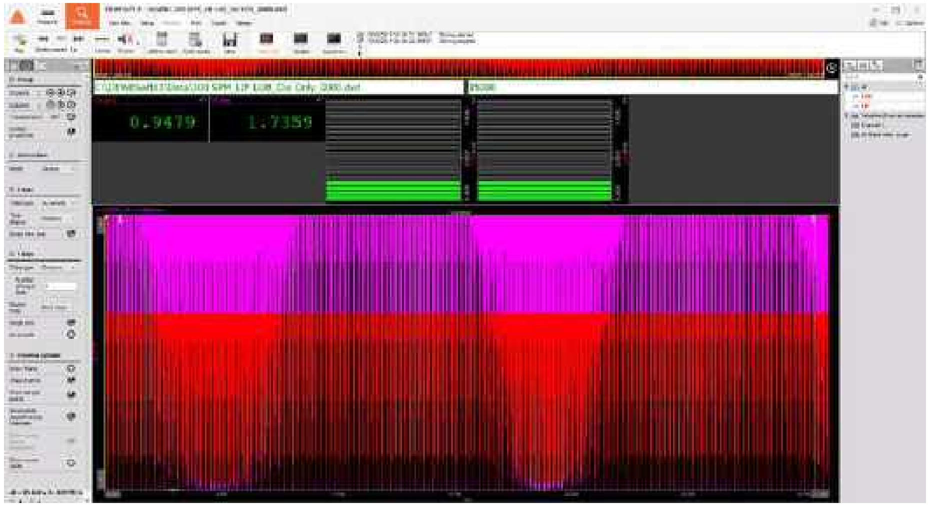
Driver Seat & Commander Seat Vibration according to ISO 2631-1 (1985)

STAMPING PRESS MONITORING

INTRODUCTION

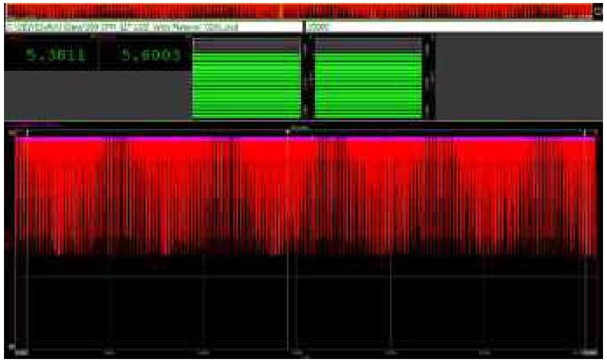
This application note shows how Dewesoft is an effective way to provide solutions for diagnostic stamping press monitoring. The hardware and easy-to-use software provides results to help identify suitable dedicated monitoring solutions for their many existing presses.

The customer, a large manufacturer of precision stamped metal parts, has many presses that are producing laminated stacks for alternators and electric motors. Their concern is with press head distortion. They were looking for a system to have the capabilities to measure force, vibration, displacement and temperature.



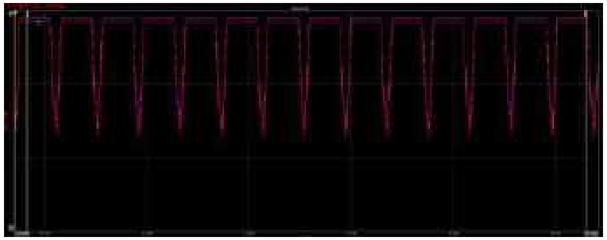
SETUP

They measure the die displacement as the upper die travels downwards, pierces, cuts and exits the coiled steel stock as it is indexed through the press. The Dewesoft hardware/software is used to capture displacement versus encoder angle of the cam. The customer is only interested in capturing 120 degrees of motion (60 before and 60 degrees after the bottom).



COMPARISON

Data comparison of the die coming into contact and piercing through the material.



MEASUREMENT SETUP

DATA ACQUISITION SYSTEM

• DEWE-43A

SENSORS

• Eddy current sensor

SOFTWARE

• Dewesoft X3

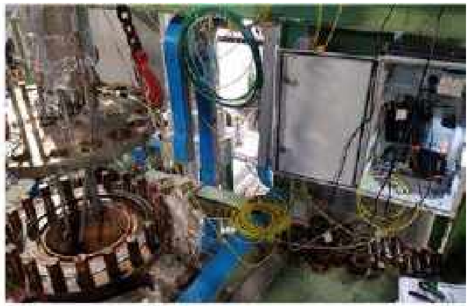
CONCLUSION

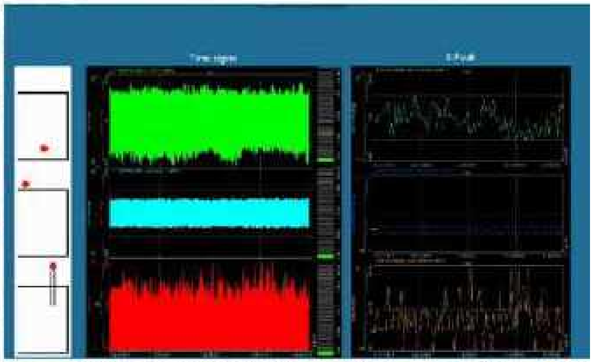
With the use of Dewesoft equipment we were able to help the customer better understand the long-term performance of their stamping presses. In the end this will help the customer move their mode of operation from reactive (now) to preventative and eventually to predictive.

BUBBLES IN A TANK

INTRODUCTION

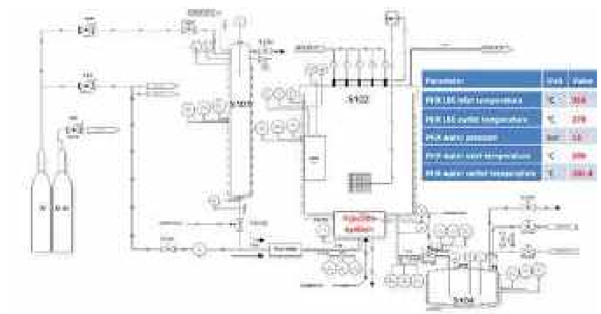
The presented Dewesoft application is a project of a consortium of Italian companies, operating in the field of Reliability, Maintenance Consulting, PdM and Condition Monitoring, dealing with New Technologies, Energy and Sustainable Economic Development. The main goal of the project is to simulate and correlate the dimensions of a potential micro-crack found on one of the PHX (primary heat exchanger) pipes of an experimental reactor, with the acoustic noise made by the steam bubbles at their exit. Regarding this goal, the results expected from the tests are: generate reliable experimental data, improve the knowledge and physical behavior of the phenomena generated during the creation of a micro-crack, correlate the dimensions of the micro-crack with acoustic signals and other signals types, provide data for the development and validation of the simulation codes. On the basis of the experimental conditions expected (see picture below), another company was involved to evaluate the possibility to use vibration and/or acoustic emission transducers to detect the steam bubbles flow getting out of the micro-crack.

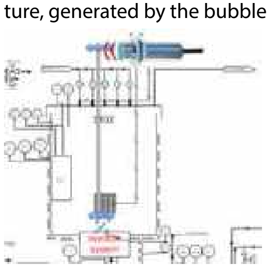


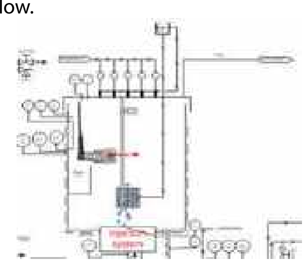

MEASUREMENT SETUP

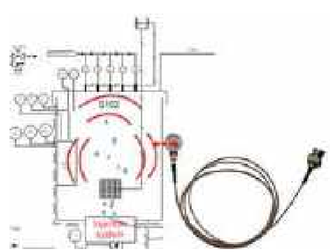
- SIRIUSm-4xACC
- DSA Plugin
- 1 Proximity sensor
- 1 IEPE Accelerometer high temperature
- 1 IEPE Accelerometer high sensitivity
- 1 Acoustics emission



The proximity sensor was positioned outside the tank to measure the movement of a metallic support, properly designed, in contact with the bubbles flow. The IEPE accelerometers were positioned within the tank (in the Argon plenum) on a metallic support, in contact with the bubbles flow. The acoustic emission sensor was positioned outside the tank to measure the noise at high frequency which spreads in the structure, generated by the bubble flow.


Sensors installation


Proximity sensor


Acoustic emission

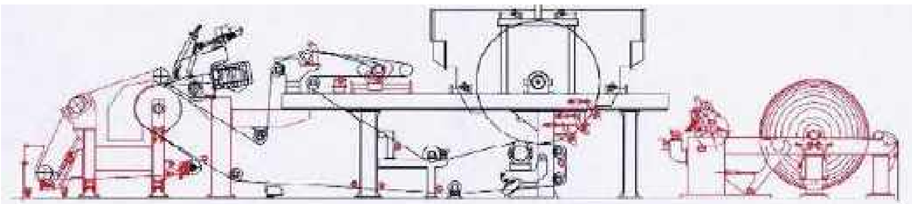
CONCLUSION

Dewesoft was selected as the dedicated acquisition system that allows the monitoring, the historicising and elaboration of the data gathered in real time. In particular, the great flexibility of the Dewesoft solution allows the acquisition of more signals and therefor could be useful also for the acquisition and development of the data gathered with microphones, thermocouples, pressure transducers and other signals found on the facility.

TISSUE PAPER INDUSTRY MONITORING

INTRODUCTION

The presented Dewesoft application is one of the standard monitoring services performed by an Italian company in the field of Tissue paper industry. The Italian company operates in the field of Reliability, Maintenance Consulting, PdM and Condition Monitoring. The activity is focused on monitoring a big gearbox for Tissue paper machine.



Tissue paper machine with dryer

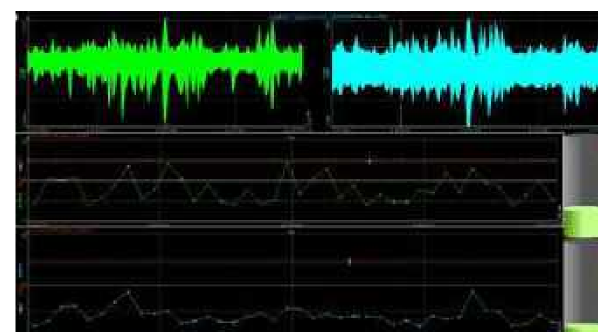
The activity consists in monitoring the behavior of a big gearbox along two specific directions using two IEPE accelerometers. The measuring activity is performed for one/three months in average, for that reason a standard system is designed to be installed for a medium-long time and then be used without significant changes in the same or in another kind of application.

In order to design a flexible and general-purpose acquisition panel, which can be able to cover every possible measuring activities on the mentioned machine and environment at the same time, a system with small dimensions, flexible number of channels input and an easy software configuration is required. A standard configuration is composed of: sensors and cables, an acquisition box and a remote-control channel.

For such technical specifications, Dewesoft software and Monodaq hardware were selected as flexible solution to be implemented in a box which can be easily re-configured, in both hardware and software parts, basing on the activity that has to be performed. Monodaq are EtherCAT® modules with several possible interfaces: IEPE, strain gauge amplifier, digital inputs, digital outputs, analog output, wide range voltage input. In the presented application four IEPE interface module have been installed. Moreover, those modules were upgraded to 40kS/s, which allows the module having a 3dB bandwidth of 20kHz. Another significant feature is the EherCAT cabling solution. Thanks to that, basing on the application, it is possible to install the modules outside the box close to the sensors in order to save money in cabling with UTP cable instead of analog cable. Single channel instruments are daisy chained by an affordable network cable which provides signal and powering.

Acquisition box. (A) Monodaq units, (B) Power over Ethernet injector, (C) Power units, (D) Rugged PC with Wi-fi

In the following figure a setup overview of the gearbox monitoring is shown. This screen plots the time signals of accelerometers and the trend of the 0-peak value. Using two thresholds in combination with the Sendmail-plugin it is possible to receive e-mails on alert, for dangerous gearbox working conditions.



Gearbox monitoring Dewesoft setup

DEVELOPMENT AND TESTING FOR ADJUSTABLE FURNITURE

INTRODUCTION

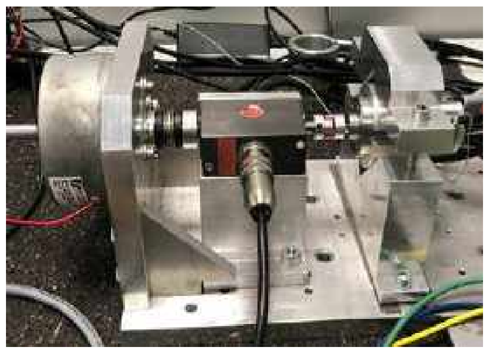
Our company in Austria develops mechatronic system solutions for adjustable home and office furniture. We constantly strive to create new and better technology. As we are implementing industry-leading solutions in to our products, we have to rely a lot on our internal testing, as we have to create our own database for evaluating solutions. For example, at the end, when we are testing the final design of the actuator that we would like to release and start to sell, we are performing more than 200 tests that this actuator design needs to pass in order for us to be OK. This means, that we need to have a possibility to perform a wide variety of tests quickly and easy on different locations. We realized, that the DEWE-43A offers exactly this. With TEDS support and setup storing, we are able to quickly build up our test setup on the spot where it is needed and perform our tests. In this note, I will present different measuring scenarios, where flexibility of DEWE-43A is helping us in our daily work.

SETUP 1

MOTOR PERFORMANCE TEST

To be able to move furniture, we need to have a motor. Therefore, we build a simple test device with motor holder, torque and speed sensor and brake. Equipment used:

- DEWE-43A
- DEWESoft X2
- DSI-V-200
- LEM LTSR 15-NP Current Sensor x4
- 1535 Peaktech Power Supply 600W
- RRFL-I-1-n ETH 1Nm Torque sensor
- HB-140M-2 Magtrol Hysteresis brake
- Self-made brake controller



Motor Test Device

Analysis of Phase Currents in Early Prototype

We are using PMSM 3 phase motor with our own controller. We are monitoring current flow in each phase, DC supply current and voltage and are able to calculate energy provided to the motor. On the mechanical side, we are measuring torque and speed and are therefore able to calculate mechanical energy going from the motor. Our test runs through different loads and speeds and we collect all the data. Using the great mathematical functions included in Dewesoft X2, we are able to calculate efficiency of the motor and generate the motor performance curve live while doing a measurement.

SETUP 2

PERFORMANCE DURING SIMULATION OF LIFETIME

It is also important for us to know how the performance of our actuator may change over lifetime. Therefore, we are doing different performance related measurements during a life test of the actuator. For this, a portable measuring solution is very important, as we have to move from actuator to actuator and perform the tests. Equipment used:

- DEWE-43A
- DEWESoft X2
- DSI-V-200
- LEM LTSR 15-NP Current Sensor
- Self-made digital counter
- HBM U10M 2,5kN Force sensor

Setup for Performance Tests

Performance of Linear Actuator

While the actuator is loaded with a defined load over the lifetime, we connect our equipment and measure the DC voltage and current going into the actuator. With a self-made digital counter cable, we tap into the communication between control box and actuator and get a voltage peak every time the motor rotates. With it, we can use the counter setup in Dewesoft to instantly calculate motor speed. With the force sensor mounted under the actuator, we know the load the actuator needs to move, and we can calculate mechanical energy going out of the actuator. With this information, we can calculate actuator efficiency. At the end of the life test, we can compare results from the same actuator over its lifetime and note any changes.

DEVELOPMENT AND TESTING FOR ADJUSTABLE FURNITURE

SETUP 3

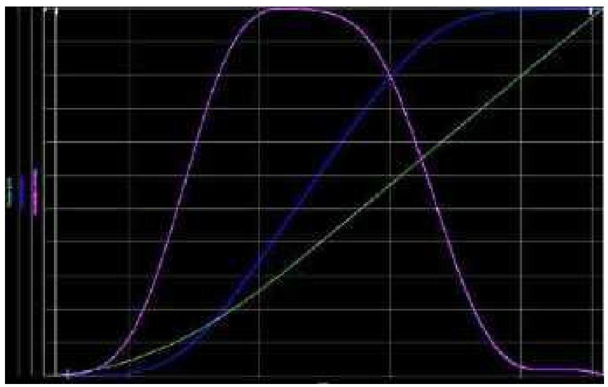
TABLE ACCELERATION AND DECELERATION PROFILE

Acceleration and deceleration profile of the height-adjustable table plays a very important role in a user experience and overall perception of the quality of the table. Therefore, different systems have been objectively and subjectively evaluated in order to find the best one and create a guideline for our future products. Equipment used:

- DEWE-43A
- DEWESoft X2
- Variohm RF603 Laser distance sensor

The laser was mounted on a special profile measuring the distance to the table top. The table was moved up and down and the position recorded. From this position, the acceleration and deceleration profile was extracted and compared to subjective evaluations.

Setup for measurement of acceleration profile



Acceleration profile on the Height Adjustable Table

CONCLUSION

As visible from the presented examples, portability and variability are essential for our measurements. What's more, prefect implementation of advanced mathematical formulas, calculated in real time, give our engineers possibility to have live view of calculated results and can adjust measured samples during testing. This increases efficiency of testing and gives us desired results straight out of first measurement.

IMPACT TESTING OF INDUSTRIAL SAFETY HELMETS

INTRODUCTION

There are different methods of impact testing for helmets and some variations between legislations in effect for each country. Motorcycle helmets are tested in different ways because in case of accident, the driver may impact the helmet against the pavement whereas in civil engineering and industrial environments, the user must be protected against impacts of falling parts.

The test shown in this example is performed like this: A load cell is mounted under the mounting bracket that holds the helmet for the measurement of the impact force, the impactor drops from top on the helmet.

MEASUREMENT SETUP

- DEWE-43A connected to an interface load cell
- Sampling rate: 100 kS/s
- Strain gage signal conditioning for the load cell with 10VDC power supply. The output signal of the load cell is 2 mV/V, so we set the full scale to 20 V_{DC} = 5klbf. The velocity of impact should be maintained at 4.0 m/s ± 0.03 m/s
- The impactor, with accelerometer attached, should be dropped onto the calibrating medium from a height which yields a maximum acceleration reading of 100 ± 10Gs.

ANALYSIS

The purpose of the measurement is to ensure that the peak force of the impact complies with the Type I (top) requirements of the ANSI/ISO test standards. The test standard informs that the rise time is approximately 0.01 msec.

CONCLUSION

Impact testing is frequently measured at 10kS/s however for better results in terms of repeatability, peak force detection and hence reliability, we have concluded that better results are achieved by using a high sampling rate of 100 kS/s. It is important to note however that there is no way of making assumptions as to what is the best sampling rate for impact tests because it depends of several factors, including the types of materials being impacted against each other. I.e. two metal parts tend to have a faster force rise time than one metal part impacting a plastic part. Extreme care should be taken before making assumptions. In this specific case, we had the chance to compare the results using 10 kS/s,100 kS/s and the differences were clear. We also did the measurement at 200kS/s but there were no noticeable changes on the results. The vertical resolution in bits is also very important when doing transient measurements and the customer could clearly see the benefits of using a 24bit ADC compared to the 8bit ADC system that had been replaced.

"The history of science shows that theories are perishable. With every new truth that is revealed we get a better understanding of Nature and our conceptions and views are modified."

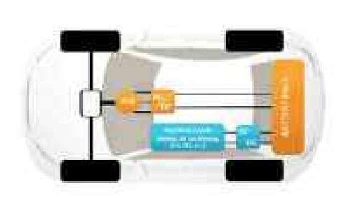
-Nikola Tesla

ENERGY


SIRIUS
PWR/USB
HS
ISOLATED
1 HV
2 HV
3 HV
4 HV
5 LV
6 LV
7 LV
8 LV
1000V CAT II
1000V CAT II
1000V CAT II
1000V CAT II

EV ENERGY BALANCE TEST

INTRODUCTION



More and more car manufactures are developing and researching their electric vehicle. And most of them need to measure the electric energy performance. Usually they should measure the DC (battery, DC/DC, PTC, A/C) and AC (motor) loads power, energy, efficiency.

For the Real Drive Test, they need the portable and on-board equipment with high sample rate, high bandwidth, high isolation, multi input channels. The traditional power analyser already does not fit to this test. The Dewesoft Power Analyser is a perfect choice, it helps the customer to achieve this test very easily.

MEASUREMENT SETUP

DATA ACQUISITION SYSTEM

• SIRIUSi-HS 4×HV 4×LV (4 high voltage, 4 low voltage, 1 CAN 2.0 input channels)

• SIRIUS PWR-MCTS   Current Clamps power supply module

SENSORS

• DS-CLAMP-500DCs 500A input range high accuracy clamps

• VGPS (100Hz GPS receiver)

SOFTWARE

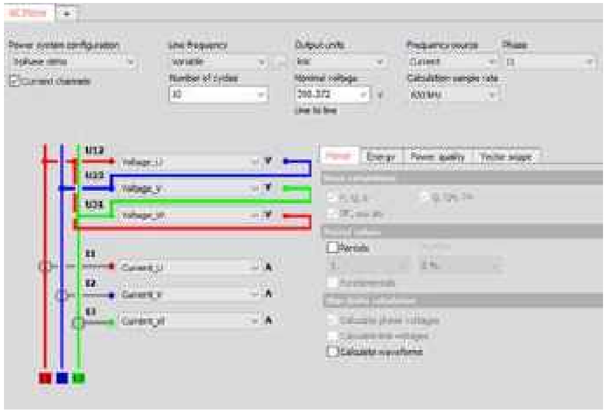
• Dewesoft X3 with Dewesoft-OPT-POWER

WIRING

Open the PDU (power distribution unit), install the high voltage cable on the screws, and then connect to the HV channels of SIRIUS.

POWER MODULE SETUP

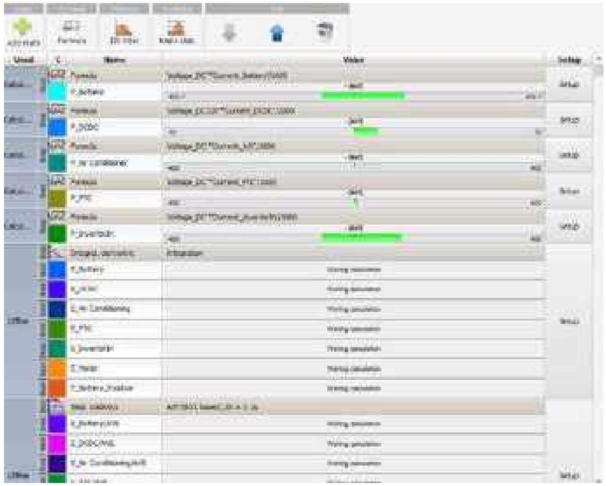
For the motor power test, we should setup the power system configuration, line frequency and frequency source (the algorithm follows the variable frequency in real-time), calculation sample rate and choose the right analogue input channels for voltage and current calculation channels.



Power setup

MATH SETUP

For DC power, energy and efficiency calculation, we use math functions.



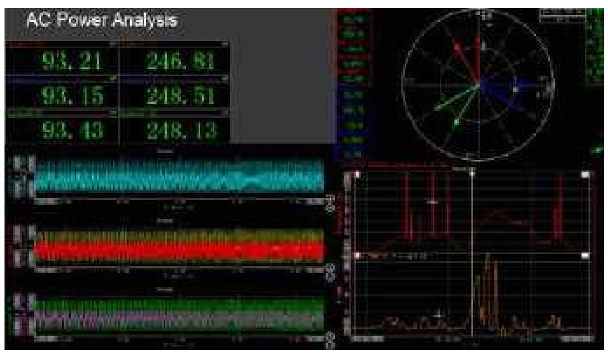
Math setup

SYSTEM MEASUREMENT

The Dewesoft software shows the power of battery, motor, DC/DC, Air-Conditioning and PTC.

DC power charts

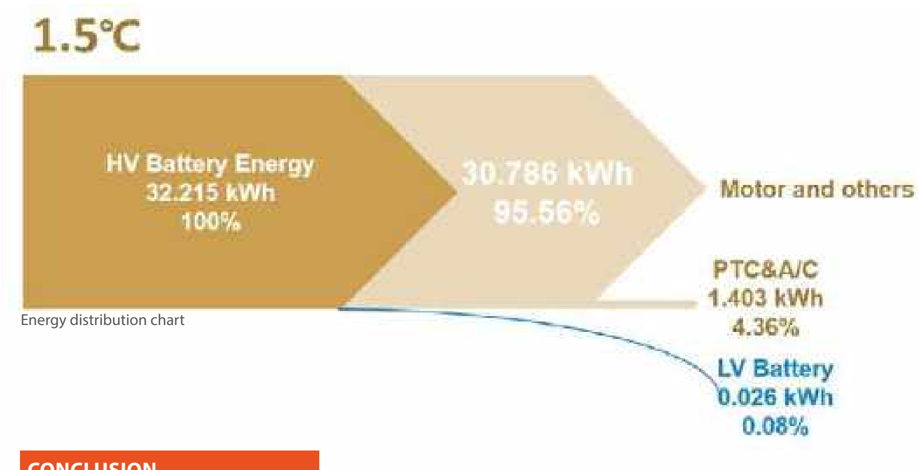
You can visualise the raw data high-frequency switching signal of the motor (U,V,W), the vector scope adapting to the actual input frequency, and the long list of output parameters of the Power Module.



AC power

EV ENERGY BALANCE TEST

Energy balance report will give you more detailed analysis about the total process of EV test.



Energy distribution chart

CONCLUSION

The Dewesoft Power Analyser is a very professional energy balance test instrument. The customer only needs to setup several parameters and create some math formulas, then he gets the values he wants. Using the energy balance report, it is very easy to get the energy consumption of any load.

ELECTRIC MOTORCYCLE DURING REAL DRIVE

INTRODUCTION

This application note shows the efficiency measurement of an electric motorcycle, using the Dewesoft Power Analyser under real driving conditions.

Measuring electric vehicles under real-driving conditions is becoming more and more popular and requires a mobile and powerful measurement instrument. Doing this at electric motorcycles additionally requires a very compact measurement system which is able to supply all sensors directly out of the measurement instrument. With the Dewesoft Power Analyser product line Dewesoft offers the ideal solution for measurement applications like this.

The SIRIUSi High-Speed slices with 1 MS/s sampling rate and 2 MHz bandwidth were used for measuring the voltages and currents on the AC side (3-phase motor) as well on the DC side (battery). The voltages were measured via the Dewesoft Starpointadapter. For the current measurement the DS-CLAMP-150DC were used. For comprehensive analysis also an acceleration sensor, a RPM sensor, an inertial measurement unit including GPS receiver (DS-IMU1) and a webcam were connected to the system.

MEASUREMENT SETUP

DATA ACQUISITION SYSTEM

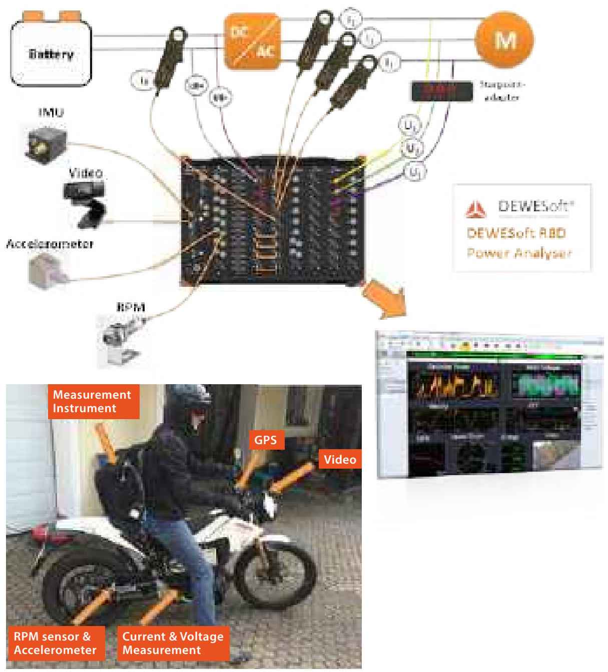
- SIRIUSi-HS 4xHV, 4xLV
- SIRIUSi-Custom (ACC, ACC+)
- Battery Pack BP2i

SENSORS

- 4x DS-CLAMP-150DC
- Starpointadapter
- DS-IMU1
- Acceleration Sensor
- RPM Sensor
- USB-Webcam

SOFTWARE

- Dewesoft X2
- POWER Plugin
- DSA package



ANALYSIS

The powerful software functionality of the Dewesoft Power Analyser allows comprehensive and detailed analysis for any situation. The combination of multiple instruments, like Power Analyser, Spectrum Analyser, Scope, Data Logger, etc. ... empowers testing never experienced before. The picture shows a screenshot of the measurement software.

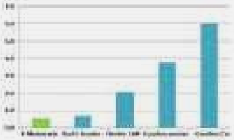
- Recorder: The Recorder window in the top left shows the Power flow (orange) during the test ride.
- Scope: The Scope visualization in the top right shows the three motor voltages (magenta, green, turquoise). Further zooming allows analysis of each pulse of the PWM modulated signal.
- FFT: The FFT chart in the middle right shows the FFT of the motor voltage and current. The switching frequency can as easily be seen as harmonic components and the moving of the fundamental frequency.
- GPS: The graph left down shows the GPS information of the test ride.
- Vector Scope: In Vector Scope voltages and currents are shown depending on their phase angle. In this case the phase angles between voltages and currents are about 180°, which means energy is right now recuperated to the battery. Furthermore the math library of the software allows to calculate efficiency factors, recuperation rate etc. already during measurement.
- Meters: The energy calculation for total, positive or negative energy is automatically done by the software and allows fast analysis of the used and recuperated energy.
- Video: The completely synchronized acquisition of video allows detailed analysis for each situation. The replay functionality of the software makes the analysis easier.

Out of the data, a lot of different analysis can be done. The following charts show exemplary results out of the efficiency analysis.

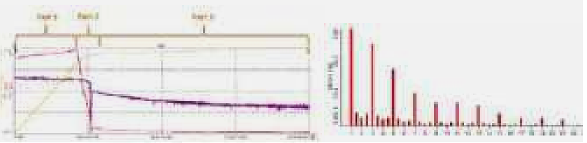
Energy Flow diagram

Determining factors which influence the energy consumption

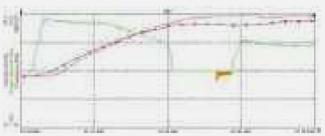
Benchmark with other vehicles



Charging Process

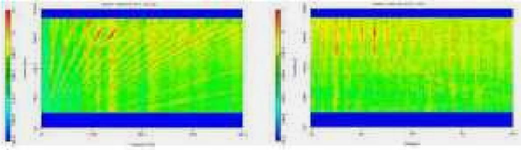


Detailed analysis of special situations



Analysis at different test tracks and driver behaviour

Order Tracking



A scientific paper concerning analysis on electric vehicles was published (Efficiency determination of electric vehicles under real driving conditions), which was presented at the ReCAR Conference 2015 in Malaysia.

Tacho Probe

Current Clamps

Webcam

Measurement Backpack

DS-IMU

WINDPOWER TESTING

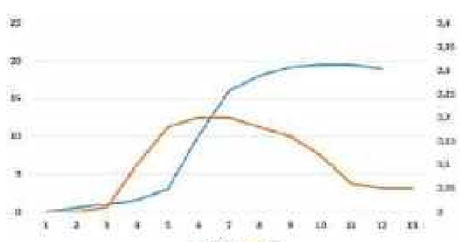
INTRODUCTION

Wind power plants generate clean electricity and are indispensable for the sustainable energy mix of the future. Dewesoft provides perfect measurement systems for the wind power industry which allows power analysis, power quality analysis and anlaysis of the behaviour at faults at the same time. Please find here some screenshots for the different measurement applications:

POWER ANALYSIS

Power Performance Analysis according to IEC61400-12 with Report Generation

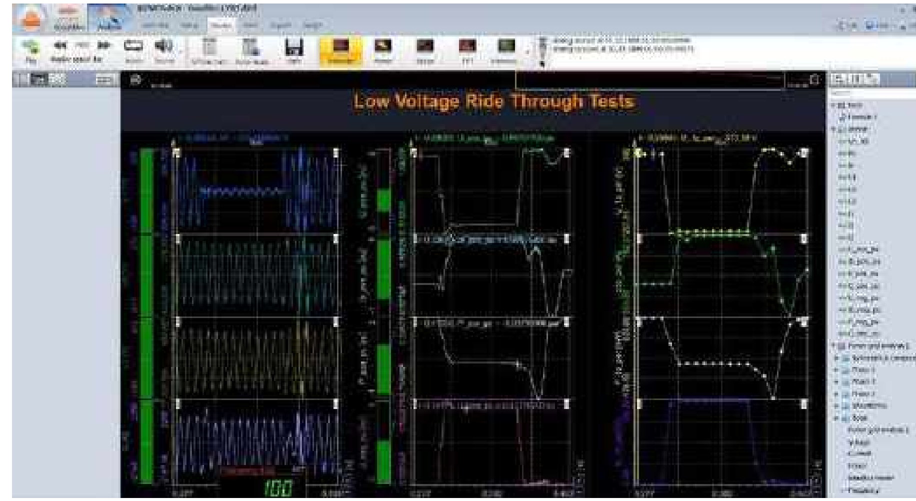
BIN Number	Wind Speed	BIN Power	Data points	CP
1	0,58	100	160	-7
2	1,02	105	699	-4
3	1,5	120	1241	-1
4	2	122	1354	0
5	2,5	125	1864	0
6	3	128	2490	0,02
7	3,5	129	1370	0,15
8	4	128	2699	0,2



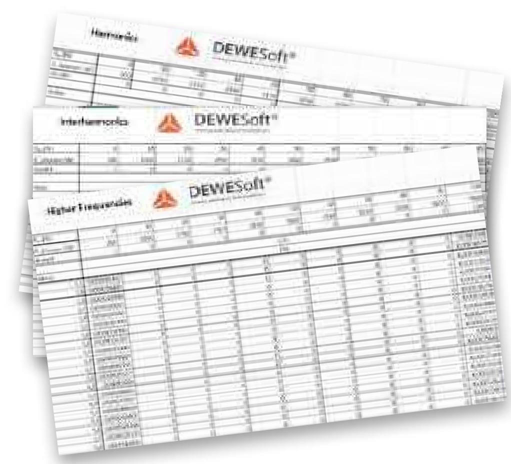
POWER QUALITY

Power quality reports according to IEC61400-21, FGW-TR3, BDEW, VDE AR4105 via Matlab, Excel, Python, etc.

Behaviour at Faults (LVRT)



Automatic Test-Sequences via Dewesoft Sequencer



ROTOR ISOLATION MEASUREMENT

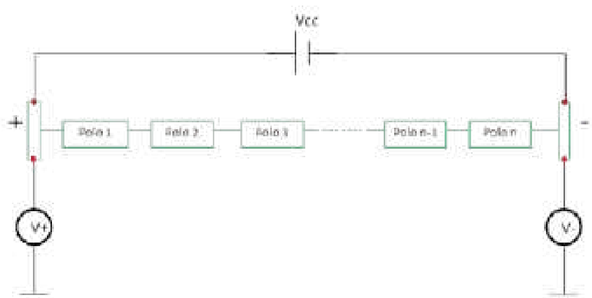
INTRODUCTION

Alternators are often used to produce electric power.

They are normally realized with a stator and a rotor, where the stator is the fixed part and the rotor is rotating due to turbines coupling.

While rotating, the rotor creates the wanted electric power.

The working principle is summarized in the drawing. The rotor is realized with a certain number of poles in series and the total generated voltage is the vectorial sum of all the voltages generated by each pole.



The alternator is able to provide power in complete isolation from ground or even with one of the two poles (positive or negative) grounded.

Unfortunately, high thermal stress, wear of materials during decades, mechanical or electrical stresses can damage the internal wiring and reduce the isolation to ground. In case of that occurrence, the rotor may result in having both poles with low impedance to ground and this can be highly disruptive.

SAFETY

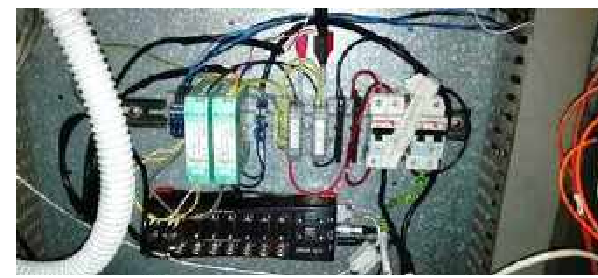
Safety rules in the customers power plants require all synchronous generators to be equipped with a protection system called "terra rotore" (rotor ground) to protect the rotor electrical winding from a low impedance to ground.

These protection systems simply measure the insulation resistance and react on two levels: a first level for warning and a second to stop the power production.

This procedure for sure prevents any rotor damage but the risk is to stop the production too often, also when the impedance variates rapidly and stays over the limit just for little time.

DEWESOFT INNOVATION

To reduce numbers of power production stops the engineers decided to design a system to be used on rotors with occasional unstable insulation to ground events. Such monitoring system is based on a simple DEWE-43 connected to two selfmade filtered voltage dividers.



They based the working principle on the fact that rotors are excited in constant current with a voltage shown above as Vcc. The two measured voltages from each pole (V+ and V-) to ground are identical in case of a rotor with good isolation. In case of a loss of isolation the two voltages will be unbalanced, even if the total sum will stay the same (Vcc).

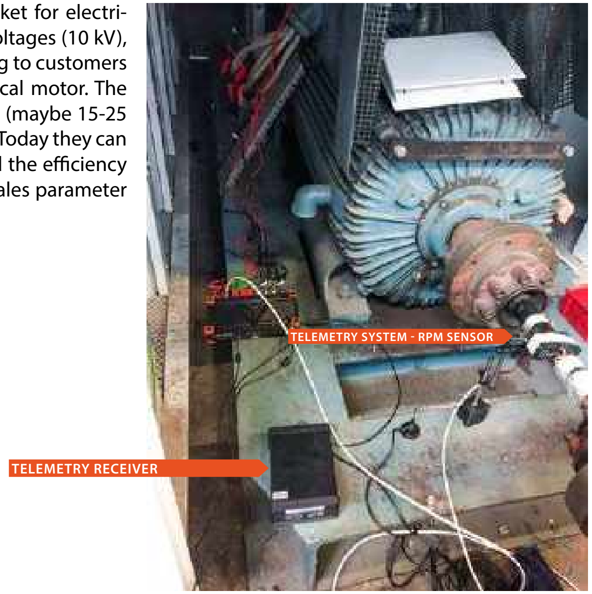
Such unbalance is related to the position of the winding where the loss of isolation occurred and so these faults can be associated to a position and distinguished from each other (impossible before). The customer may now decide to keep the alternators in operation if the occurrence of such loss of isolation is occasional, especially if it is recognized to be always the same (at the same place).

In this application the PC running Dewesoft is integrated in the company network and sends immediately events to the maintenance team that can access remotely and analyze the situation.

ELECTRICAL AND MECHANICAL POWER

INTRODUCTION

One of the biggest player in the market for electrical motors, for low voltages to high voltages (10 kV), wanted to have a kit to be able to bring to customers to show the efficiency of their electrical motor. The reason for that is to find out if the old (maybe 15-25 years old) motors are still good to use. Today they can manufacture much better motors and the efficiency is better. The system will be used as sales parameter for exchanging of electrical motors.



MEASUREMENT SETUP

DATA ACQUISITION SYSTEM

• SIRIUSi 3xHV, 3xLV, 2xACC+

SENSORS AND TRANSDUCERS

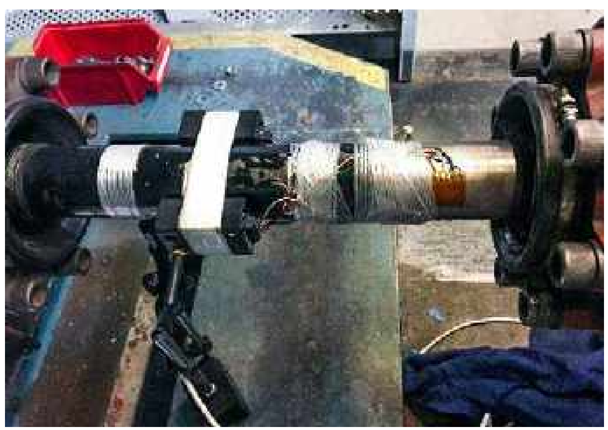
• Biensfield TT10k telemetry system

• Strain gauge full pattern for torque

• PM sensor

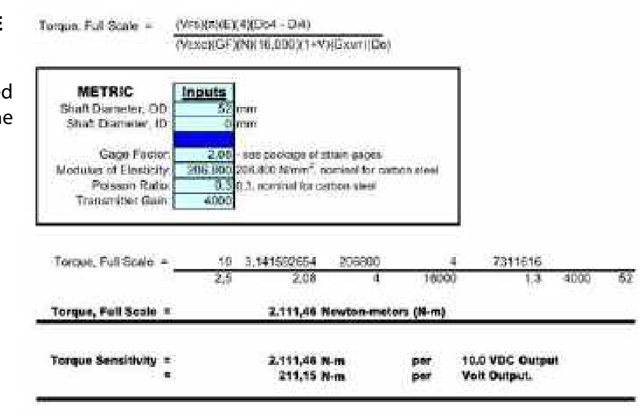
STRAIN GAUGE INSTALLATION

The torque measurement is done based on strain gages mounted on the rotating part, therefore telemetry is used to transmit the data.



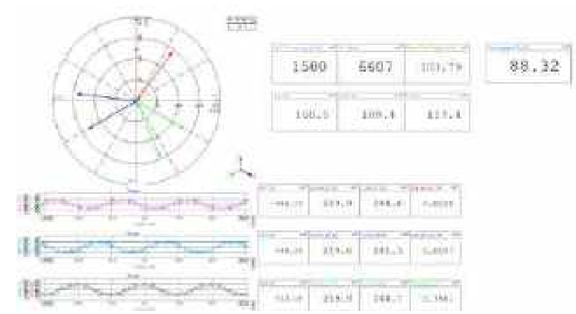
CALCULATION OF FULL SCALE TORQUE

The calculation to the right is used for determining the scaling of the torque in Nm unit.



MEASUREMENT

The screen below shows the DEWESoft Power module with a Vector scope, used to see that everything looks fine regarding voltage and current, compared with the mechanical power on the shaft.



CONCLUSION

The combination of SIRIUS and the telemetry system works very well for the customer, it is a new way for them to do measurements onsite to show customers the facts of the existing installations and convince costumers with real measurements. The measurements are also continued after an exchange of an electrical motor to prove it was the right decision they took.

POWER QUALITY TESTING (IEC61000-3-2)

INTRODUCTION

If associating "dirty power" with our electrical energy supply, most of us probably think of the pollution of our environment in the production of electrical energy by combustion plants. But that is not the point here – quite the contrary. This application note is about the "pollution" of the grid operator's product - supply voltage and current of the energy producer – through the consumers. In the last decades power plants were able to significantly reduce air pollution, but in the same time pollution of voltages and currents increased. In particular, a significant increase of the harmonics – this means distortion of the sinusoidal waveform of voltage or currents – is observed. For example, in average the fifth harmonics is since 1980 more than doubled by the number of computers in the network.

Since the possibilities for the reduction of harmonics in the supply network are limited, therefore, a limitation must also be done on the side of the consumer. Since January 2001 the standard IEC61000-3-2 finally came into effect and defines the limits of harmonic currents of electrical and electronical equipment which is used in low-voltage power supply network. The standard applies to devices from 75W (and input current <16A for each phase; otherwise IEC 61000-3-4 or IEC61000-3-12) power and divides these into four classes:

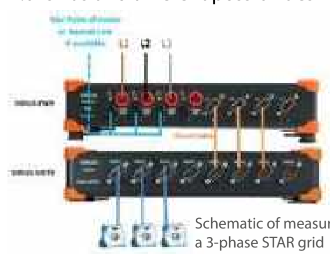
- Class A: Symmetrical 3-phase devices; Household appliances, except class D devices
- Class B: Portable power tools
- Class C: Lightning equipment
- Class D: Equipment with power between 75 and 600W. e.g. Computer, Radio, TV.

The regulations for voltages are defined in the standard EN50160 and are not further discussed here. There are a few possibilities to test standard IEC61000-3-2 in Dewesoft. It is possible to test the current harmonics with math formulas. The setup: IEC61000-3-2.dxs has two different possibilities installed to test them.

MEASUREMENT SETUP

For the measurement a SIRIUSi® Power slice with a supply unit for current transducers, and 3 current transducers MCTS-60 can be used.

In the power module setup, the input parameters can be defined easily and to evaluate the standard we use harmonics plot and FFT.



Schematic of measuring a 3-phase STAR grid

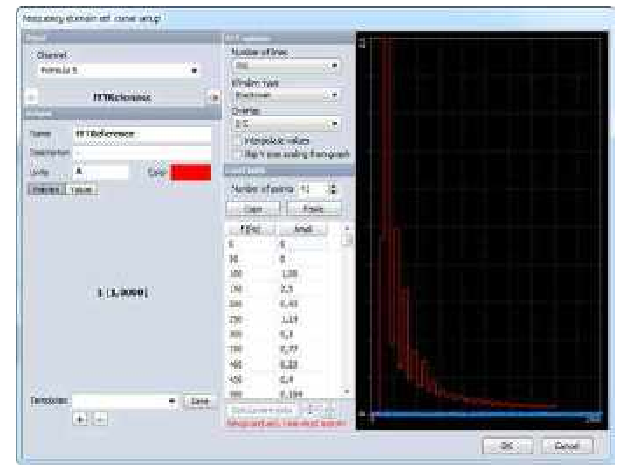
Measurement screen in Dewesoft for 1ph system

REFERENCE CURVE

TESTING WITH FFT - REFERENCE CURVE

In the setup is a math formula called FFT reference curve defined, it includes all the limits according to the IEC standard. While using this formula, the output is 0 or 1. Logic 0 means all values are below the reference and logic 1 means values are exceeding the limits.

FFT Reference curve in Dewesoft Math

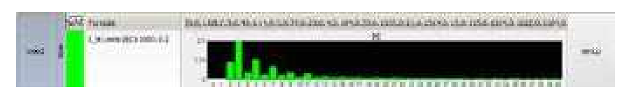


Definition of the FFT Reference curve in Dewesoft Math

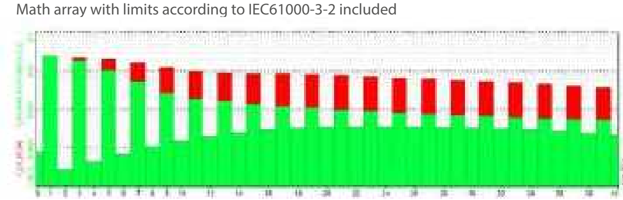
MATH FORMULA

TESTING WITH MATH FORMULA

The last implementation in this setup is a standard math formula as array. The array can be used for checking limits during and after measurement but without events. It is easy to copy and needs no calculation power.



Math array with limits according to IEC61000-3-2 included

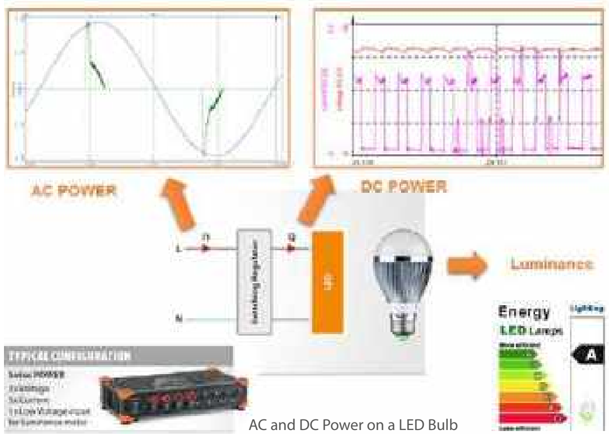


Math array (green) and Harmonics (red) to see limits during measurement

POWER & POWER QUALITY LED TESTING

POWER & POWER QUALITY LED TESTING

AC / DC POWER ANALYSIS



AC and DC Power on a LED Bulb

AC / DC POWER ANALYSIS & EFFICIENCY OF A LED

LEDs are powered by a DC line generated by a switching power supply. Therefore, for DC power analysis a measurement instrument with high-bandwidth and sampling rate is required because of high switching frequencies of the ballast units or switching regulators. The Dewesoft SIRIUS-HS amplifier fits perfectly to this application and allows doing efficiency analysis of the full energy flow (AC power, DC power, luminace) completely synchronous.

The picture above shows the waveform of the AC (left) and DC side (right) of a LED. The raw data storing capability also allows doing Transient recording or dU/dt analysis like you see on the DC side. This light bulb has a DC to AC efficiency of 80 %. The active power is 5,3 Watts. According to the energy labeling this clamp will have:

• Class A Efficiency

• 5,3 kWh/1000 hours energy consumption

POWER QUALITY ANALYSIS

So, this LED is really good because it has a really high energy efficiency, but is it really that good?

If we have a closer look on the waveform of the AC side, we see that the waveform for current isn't sinusoidal anymore. …. There is a lot of distortion power present which affects the quality of the power grid. Therefore, all electronic equipment has to fulfill requirements for harmonic currents which are defined in IEC61000-3-2. The limits for Lighting are defined in Class C. There is a separation between lighting with power > 25 Watts and below 25 Watts. For lighting below 25 Watts there are two possibilities to test the lighting equipment.

PROCEDURE 1:

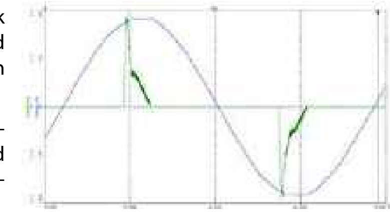
Procedure 1 analyses the current harmonics of the third and fifth harmonic and in addition checks the waveform of the current within one period.

The harmonic current limits are listed in the following table:

Harmonic Order	Limit
I_H3	86%
I_H5	61%

Limits of 3rd and 5th Harmonics

Furthermore, also the waveform has to be checked. The peak value of current has to appear at a phase of 60° and should go back below 5% not before 90° phase. The following screen shows the waveform out of IEC 61000-3-2 (page 21).


Voltage and current waveform

If we have again a look on our LED bulb, it will fail for all requirements. The Harmonic Currents for I_H3 and I_H5 exceed the limits, and as well the waveform characteristic is not allowed according to the standard.

Dewesoft allows very quick and powerful analysis according to these requirements. In the Scope View the waveform immediately can be analyzed with a couple of trigger and analysis capabilities. Also, the Harmonic Currents can be verified quickly whether with the Harmonic FFT chart or the Harmonic Vector Scopes with absolute values and as well percentages.

PROCEDURE 2:

The second valid procedure is to check if the harmonic currents for the individual harmonics don't exceed the limits out of equipment which is classified in Class D. The following table shows the limits for the harmonic currents (out of IEC 61000-3-2:2014, Table 3, column 2 - Class D equipment, page 24):

Harmonic Order	Limit
I_H3	3,4 mA / W
I_H5	1,9 mA / W
I_H7	1,0 mA / W
I_H9	0,5 mA / W
I_H11	0,35 mA / W
Odd Harmonics from I_H13 to I_H39	3,85/n mA / W

Limits of odd Harmonics according to IEC61000-3-2

The harmonic currents in this case are referenced to the nominal active power of the light bulb.

This analysis can be done very convenient directly in Dewesoft. Again, with the Reference Table functionality all harmonics and their limits can be shown within one diagram. In the picture above you see the harmonic currents. For this particular LED almost all harmonics are exceeded.

POWER QUALITY

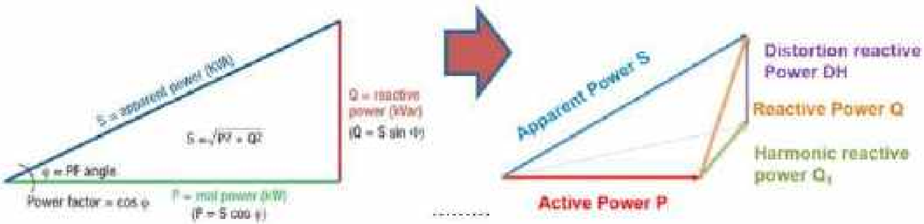
POWER QUALITY – A CLOSER LOOK

In this scenario the typical power triangle (P, Q, S) of AC power analysis doesn't fit anymore because other parameters like the distortion or harmonic reactive power have to be considered due to non-linear loads.

Fortunately, Dewesoft power module brings all needed tools to proceed in the non-linear field. Together with the Harmonic Reactive Power (QH), occurring through the phase shift between voltages and currents of the same frequencies, a new entity has to be taken into account: The Distortion Reactive Power (DH).

DH is defined as the combination of voltages and currents of different frequencies which produce the distortion power.

The old power triangle (P, Q, S) is shown in the left picture, the new one including distortion is shown in the right picture:



If we finally have again a look at the LED we see that the light bulb creates a lot of distortion power, although it's really efficient. This can be seen especially at the high distortion power (DH) and the high current THD.

P = 5,3W

Q = 10,4VAr

QH = -0,9VAr

DH = 10,4VAr

S = 11,7VA

THD_I = 183 %

CONCLUSION

Testing the IEC61000-3-2 standard can be done in different ways. Depending on different preferences Dewesoft offers a few ways to evaluate the given limits. This could be done also in combination, so it is possible to see if limits are exceeded already during measurement. Setup will just take a few minutes, by the way this complete setup is also available.

The Dewesoft Power Analyzer makes it possible to check both Efficiency and Power Quality Analysis of Light Bulbs within one instrument. … This has never been experienced in lighting testing before.

In this test we checked all in all 10 LED light bulbs and the surprising result is that just one of them passed the Power Quality Tests.

VOLTAGE SOURCE

CHECK OF VOLTAGE SOURCE

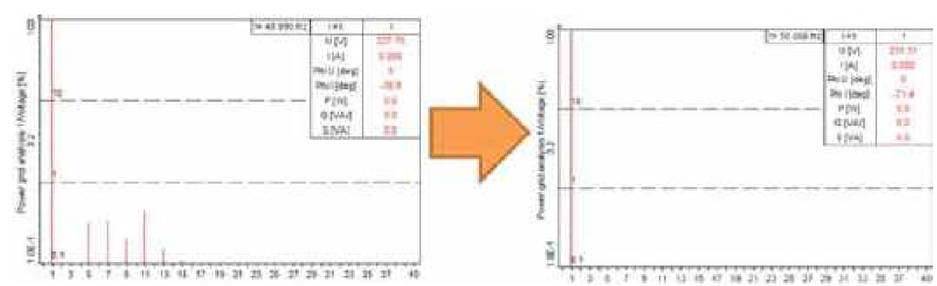
Before the power quality emissions of the LED bulbs can be tested, the voltage source has to be checked, if all parameters (harmonics) are within the required limits. The IEC 61000-3-2 regulation requires that the harmonic voltages are below these specified limits:

The harmonic currents in this case are referenced to the nominal active power of the light bulb.

Harmonic Order	Limit
I_H3	0.9 %
I_H5	0.4 %
I_H7	0.3 %
I_H9	0.2 %
Even Harmonics from U H2 to U H10	0.2 %
All Harmonics from U H11 to U H40	0.1 %

Limits of voltage harmonics

One big benefit of using Dewesoft instruments is the setting "background harmonics" (see 1.3. Background Harmonics) where possible distortion and voltage harmonics of the grid can be compensated and tests can be done according to the IEC 61000-3-2.



Background harmonics compensation

EFFICIENCY AND POWER QUALITY ANALYSIS

INTRODUCTION

This application note is about the measurement and analysis of a Power system, to find abnormal signals such as Harmonics, Voltage Drops, Transient, THD, etc.

MEASUREMENT SETUP

DATA ACQUISITION SYSTEM

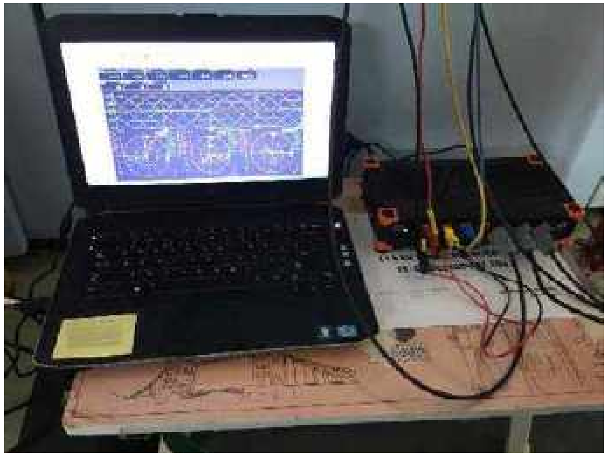
- Dewesoft SIRIUSi-4xHV-4xLV
- Sampling rate: 200 kHz when detecting an event, and slow sampling at 50 Hz for normal signals

SENSORS

- 3 x Current Clamps: Dewesoft DS-CLAMP-5AC (5A AC Current range)

SOFTWARE

- Dewesoft X2 Professional software
- Dewesoft-OPT-POWER (POWER module for Dewesoft, calculates more than 100 parameters based on voltage and current like P, VA, VAR, cos phi, Harmonics, Frequency)

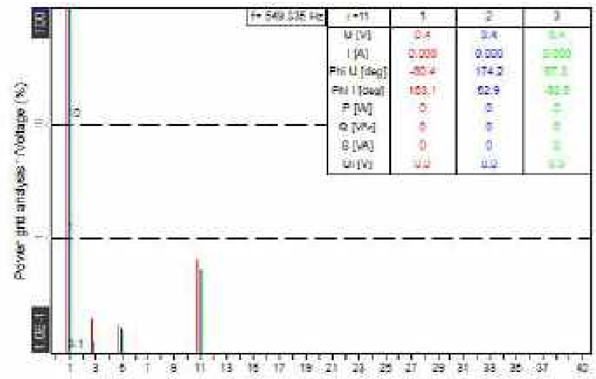
Measurement setup

ANALYSIS

HARMONICS

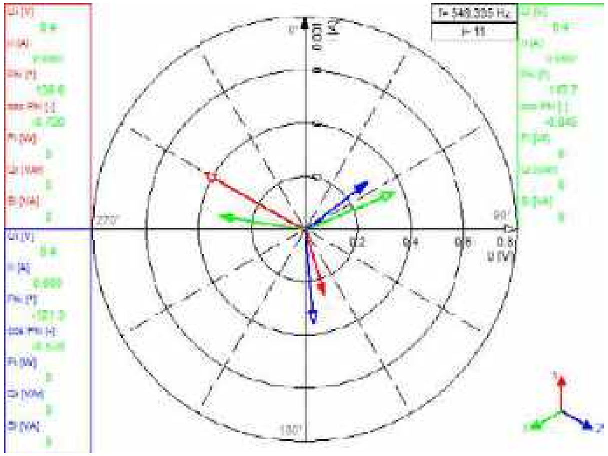
The highest amplitude in the harmonics spectrum occurs at order no.11, it shows 0.8%, which is not much.

According to IEC61000-4-7 the Individual harmonic limit is 5%, so the result can be considered as: excellent.



DIRECTION OF HARMONICS

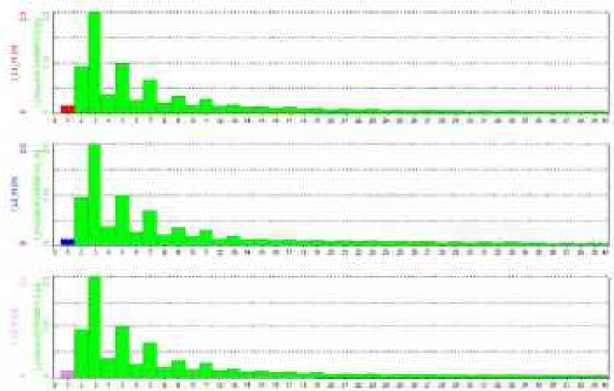
When you look at the phase angles of the Harmonics (between +90° and +180° or between -90° and -180°), the direction of Harmonics at order no.11 is flowing from the load (outflow).



The harmonic currents are referenced to the IEC61000-3-2 standard.

When we reference the harmonic current to the IEC61000-3-2 standard, it is in the normal level.

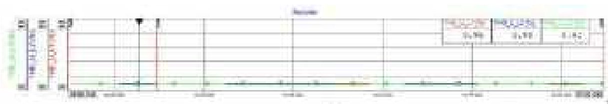
(Result: excellent)



THD

(Total Harmonics Distortion) referenced to IEC61000-4-7

The total harmonics distortion (THD %) of the voltage limit is 8%



VOLTAGE SIGNALS

The nominal voltage line-to-line is 117.6 Volts (RMS)

We set up the limit ±5% as shown on the table on the right.

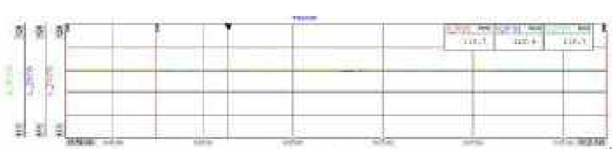
Voltage	Normal Voltage (Volt, rms)	Limit (%)	Limit (Volt, rms)
U12	117.6	±5%	111.72 - 123.48
U23	117.6	±5%	111.72 - 123.48
U31	117.6	±5%	111.72 - 123.48

Note: According to EN50160 standard, limit ± 10%

Voltage RMS Graph

The measurement value of RMS voltage is about 118.7 Volts that is in the normal range.

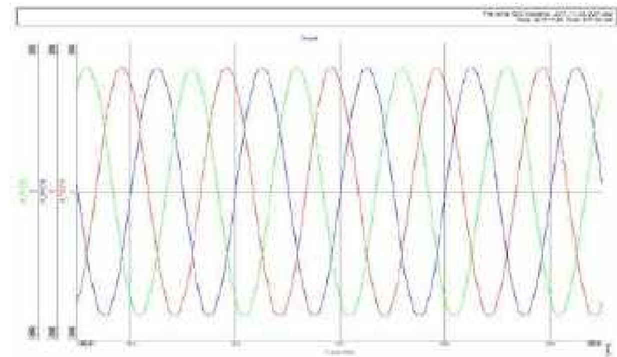
(about ± 0.01%), excellent



Voltage waveform (Scope)

Checking the raw voltage signal in a Scope instrument, the waveform of all 3 phases show a perfect sine wave.

Result: good



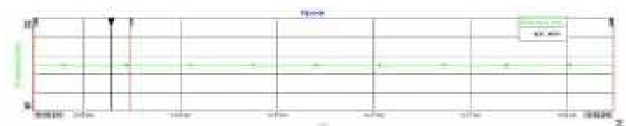
FREQUENCY

We set the tolerance band of the frequency variation to ± 0.2%

Standard: 50 Hz

Limit: 49.90 – 50.10 Hz

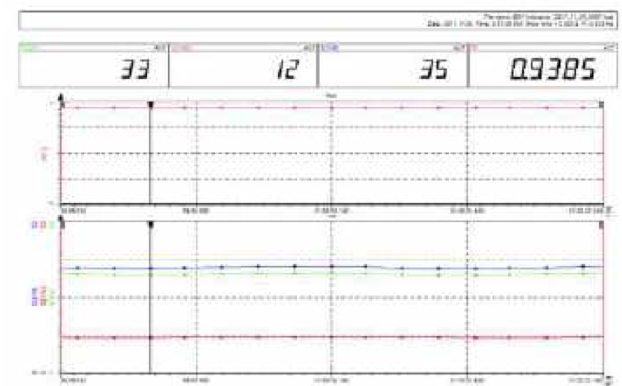
The frequency graph shows the frequency is 49.996 Hz (0.008% of 50Hz), Result: excellent



POWER (P, Q, S AND PF)

The graph shows the total power value (P, Q, S and PF), the power factor is 0.9385 (≥ 0.85)

Result: good



CONCLUSION

The power system of this station shows a very good efficiency. We got the result that the harmonics levels are very low according to the IEC61000-3-2 standard, the THD of voltage is excellent (not over 1%), the power factor is 0.9385 and the waveform of voltage and current is a smooth sinewave.

The Dewesoft Power Analyser makes it possible to check both Efficiency and Power Quality Analysis of power plant and can analyze a big variety of parameters.

PERFORMANCE TEST OF DIESEL GENERATOR SET

ABSTRACT

The last decade has seen a large-scale growth in the requirement of uninterrupted power supply for industries, residential, commercial complexes, and educational institutions and most critically: hospitals. At many of these locations, standby power is provided by diesel-generator (DG) sets. As per Central Pollution Control Board [CPCB], India norms Diesel generator sets should comply with noise standard less than 75 dBA and it is tested by ISO 8528 standard for noise level. To comply, this generators are manufactured with acoustic enclosures to get optimum performance of noise level and power.

So canopy enclosure is the main component in industrial DG set and engine performance is depending on canopy. To get optimum performance of the canopy, designers mainly needs to juggle in between Sound Levels of DG and Temperature. Efficiency of DG set is directly dependend on the acoustic enclosure and various parameters like inlet temperature, ambient temperature, canopy temperature, canopy out temperature, Radiator, water in/out temperature, Vibration and Sound levels.

The Dewesoft products provide an operative solution for a quick measurement of DG set parameters. We have used DEWE-43 eight channel data logging system for microphone and accelerometer inputs and KRYPTON eight channel thermocouple inputs. The software is easy to set up and very interactive. There are various design options to set the communicative monitor screen.

Key-Words: DG set, Central Pollution Control Board, DEWE-43, KRYPTON

INTRODUCTION

Our client is one of the largest manufactures of DG set in residential, commercial and for special applications. The company manufactures DG sets ranging from 3 KVA to 1000 KVA. There are specified certification standards to meet by any capacity of DG sets. After certification only, the DG sets are viable to be sold in market.

The standard regulation for any DG set to be approved for sound, vibration and temperature measurement are as follows:

- Standards for sound measurement [ISO 8528]
- Standards for Vibration Measurement [ISO 8528]
- Sound Power
- Temperature measurement
  - Engine Inlet Temp.
  - Canopy In Temp.
  - Ambient Temp.
  - Alternator In/Out.
  - Radiator Water In/Out Temp.
  - Canopy Out Temp.
  - Delta T (Canopy In –Canopy Out)
  - Vibration above and below AVM.

The main application is to measure these parameters simultaneously and only at a particular interval of time and at different loads. The regulations for the measurement of the DG set parameters suggest to continuously monitor the temperature, vibration at the mounting of engine and noise measurement.

MEASUREMENT SETUP

For the measurement we used 10 sensors including eight thermocouples, one vibration sensor and free field microphones for noise measurement. The instrument and sensors used for this particular measurement are listed below:

DATA ACQUISITION SYSTEM

- DEWE-43A: 8 Channel Data Logging System
- KRYPTON 8xTH : 8 Channel Temperature inputs

SENSORS AND TRANSDUCERS

- BSWA Free Field Microphone [MPA 201]-6
- Piezo-resistive vibration Sensor [MSI-4000A]-1
- K type thermocouple-1
- J type thermocouple-7

USED SOFTWARE:

- Dewesoft X2
- Additional Plugin: DSA
- Additional Plugin: Sound Power

Dewesoft data acquisition system along with mounted sensor on DG set

CHANNEL SETUP IN SOFTWARE

As per the requirement of the client, we needed to continuously monitor the data of sound, vibration, and temperature. So the measurement of all the above parameters has to be done after the span of 1 minute. We have set following recording parameter in Dewesoft software under channel set up.

- Triggered condition: Fast on triggered
- Sampling rate: 5000 S/ch
- Reduced Rate: 0.2 s
- Number of channels: 15

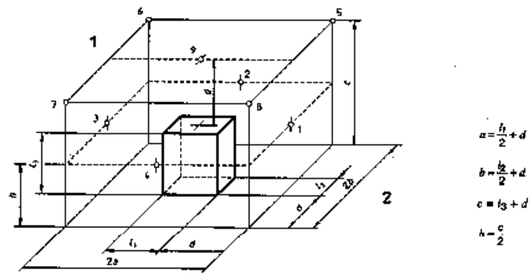
TEMPERATURES

Apart from basic temperature measurements, we have added Math in Dewesoft software. We want to measure LAT, Delta T and the difference between two temperatures. [Canopy temperature - ambient temperature].

As per standard, the Delta T value should be less than 7 deg. We have set the indicator from design by using Dewesoft software during the measurement.

NOISE

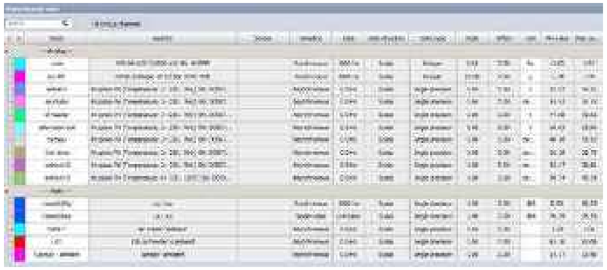
In the standard, different number of noise measurement points are defined with respect to size of genset canopy. These points are measured in dB(A) value with Leq mode and the final result is calculated with logarithmic average of all points. This we have set up with arithmetic functions for calculating final averaged results.



Noise measurement point DG Set

VIBRATION

In the DG set, the engine and alternator assembly is mounted on AVM to avoid transfer of vibration to the floor. Transmissibility of vibration is calculated to check isolation of the mounting. This is done by measuring the vibrations below and above AVM. This is calculated by using 'Math' function.



Channel setup in Dewesoft software

MEASUREMENT/ANALYSIS

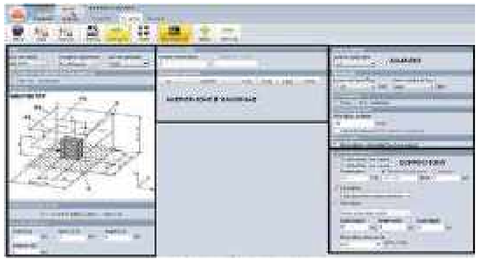
The measurement screen is set up to see all the standard measured parameters like temperature, vibration, noise and customized parameters which were added from the math function.

Measurement screen in Dewesoft software

MEASURE SOUND POWER

As per CE standard, if an Indian manufacturer wants to export the DG set to any EU country, they need to comply to sound power as per ISO 3744 standard. We have utilized the Dewesoft Sound Power software plugin to set up the microphone positions as per standard. The sound power setup is less time consuming and incorporated with all standards of sound power.

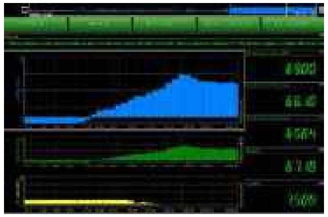
There is a predefined measurement setup for the sound power measurement, where we have to choose the ISO standard, geometry, numbers of microphones and its positions and correction factor according to ISO standard.



Predefined channel setup for sound power measurement

Microphone arrangement for sound power measurement of DG set.

The sound power level (Lw) for DG set and related SPL was measured. As per standard, we can also add background noise correction factor and metrological correction factor by the simple guided interface.



Sound power measurement

CONCLUSION

The real time measurement as well as data storing at triggered events was successful for this particular 15 KVA diesel generator set. It seems the equivalent noise level in dBA is on the higher side with a small margin. The expected value is less than 75 dBA. The averaged value is matching with the calculated results. Temperature measurement and LAT value were under an acceptable limit.

Including setup time, sensor mounting and measurement with particular triggered condition, everything was completed in 1 hour. The overall experience to use Dewesoft hardware and software is: quite less time consuming, easy to setup, easy to measure and most importantly very sophisticated analysis options were provided by Dewesoft software with self-interactive display screen.

The ready report is generated for particular triggered time intervals as per the customer requirement.

FUTURE SCOPE

In generator industry, after performance the most important point is the quality of the generated energy. This can be assessed by several energy analysis parameters and can easily be tested with our power analysis software.

HIGH-VOLTAGE DIRECT CURRENT (HVDC) TESTING

INTRODUCTION

HVDC converter stations are getting more and more popular. They are very often used for long-distance power transfer and also for the connection of different grids (e.g. different frequency). This application note shows the necessary system tests for HVDC installations and the analysis capabilities of the Dewesoft Power Analyser.

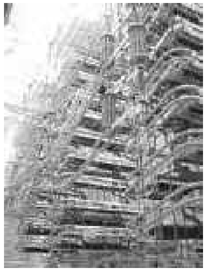
The tests include:

- Converter Station tests
- Low-Power transmission tests
- High-Power transmission tests

For Efficiency & Losses Analysis on HVDC lines there is a separate application note.

Dewesoft instruments are the perfect solution for testing HVDC lines and HVDC converter stations. Both, factory system tests and tests at energized systems, can be done - all according to international standards like IEC 61975. In IEC 61975 the tests for HVDC stations are divided in converter station tests, low-power transmission tests and high-power transmission tests. The converter station test includes inter alia:

- High-Voltage Energizing
- Energizing of reactive components (AC filters, capacitor banks, reactors)
- Tests at different DC configurations
- Trip Test
- Open Line Test
- Back-to-Back test
- Short-Circuit test



TRANSMISSION TESTS

The transmission tests are divided in **low-power** and **high-power** transmission tests. Together with the converter station tests, the low-power transmission test should verify that the equipment works properly. The low-power transmission tests includes inter alia:

- Basic operation tests (Steady State, Start-Stop, Current Ramping, etc.)
- Control Mode Testing (Reactive Power control, voltage control, DC power control)
- Different DC configurations
- Switching operations of primary equipment (Transformers, tap changers, AC and DC filters, reactive power compensation)
- Dynamic Performance Testing (Step response, Commutation failure, interactions)
- AC and DC system staged faults (Close 3-phase-earth, busbar 3-phase-earth, DC line fault etc.)
- Loss of telecom, auxiliaries and redundant equipment

HIGH-POWER TRANSMISSION TESTS

The high-power transmission tests are done to verify the steady-state performance parameters of the HVDC system. The tests include inter alia:

- **Loading Tests**
- Minimum-, rated- & overload power transfer
- different AC system conditions and
- different voltage levels
- operation with filter banks or reactive power banks unavailable
- steady-state range of AC power frequency and voltage
- extremes of ambient
- bipolar and monopolar operation with and without earth

- **Reactive Power Control (tests have to be done at same operating points like at loading tests)**
- AC / DC filter
- Shunt reactor
- DC Smoothing Reactor

- **Harmonic Performance and filter rating (test have to be done at same operating points like at loading tests)**
- AC & DC filter check
- Harmonic Performance
- Interference with third party electrical system

- **Overload / Temperature Raise**

- **Audible Noise (measurement at different operating points: low-, rated- overload power etc.)**
- Component generated audible noise (transformers, filters, valves etc.)
- Conductor generated audible noise (Corona effect)
- Impact generated audible noise (power circuit breakers, disconnect switches)

- **EMC tests (Power Line carrier, Telephone Interference factor, etc.)**

MEASUREMENT

A couple of signals have to be measured:

- AC voltages on each phase
- AC currents on each phase
- DC voltages on both poles
- DC currents on each pole and on each DC neutral connection
- AC currents in the valve winding on each phase
- AC currents in filter banks
- Transformer primary currents
- AC busbar voltages
- AC currents on converter feeder
- AC currents in filter banks
- Other signals (Protections, Control signals, firing and extinction angles etc.)

ANALYSIS

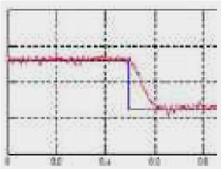
Out of the measured signals a couple of calculations and analysis have to be done:

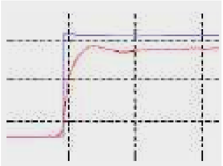
- RMS Voltages and Currents
- Active-, reactive, apparent power, Phase angle, power factor, Impedance
- Harmonic voltages and currents
- Unbalance and symmetrical components
- Inrush-Currents, Resonance
- DC / AC side interactions at switching processes
- Transient Stability at system state change or switching of primary equipment
- Overvoltage, Transient Recording
- And a lot more …

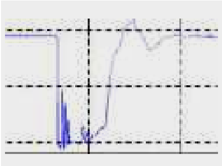
In all of these tests, the HVDC system shall recover in stable operation and all parameters should be within limits out of manufacturer's specifications and international regulations.

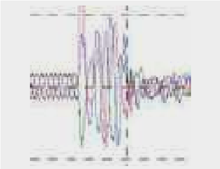
Especially the analysis of the Inrush-Current and the analysis at switching processes (voltage and current) requires high-bandwidth (2 MHz), high-sampling rate (1 MS/s) and high-accurate inputs. All voltages and currents (AC, DC) can be measured synchronously and power analysis for different configurations (AC, DC) can be done. Beside this also the required analysis for audible noise is possible (e.g. Corona effect) – all within just one instrument.

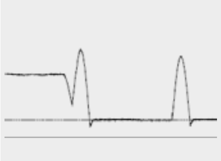
Exemplary results out of the different test

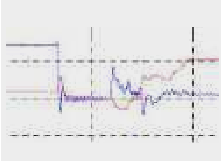

Step of DC Voltage

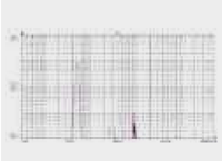

Step of AC RMS Voltage

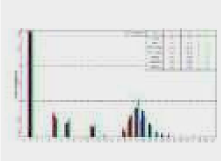

DC Line Fault

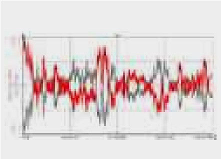

AC Line Fault

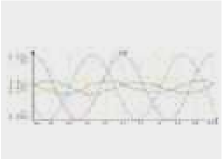

Firing of Valve

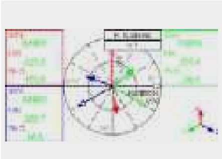

Active / Reactive Power

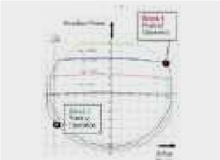

FFT Analysis


Harmonic FFT


Power Flow


Scope AC Voltages


Vector Scope AC Voltages


P,Q diagram-circular Operation

VERY HIGH POWER CONVERTERS

Advanced Measurement Tasks and Realization

ABSTRACT

Converters for several tens of Megawatts have to be controlled for magnetic symmetry and have to avoid any DC current injection into line transformers. Measurements for such systems require special sensors, data acquisition and evaluation. Battery powered Mega Watt drives become feasible for demanding operations. Measurement at the battery, especially short circuit behavior at currents up to 50 kilo-Ampere, is a key point for such applications.

INTRODUCTION

Converters for some tens of Mega Watts are implemented today in novel structure as direct conversion systems with "flying" capacitors rather than conventional DC-link converters. Special applications are converters from 3-phase 50 Hz to the railway system 1-phase 16.7 Hz. While the former standard of DC-link converters used pre-calculated pulse patterns for switching, the legs of the new approach are composed of a series connection of individual four-quadrant choppers with a relatively large DC capacitor, being the single component at the DC side of this four-quadrant chopper, considered here as converter cell. Switching is influenced heavily by the actual state of charge conditions and coming statistically mainly for a certain converter cell. All converters are required to establish a pure AC source with practically no DC component because such a DC component might drive the transformer core into saturation. Even a small saturation at the converter's transformer yields DC components in current at both sides of the transformer, hence also at the grid. At the grid side, such DC components will be moved to all grid transformers increasing the local noise level dramatically. In order to evaluate correct and DC-free operation a reliable and high resolution measurement at the converter beyond its own measurement system for internal control is to be realized. This report describes a special sensor arrangement capable of performing this demanding task without power circuit interruptions at the converter. Commissioning and acceptance test measurements are also monitored continuously by this measurement system, enabling at the same time online evaluation of signals including zoom functions.

High power converters find their application also at tasks considered not-realizable before. The standard diesel engine propulsion for a very heavy transport truck for mining (loaded total mass about 200 tons) shall be converted into a pure electric vehicle without diesel engine. The necessary 0.8 to 1 Mega Watt power shall come from overhead catenary lines providing power for up-hill driving and charging a battery which provides power for offline standard horizontal and down-hill routes. Battery weight will be between 2 and 4 tons which appears to be a lot but actually is small compared to the empty mass of the vehicle of about 80 tons and payload of about 120 tons. However, the battery pack is a demanding system. Special attention is paid to emergency case conditions, e.g. a battery short circuit. Testing such conditions is quite demanding as current interruptions may occur within, some up to some hundred milliseconds at short circuits. A rugged high current measurement device for 7.5 kA continuous rating and about 50 kA short-time over-current capability, is presented together with pre-amplifiers. A data acquisition system fulfilling demands of continuous monitoring and online vision capability, forms a very important part of the system during development. The same data acquisition system shall be implemented for continuous data acquisition and storage, including online detection of critical system conditions for the test vehicle, as well as for the final implementation on all converted trucks at the mining plant.

MEASUREMENT SETUP

DC CURRENT CHECK AT TRANSFORMER FOR 3-PHASE 50 MW CONVERTER

This 50 MW converter is used for power transfer between 3-phase 50 Hz – grid and 1-phase 16.7 Hz railway grid in Austria. Each side can be controlled individually for reactive power which is necessary to compensating high capacitive loading of high voltage cables (up to 40 MVar) at the 3-phase side, and to accomplish voltage regulation at the 1-phase side. Active power flow may go from 50 Hz to 16.7 Hz side or reverse at speedy change rates. The converter operates at 110 kV(RMS) using standard transformers to grid sides.

At the 50 Hz-side, this converter is connected via a large 300 MW transformer to the 380 kV main grid. Well known at that grid level are noise problems with transformers that get magnetically out of symmetry through DC currents originating in switching transients. During normal operation, there are no DC currents on the AC lines. This condition must be guaranteed also with the converter which might produce very small DC components in voltages at secondary side finally causing DC components in currents at primary (high voltage) side. Such converters generally employ a certain DC component control at the inverter legs avoiding DC components. Measurement has to testify proper operation of this control even under transient conditions such as short-circuits, when voltages break down for short time intervals and regain their original value very soon. At such a transient condition without a working control, magnetic saturation may occur at the transformer.

We measure currents at secondary side of transformer using current-compensation transducers which also record the DC components of the currents continuously. At the primary side of the transformer, standard passive current transformers are implemented. Also these transducers provide information of DC current components, but over a few cycles only. Therefore we continuously record secondary and primary currents at the transformer und subtract values under consideration of the current transfer ratio of the main transformer. The difference in relative currents shall be the magnetizing current of the transformer which is usually about 1% of the rated current. However, if this current difference becomes unipolar and gets the shape of typical magnetizing current peaks we identify the circuit becoming saturated in one polarity. Such a condition can occur through external (i.e. grid side) effects. However, the converter has to react on it and minimize DC component by active control. At commissioning and acceptance tests, proper control operation is evaluated by software imposed on measurement signals.

SHORT CIRCUIT CURRENT MEASUREMENT AT LITHIUM-ION-BATTERY FOR 1 MW DRIVE

Heavy trucks for transport in mining environment are already electrified for very high weights (total weight about 400 tons) in the drive part employing in-wheel electrical machines due to limits of mechanical drive-train components (gear). Catenary lines provide support for uphill transport while the conventional diesel engine powers motion on horizontal tracks.

The "smaller" version at 200 tons of total weight loaded is generally run by diesel engines only. A project has been started to evaluate possible modification of existing 200 ton trucks into electrical motion purely. Lithium-ion batteries are the power source for operation outside of catenaries and also allow recuperation of breaking energy at down-hill routes.

However, lithium-ion batteries are components with excessive short circuit currents that must be handled in emergency conditions. Typical values of short circuit currents of one strand are around 20 kA. We define a current sensor composed of three 2500 A (continuous) shunts. The arrangement includes some current bus bars interconnected by contacts fixed with screws. Inherently we have contact resistors along with the design. We use difference amplifiers to get all current signals individually and add the signals at a next stage of a precision operational amplifier. Then we go to data acquisition stages.

Short circuit currents should be kept within short time intervals of several milli-seconds using special fuses in order to avoid melting of current conductors of inter-battery connections. We found that about ½ second was enough to melt and create an interrupted circuit at large cross-section aluminum conductors at an arrangement of 200 Volts and 100 Ampere-hours. However, we also approach limits of current interruption capability of fuses and malfunctions are critical in the final application. Proper measurement and documentation is necessary to fulfill safety demands.

Beyond short circuit current measurements we plan use the same standard data acquisition software also for multi-channel continuous monitoring of normal drive operation at lower measurement rates jumping to high data acquisition rates at defined conditions which are beyond normal operation (e.g. over-current, current interruption).

ANALYSIS

MAGNETIZING CURRENT MEASUREMENT AT TRANSFORMER OF 50 MW CONVERTER

We can monitor the magnetizing current and with this the magnetic circuit operation online by high-resolution measurement including calculation directly. Also limits for certain values can be defined and a reaction on moving beyond these limits can be implemented.

SHORT CIRCUIT CURRENT MEASUREMENT AT LITHIUM-ION-BATTERY FOR 1 MW DRIVE

Short circuit values are greatly influenced by internal and external resistances not known before or along with the measurement. We employ a medium-fast 16 bit conversion to obtain a safe over-range capability in case of critical actions. A continuous short circuit lasts between ½ and 2 minutes before battery starts burning in the case of NCM cells. Analysis is generally done in post processing also checking limits of cell interconnections.

CONCLUSION

New opportunities for Power Electronics applications in the field of very high power require handling of difficult and new measurement tasks efficiently. Measurement systems are composed of sensors, data transmission, data acquisition and storage, and data monitoring and evaluation. Within such systems used for very high power applications in novel circuits, sensors and data transmission are application defined components and structures heavily influenced by the specific measurement task and a demanding field for the engineer. A universal and versatile software package allows concentration of the engineer on the actual measurement task rather than working mainly on software design and assembly.

BANDWIDTH CALIBRATION

INTRODUCTION

Devices required for calibration should be at least a factor of 3 more accurate and powerful for considering problems. Although pulse generators can deliver very high currents with steep edges for a short time (so that operating points for the bandwidth can be found), this is not sufficient for a calibration. There are still no meaningful values for the transfer factor, its linearity, the temperature coefficient, the start drifts due to self-heating, the amplitude frequency requirement and area of application. In order to be able to make reliable statements about these exceptionally accurate and reliable current transformers, it is necessary to further develop the conventional test methods with sine generators in order to come as close as possible to the extreme requirements. From the range of linearly regulated HERO® precision power amplifiers, as PA507F, although it delivers only ± 25 A, it can be used to reach the required flow by repeatedly inserting the wire through it. For this purpose, it provides its voltage reserve of ± 400 V. Its bandwidth from DC to 150kHz (-3db) is well above the requirements for ultra-stable current transformer class.

MEASUREMENT SETUP

For bandwidth calibration DEWESoft uses the linear regulated HERO® precision power amplifier, which is powered via a FLUKE 5502E calibrator. The calibration objects are connected at the output side of the amplifier, as well as a high precision shunt which is considered as reference. This high precision shunt has a high bandwidth >1000 MHz and is characterized by highest precision and low temperature drift.

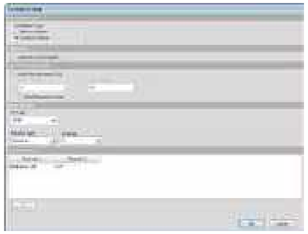
Schematic of a bandwidth calibration station

Rohrer HERO® Power is a precision power amplifier we need for constant currents. In our case we use the voltage input and convert it into current. Scale for converting is given by power amplifier with 1V = 5A. To avoid phase errors at higher frequencies, it is necessary to fix the cable with some fill material, like Styrofoam.

Bandwidth calibration of DS-CLAMP-500DCS with fixed wire

MATH SETTINGS

Dewesoft uses math for phase calculation. A Correlation Math defined as type cross correlation is implemented. In the setup we selected "Track first harmonic (H1)" and defined the input channels which has to be compared to each other. For channel 1 we selected the reference input and for channel 2 the device which should be tested.

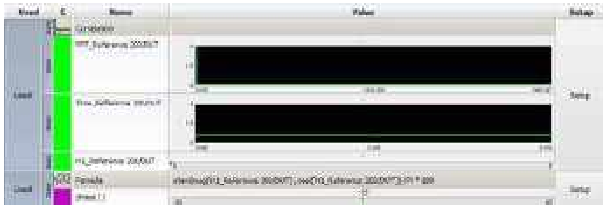


Correlation setup in Math

After that, a formula for phase calculation was needed. Out of the H1 from our cross correlation we were able to calculate the phase with following formula:

$$\varphi = \tan^{-1}\left(\frac{Im(Reference_{H1})}{Re(Reference_{H1})}\right)$$

The picture on the right shows the needed math calculations for the bandwidth calibration.



Formulas in Math

The phase results can be used directly for evaluation. For amplitude we had to filter out the noise. Therefore, we switched off the power amplifier, set Dewesoft channels to zero and measured the values at this point. This 0 Hz result (amplitude_noise) was needed to correct the phase result using following formula:

$$Amplitude_{corrected} = \sqrt{Amplitude^2_{measured} - Amplitude^2_{noise}}$$

This equation can be used for the certificate.

Note: This correction should be done for all measurement points. The measurement points are normally 16.7, 50, 60, 100, 500, 1000, 2000, 3000, 5000, 10 000, 30 000, 50 000 Hz.

Part of a certificate

CONCLUSION

The calibration of different current clamps can be done in Dewesoft with some additional equipment. With the high precision shunt, we are able to do a 12 points standard bandwidth calibration up to 50kHz, which is sufficient for most cases. It is also possible to connect more than one current clamps at once. The whole calibration of e.g. 3 current clamps can be done in half an hour (including setup but excluding warmup time of 30 minutes for calibrators and equipment).

MEASUREMENT SETUP

The purpose of the Rod Control system is the regulation of the reactor power. Due to the change of position of the control rod, the average temperature of reactor cooler is maintained on requested temperature.

Rod Drop tests have to be done regular (e.g. every year) or after every change at the system (change of fuel, lift of reactor head etc.).

In the tests the drop time of the rods at normal temperature (no load parameters) and pressure are measured and checked if the requirements of the technical specification are reached.

EXAMPLE: REACTOR WITH 2X 30 RODS (ONE SYSTEM AS BACKUP)

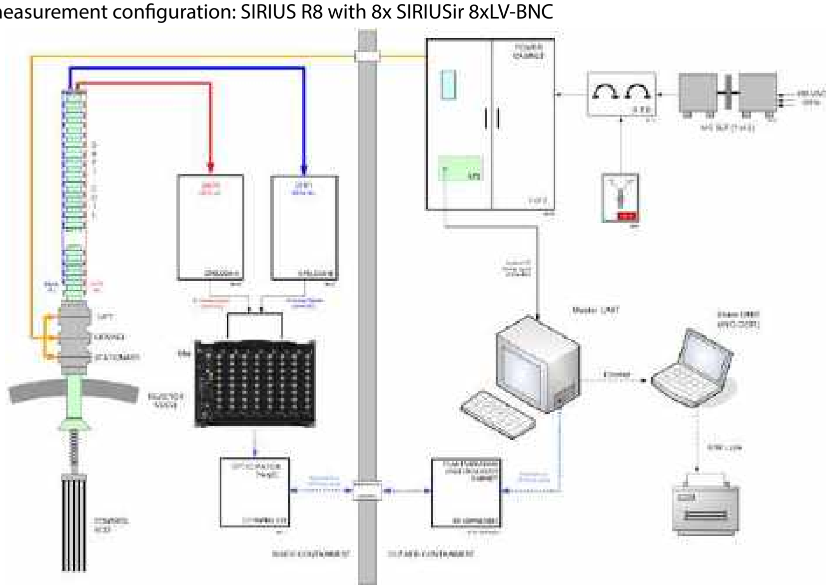
Technical Specification:

Rod-Drop time from fully withdrawn position should be below 3 seconds as soon as a temperature of 300 °C is reached or coolant pumps are operating.

Process:

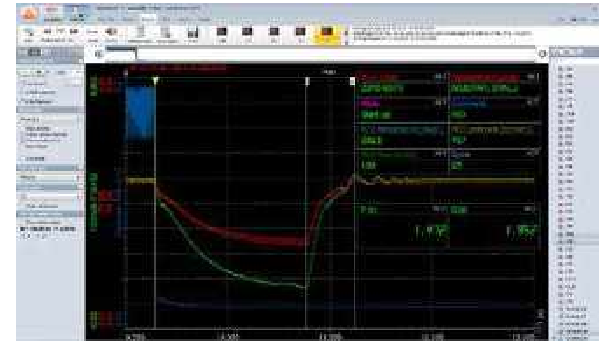
Drop of the rod starts with the loss of power supply on stationary coil. Rod is falling to the reactor core through 20 coils (20A and 20B coils) which are placed in the DRPI (Digital Rod Position Indication System) detector. The induced voltages on this coils (30 mV_{DC}) are measured and trend and time of falling of the rod as displayed.

Example measurement configuration: SIRIUS R8 with 8x SIRIUSir 8xLV-BNC



This application affords a high number of isolated inputs. For example a system with 30 rods, and a backup system for the same amount of channels, needs 60 channels for rod measurement and an additional channel for trigger input.

Isolated inputs are important because of safety reasons. The SIRIUS R8 system is placed inside containment and the data is transfered to control room via optical link.



Dewesoft allows fast and convenient analysis of the Rod Drop tests. This kind of application requires perfect working measurement systems.

- Usually safety inspectors are present during this tests. At old measurement systems the tests only could be done rod by rod, which was very time-consuming and as well dangerous as people have to be inside the containment room during tests, where also high-voltage is present. Dewesoft ensures reliable and save measurements because of the high number of input channels and the isolated voltage amplifiers.
- As the tests lasts only a few seconds, enhanced Trigger funcitionality, as Dewesoft provides it, is very important to capture all data.
- The time is synchronized to the instruments in the control room, which is elementary for these tests.
- The cursor functionality in Dewesoft allows a quick validation if the Rod Drop process meets the requirement out of the technical specifications (t1, t2, delta t).
- The multi-screen functionality allows to build up the analysis screen for each rod and allows very fast analysis and documentation of the tests.

CONCLUSION

- Analysis directly in software with cursor functions
- Powerful triggering options for start and stop of measurement
- Time synchronisation with other instruments
- Multifiles, eisplays and files for each Rod
- Measurement of all banks and rods within one instrument (high-channel count)
- High safety because of isolated inputs and measurement of all rods together within one instrument (no staff inside containment room, no danger of high-voltage, faster measurement)

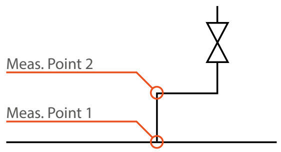
VIBRATION MEASUREMENT ON SENSITIVE NOZZLES

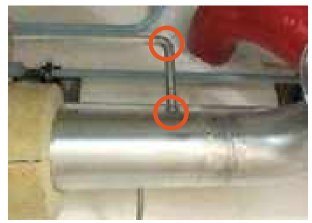
INTRODUCTION

During commissioning phases, especially for First-Of-A-Kind nuclear power plant, many circuits and/or components need to be tested. So, to qualify the design of the SIS (Safety Injection System) circuits and to check the vibration level of the sensitive nozzles, a first test campaign was conducted at this power plant in 2017 to measure the vibration level of about 200 sensitive nozzles.

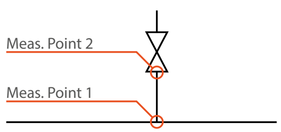
SENSITIVE NOZZLE DESCRIPTION

Sensitive nozzle type 1 (elbow)

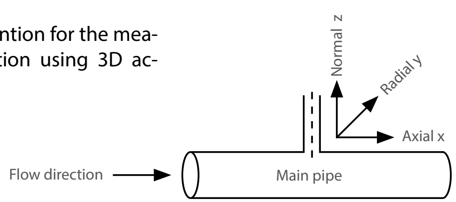


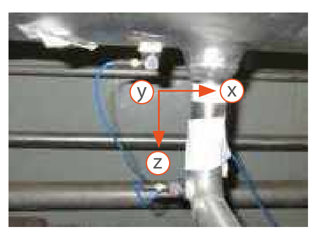


Sensitive nozzle type 2 (valve)



There is a convention for the measurement direction using 3D accelerometers.

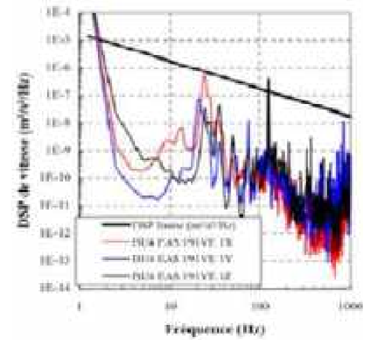




MEASUREMENT CRITERIA

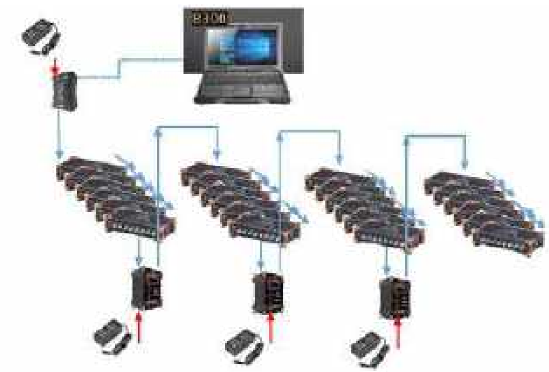
Acceleration is measured at each location with a 3D accelerometer. From the acceleration mathematical functions are created to obtain the velocity in RMS value between 10Hz & 1000 Hz. The results are given in mm/s. The first criteria to validate the conformity of the sensitive nozzle is that the value should be less than 12 mm/s (RMS value between 10 Hz & 1000 Hz). If the measured level is higher than 12 mm/s, the autospectrum is calculated and compared to a dedicated template.

And if one criteria or both are not fulfilled, the nozzle becomes definitely sensitive, periodical vibration measurements are conducted to check its behaviour, and if needed, the design can be modified (add more support for example).



MEASUREMENT SETUP

Customised EtherCAT® SIRIUS 6xACC, organized in 4 different networks for fixed configuration:



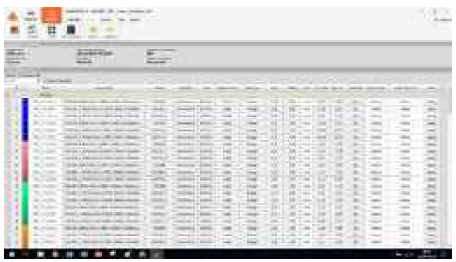
And 4 mobile systems based also on EtherCAT® SIRIUS 6xACC:

Before to deploy the equipment on site, all the SIRIUS assembled by sets of 24 were tested in the lab.

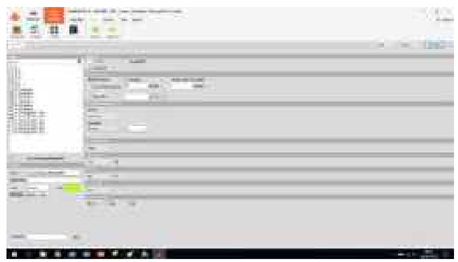
Equipment tested in the lab

MEASUREMENT PROJECT

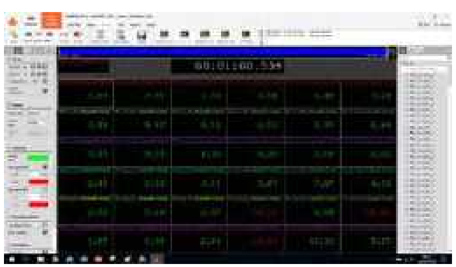
Dewesoft X2 SP10 with DSA option was used to create the measurement project and then to conduct the measurement. The following pictures are just screen copies to illustrate the step creating measurement project and visualization.



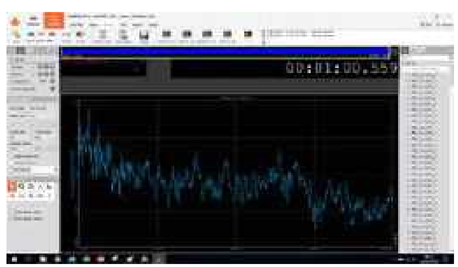
Channel setup – 24 SIRIUS 6xACC



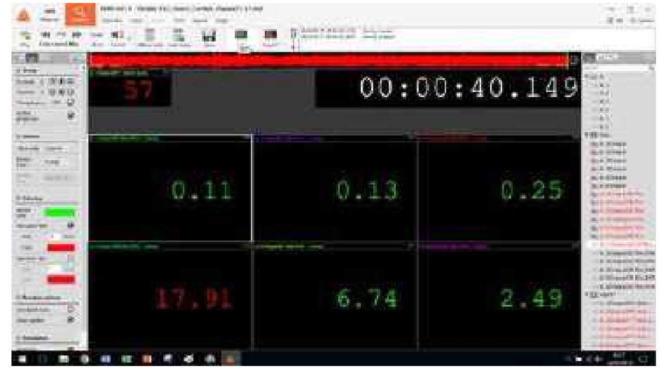
FFT analyzer setup



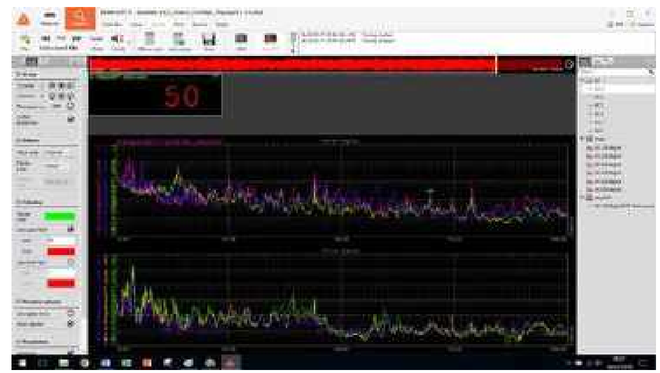
RMS value for 36 channels



FFT, calculated offline



RMS visualization for mobile system (6 channels)



FFT calculated offline

CONCLUSION

The challenge was to be able to procure and deploy more than 100 SIRIUS 6xACC in a short delay (about 5 months). The advantage of the SIRIUS EtherCAT® solution was to be able to install 4 independent "systems/lines" of 24 SIRIUS, using only a few Power injectors. The robustness of the SIRIUS allows to use them in an industrial environment not always "safe" for the equipment. The measurement campaign was a success!

MODAL TESTING ON A WATER TURBINE

ABSTRACT

This application note shows how Dewesoft products provide an effective solution for a quick validation of modal parameters in the field. The mobile measurement instruments and the easy-to-setup software are used for checking a redesigned water turbine and saving the data for evidence in case of trouble in future.

INTRODUCTION

The client, a big power plant operator in Austria, installing and maintaining water hydroelectric power stations, asked for our help in validating a redesigned water turbine model which was currently in service at another company, specialized in turbine manufacturing.

The water turbine had a diameter of approximately 4 meters and a weight of 10 tons. It was a Pelton type with 23 spoon-shaped buckets, driven by 6 water valves with around 120 bar, running at a nominal speed of 500 rpm, and generating a power of 250 MW.

The design had been improved, because the old model broke due to unexpected resonance overlap of a higher harmonic of the shaft speed and the self-resonance frequency of the buckets. This resulted in heavy vibrations and caused the turbine total loss. Therefore the new design has a modified shape of the buckets, which shifted the first mode from 700 Hz up to around 770 Hz, which was considered as safe.

MEASUREMENT SETUP

DATA ACQUISITION SYSTEM

• SIRIUSi custom with 2xACC, 2xACC+, 2xHV, 2xMULTI

SENSORS

• Modal hammer Endevco 2302-100 (scaling: 22,7 mV/N)

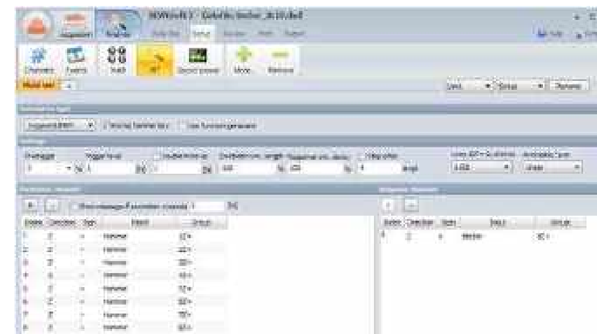
• Acceleration sensor PCB352A56 (scaling: 99,3 mV/g)

SOFTWARE

• Dewesoft X2

• DSA package (including Modal test FRF)

MODAL TEST SETUP



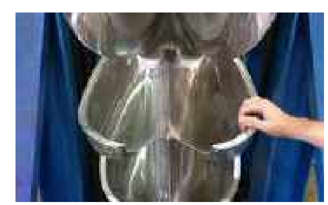
“Triggered, roving hammer” was chosen to be the proper method. The advantage is that only 1 hammer and 1 sensor is used. The accelerometer is always mounted in point 8, while the hammer is moving through the points 1 to 8. On each point 3 hits were done, to get a good averaged result.

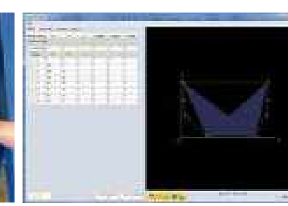
The selection of the sampling rate (5000 Hz) and line resolution (8192 lines, df = 0.305 Hz) was most critical, in order to separate the modes around the interesting frequency (770 Hz). They were lying very close, and the phase was turning multiple times.

From the very fine frequency resolution, you can see that quite a big amount of data (= long measurement time) is needed to calculate one FFT -> t = 1 / df = 1 / 0,305 Hz = 3,28 sec.

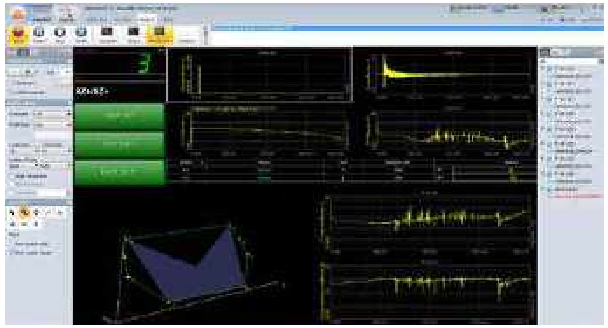
GEOMETRY MODEL

The bucket was modeled by 8 points, aligned on the upper edge.





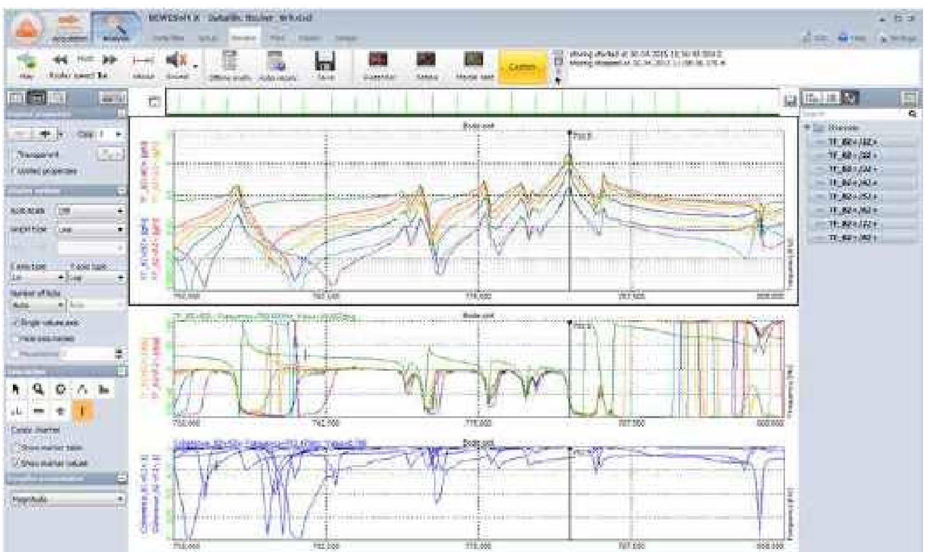
The display is the default auto-generated measurement screen. The only change done was importing the geometry model, then we could immediately start the measurement. This allows online validation of the excitation and response signals (to repeat faulty double-hits), as well as seeing the transfer function and coherence.



ANALYSIS

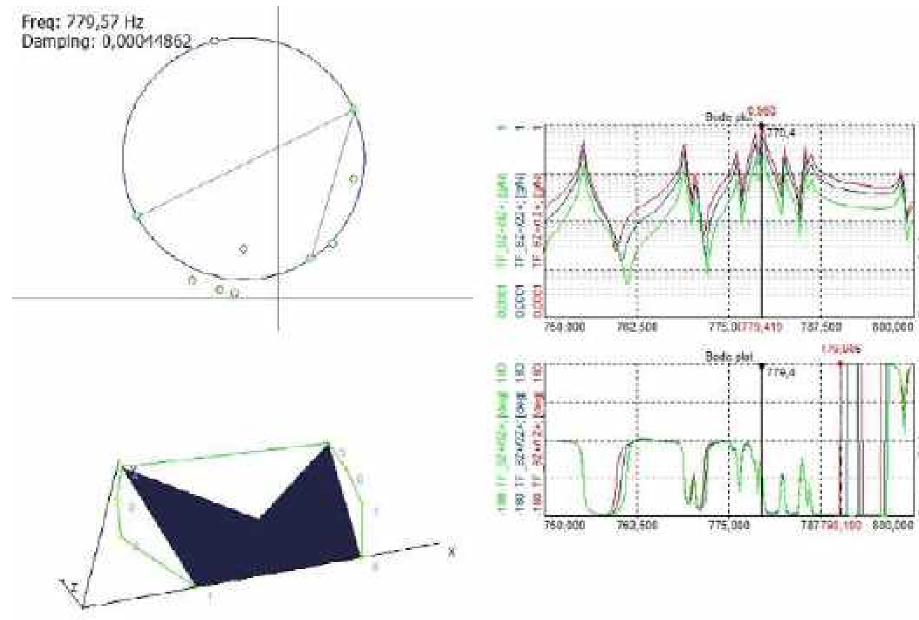
A new screen was created showing all transfer functions amplitudes, and below the phases. When the phase passes +90 or -90 degrees, and amplitude is max, this indicates a resonance.

The spectrum shows a lot of resonances, but for now we are mainly interested in ca. 780 Hz.



EXACT FREQUENCY

The modal circle gives us the possibility to get more accurate results from our experimental modal test. It interpolates between the FFT lines. The FRF animation below shows the first mode shape (up/down-movement of bucket). – Notice the low damping factor because of the massive steel structure.



CONCLUSION

The measurement on all 23 buckets showed an average resonance frequency of 782,5 ± 3,9 Hz, which is OK, according to the customer. The new turbine design is hereby evaluated as being safe. The whole measurement including setup took around 2 hours, which shows DEWESoft’s convenience to quickly acquire data.

"There are two possible outcomes: If the result confirms the hypothesis, then you've made a measurement. If the result is contrary to the hypothesis, then you've made a discovery."

-Enrico Fermi

OTHER


DEWESoft
SIRIUS-R2DB
DEWESoft
SIRIUS-R8DB

FRF AND VIBRATION ON TURNTABLES

ABSTRACT

With more than 30 years of research and development, our customer is one of the leading producers of classic turntables and tonearms. All of their products share the same design philosophy in order to produce products capable of the highest quality of analogue playback. To obtain that quality, any noise and vibration from the surrounding and the motor should be filtered out. That is why vibration and frequency response measurement on all parts of the turntable is an important part of their work.

INTRODUCTION

How to extract maximum musical information from vinyl records is, in theory, very simple. The cartridge needle should follow the grooves on a record, rotating at the correct and constant speed. The needle movement is then transferred via cantilever to cartridge coils. The rest of the chain should be as solid as possible. Cartridge is connected to a tonearm, which is bolted to the chassis. The chassis also supports a massive record platter rotating on a bearing.

For the tonearms, light weight material must be used. This makes them less rigid and more prone to vibration. On the other hand, the turntable main chassis must be heavy and rigid. To take all this into account, vibration and frequency response measurement should be done.

MEASUREMENT SETUP

DATA ACQUISITION SYSTEM

- SIRIUSm 4x ACC

SENSORS AND TRANSDUCERS

- Dytran Single axis (or triaxial) accelerometer
- Dytran Impact hammer

SOFTWARE

- Dewesoft-X-DSA (FRF and FFT)

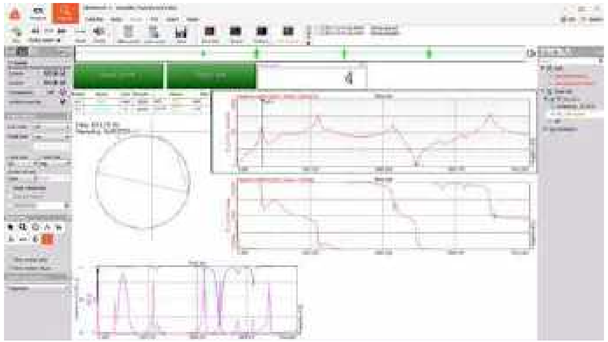
TEST SETUP

First part of measurement is done on different components of turntables, like holders, plates of chassis, tonearms, etc., to detect resonant frequencies of those parts.

Dewesoft-X-DSA together with SIRIUSm system is a perfect solution for this application. Measurements are done either with a single axis accelerometer or a light weight triaxial accelerometer.

ANALYSIS

Parts of the turntable are made out of different materials. In analyze mode the customer compares resonant frequencies of these parts to be able to find the best solution for different types of turntables.



CONCLUSION

Nevertheless, analogue replay nowadays is called 'inferior medium', because there is no known limit to the extent of recoverable information compared to the limits of digital playback. This makes analogue replay closer to the human ear and brain. Designing a turntable and tonearm is not a finished process but an ongoing one, to find compromises to reach 'a perfect' sound. And Dewesoft can also help with that.

MODAL ANALYSIS ON A TENNIS RACKET

INTRODUCTION

The customer is a leading global manufacturer of premium sports equipment. Their products are used by many top athletes.

During a tennis game, a tennis racket is exposed to vibrations. When we hit the tennis ball, the racket is excited and freely vibrates with its own frequency. Because of that, tennis racket manufacturers such as our customer have to monitor the frequency response of a racket and modify the structure in accordance with findings.

MEASUREMENT SETUP

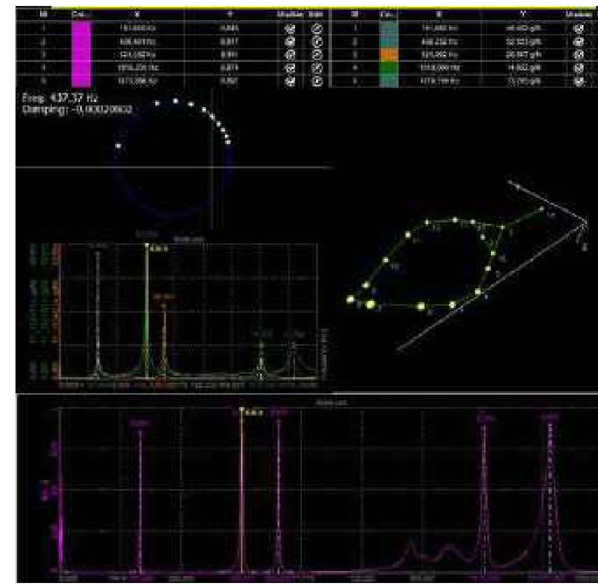
To gather measurements to be used in their analysis, the company is using an 8-channel SIRIUS DAQ device with 7 ACC modules (for accelerometers and impact hammer) and one MULTI module that is used as a function generator. They are using Dewesoft X2 software with the DSA package (Modal test) and FGEN option.

As illustrated below, the tennis racket is hanging in the air, attached with two thin strings. The triaxial accelerometer is glued on the racket, measuring the vibrations in all three directions. The racket is struck with a modal hammer on multiple points. Using the FGEN option in Dewesoft in MULTI module on SIRIUS, the shaker is excited for modal analysis. Tests are being conducted with a Photron SA3 highspeed camera with Photron plugin in Dewesoft.

ANALYSIS

For the analysis, the technicians are monitoring the frequency response spectrum (transfer functions) of all the points as well as the MIF (mode indicator function).

With the markers included in our Dewesoft functionality, it is easy to search for maximum peaks (amplitude) and their position in frequency domain. With modal circle visual control, the resonant peak can be examined in detail, offering a more exact measurement of the frequency and damping factor of the peak with the circle fit procedure.



Geometric parameters of the racket is defined in the geometry editor (utilizing a Cartesian Coordinate System) and can be animated at each frequency.

Results are compared with one of the most accurate finite element models on the market.

Another test is done on the field, with a mobile data logger on the player, where the technicians import the TXT files and analyze them using Dewesoft to determine.

CONCLUSION

With monitoring the frequency response, one of the world's leading manufacturers of sporting goods can improve the tennis racket and modify the design to where the user needs it the most for a faster game.

DYNAMIC MONITORING CABLE TEST

INTRODUCTION

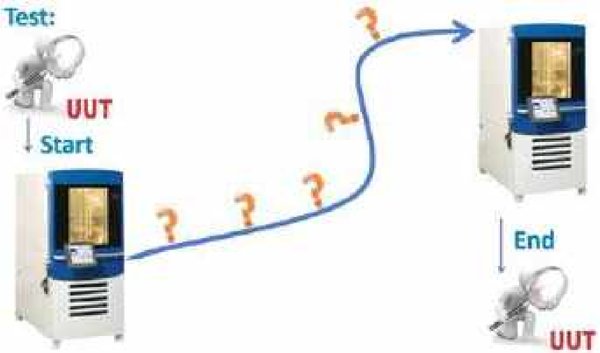
A manufacturer of healthcare equipment must make sure that the equipment he develops meets the highest standards. Reliability is the key, as it must perform flawlessly. Many intensive tests are executed during the development of the equipment, and it all starts with testing the quality of supplied components. Tests can be mechanical and/or environmental.

Testing the reliability of the cabling (communication, power, signals etc.) is one of the tests that is carried out. Cabling is subjective to complex movements on medical scanners. With the help of a robot, real life use is simulated over a period of weeks or even several months and should be perfectly registrated.

OLD STYLE vs. NEW STYLE

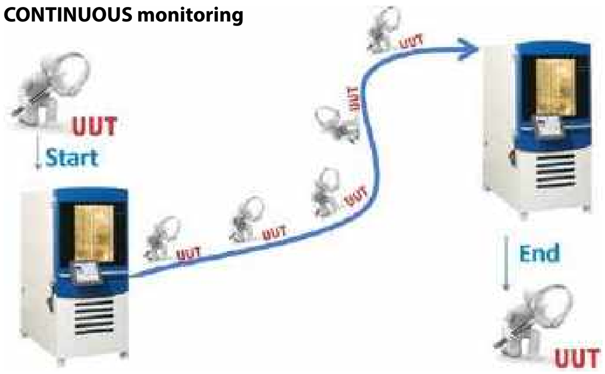
In the past the components were tested BEFORE external stresses like vibration, temperature, power supply variations or movement were applied. Then, after an x number of cycles the UUT (Unit Under Test) was checked again, once more an x number of cycles and then check etc.

Check only BEFORE and AFTER test



This gives some information, however if a failure occurs it is unknown exactly WHEN it occurred. There is also the possibility that a failure mechanism is present DURING the period that the test is running, but not in between tests when checks are done. Best solution: CONTINUOUS MONITORING.

CONTINUOUS monitoring



EXAMPLE: CABLE TESTING

The cable resistance is dependend on the amount of copper strains, shielding, connection to connector (solder, clamp) etc. This means, that before a conductor shows an OPEN-CONTACT there could be several failure mechanisms influencing the conductivity, causing problems in the operation of the medical device.

To imitate real life use, the cables are injected with a current (which is measured over a calibrated shunt) and the voltage drop over the cable. As the voltage drop is very low in the 'short circuit' behavior of the cable and high when the conductor is open, isolation of each channel is crucial. Having a high 24-bit resolution improves the accuracy of the measurement.

A complete test can easily involve 32-cables, measuring 32x current and 32x voltage = 64 ch.

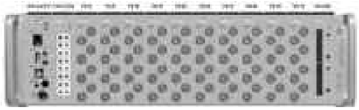
Additional there are counter channels, to count the amount of test movements, temperature channels, some control channels and video to check whether the movement still goes according to the robot program. The video is also very useful in monitoring if any cabling gets tangled up or a cable guide does not work as it should.

To calculate the resistances, we use the simple formula R = U / I.

Of course, oversampling and filtering is needed to get the best results.

HARDWARE

- 1x DS-NET-GATE with Dewesoft X software
- 1x DS-NET-TH8-CON thermocouple K – total 8 channels
- 10x DS-NET-V8-BNC voltage input ±10V (24-bit) – total 80 channels
- 1x DS-NET-V8-200 voltage input ±200V (24-bit) – total 8 channels

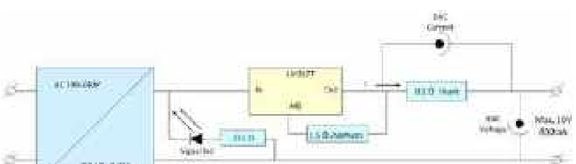


Dewesoft DS-NET configuration

MEASUREMENT

CURRENT SOURCE

As low cost current source we developed a 'simple' board based on an analog LM317 transistor, with isolated power supply for each channel to avoid cross talk problems. The use of a 10 V DC @ 800 mA as current, turned out to be a good ratio between accuracy and low thermal drift.

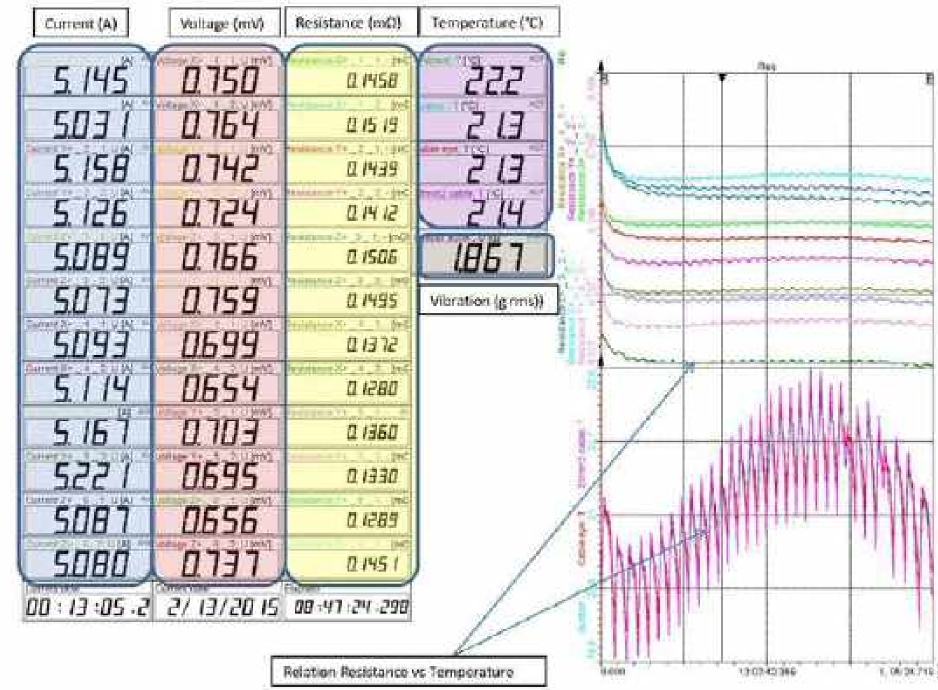


Schematic of current source

Current Sources and shunts in 19" rack (air cooled for stability)

Measurement screen of cable resistance testing. The digital meters change colour when a resistance breaks out of the set tolerance band.

Measurement screen (camera images are blurred because of confidential info)



Measurement screen of resistance testing during shaker excitation.

CONCLUSION

The multichannel Dewesoft DS-NET system and Dewesoft X software enabled the customer to perform multiple life cycle tests in just several weeks. Due to the applied mechanical stress tests and the fact that cable resistance was measured in milliohms, a perfect overview of cable wear and aging was provided.

This is now a standard test that is performed almost daily at the manufacturer.

The same measurement principle is also used when testing switches and busbars.

HILLSTRIKE

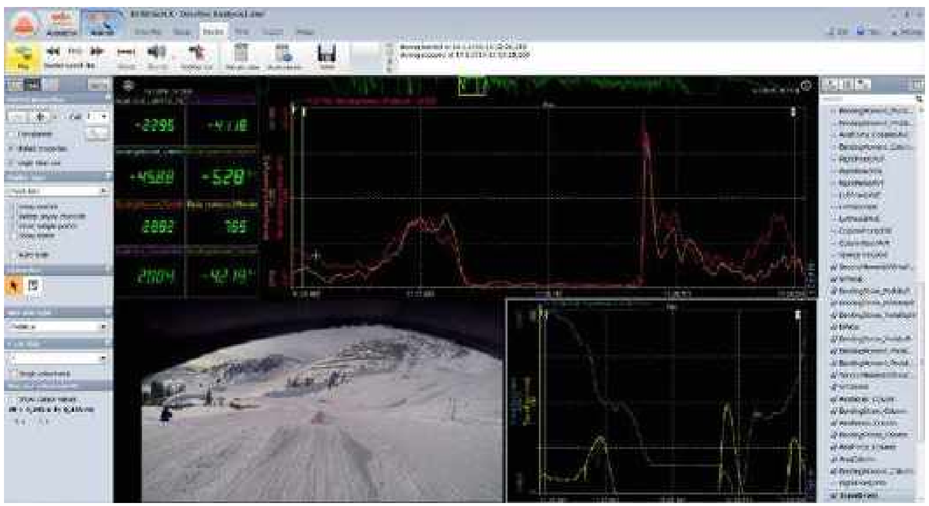
FACING NEW CHALLENGES

KRYPTON instruments again performed a perfect measurements. This time it was not just cold, but also fast and extremely bumpy.

WHY?

Dewesoft helped a local startup company called Hillstrike to test their Kickstarter product - a Snowtrike that brings the entire experience of pure downhill biking to the snow. The purpose of this tests was to make sure that their trike is not just easy to ride but also engineered to withstand extreme usage.

Three KRYPTON 3xSTG modules were mounted on a trike to measure chassis loads. Powered by a DS-BP2i battery pack, the modules acquired signals from half-bridge configured strain gauges. Bending and axial loads were recorded to aid the design optimization of the chassis in order to reduce its weight and ensure safe use for the customer.



Check out also the video:

https://www.youtube.com/watch?v=gFqvz7Y5VEk

VIBRATION ISOLATING RACK FOR SIRIUSwe

ABSTRACT

The Vibration Isolation Rack VIB-ISO-BASE expands the operation range of the watertight EtherCAT® SIRIUSwe instruments and SBOXwe computer to high vibration environments. It was designed with the help of our in-house shaker and Dewesoft Modal Test mathematics module.

INTRODUCTION

Machines with moving parts normally produce some form of vibration. Usually these vibrations have lower magnitudes which don't affect the lifetime of electronics in measurement instruments. However on machines that produce vibrations of higher magnitudes during operation (pneumatic hammers, vibratory separators…) the lifetime of electronics can be significantly reduced. Without a considerable redesign to electronics, instruments can only be used in such environments if the electronic boards are enclosed in rubber or are isolated from the outside vibration by some form of a damping system.

ISOLATION MOUNT

We opted for the second option – isolating SIRIUSwe instruments from outside vibration. We developed a mounting mechanism that isolates the instruments by suspending them on four rubber dampers. The mounting mechanism was finalized after three testing-redesign iterations.

Mounts were tested under a random vibration specified by the power spectral density (PSD).

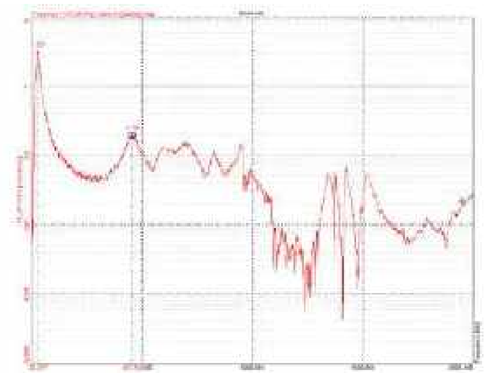
PSD of random vibration RMS ≈ 15g

Tests were performed on an in-house shaker, covering all three directions. The isolation effectivity was evaluated by acceleration measurements on the instruments and different parts of the mount. A SIRIUS-ACC instrument acquired the data, calculating the Dewesoft Modal Test mathematics in real-time. In this way the isolation performance was evaluated in a couple of minutes.

SIRIUSwe mounted on one of the prototype mounts, before the vertical direction shaker test

The VIB-ISO-BASE has a low natural frequency, where the excitation vibrations are amplified (around 30 Hz depending on the excitation direction). All of the vibration frequencies higher than that are dampened by the mount. It is especially effective at higher frequencies which are more harmful to electronic components. The instrument acceleration amplitudes are at least fourteen times lower than the excitation amplitudes at frequencies above 1000 Hz.

The durability of the mounts and instruments was also tested in all three directions, while continuously storing measurement data.



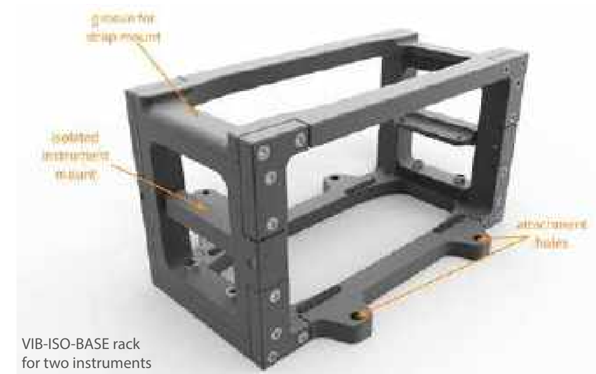
Vibration transfer curve from the vertical direction shaker test

INSTRUMENT RACK

The developed isolation mounts were incorporated in a robust instrument rack that can house SIRIUSwe or SBOXwe instruments. The instrument rack can successfully sustain the vibrations in any direction, it provides the same isolation to the units as the developed isolation mount.

The VIB-ISO-BASE rack can house one or two instruments and can be extended to house up to four SIRIUSwe instruments by using the VIB-ISO-EXTENDER. The rack is bolted or strapped to remain fixed.

VIB-ISO and VIB-ISO-EXTENDER are now available to buy as an accessory to SIRIUSwe line of instruments.



VIB-ISO-BASE rack for two instruments

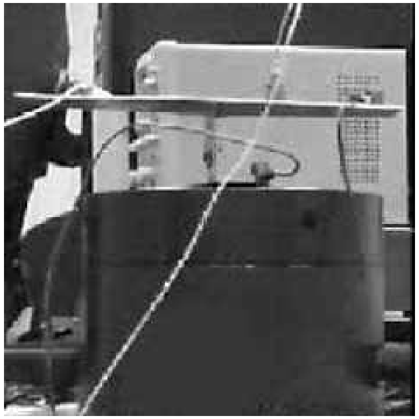
Final prototype mounted on a shaker with SIRIUSiwe and SBOXwe on top extension

The VIB-ISO-EXTENDER extends the rack to hold 4 instruments

VIBRATION TEST RESEARCH SYSTEM

ABSTRACT

The application note describes how Dewesoft products (SIRIUS-ACC in addition with accelerometers) provide an effective solution of a vibration/research system. The attached example is based on the reduced model of the mentioned system.



INTRODUCTION

The customer is a manufacturer of electronic control systems for aircrafts. All products must be tested on a max vibration response levels measured at the same time in predefined points on object's surfaces, in accordance with internal rules. A device is mounted on an electrodynamic shaker (the type of the shaker, as well as applied forces and accelerations, number of measuring channels, depends from object's masses) and receives the 3 min/octave sweep sine excitation in the frequency range from 5 to 200 Hz.

MEASUREMENT SETUP

DATA ACQUISITION SYSTEM

- SIRIUSi ACC
- IEPE B&K type 4513 accelerometers (3 pcs)
- Shaker B&K type 4808
- Amplifier B&K type 2719
- Vibration control system B&K type 7542

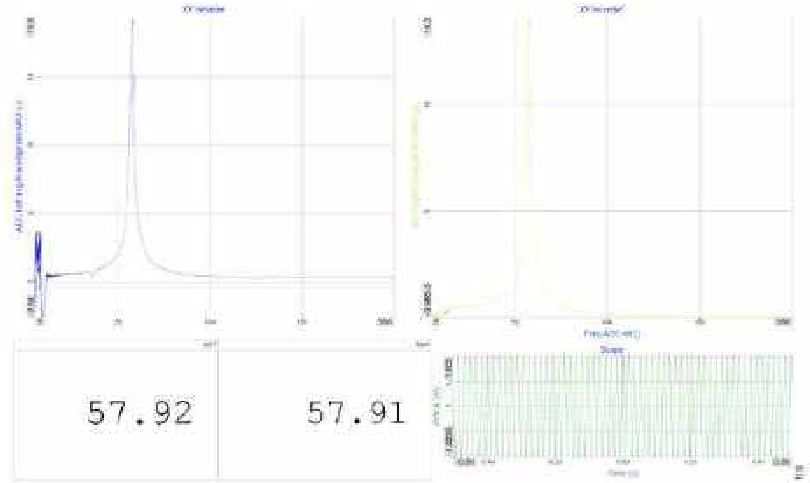
SOFTWARE

- Dewesoft X2 PROF software

ANALYSIS

Analyzed data:

- Vibration levels are measured and recalculated as the max value in the 50 Hz bandwidth of the tracking filter.
- The reference frequency channel of the tracking filter is based on the frequency which is extracted from the reference accelerometer vibration signal.
- The reference frequency is calculated with the Exact Frequency option.
- The mentioned reference frequency can be compared with the recalculated one from the COLA signal by the Sine processing option.
- Vibroaccelerations should not be more than defined levels.
- Results should be represented as a X-Y graph Value/Frequency



Vibration values – blue and yellow lines. Frequency values – calculated from reference accelerometer and COLA signals.

CONCLUSION

Different kind of test systems with difficult analysers can be easy assembled in a short time using Dewesoft's DAQs and the software inbuilt Math options.

IMPACT TESTING OF ELECTRONICS

ABSTRACT

This application note describes how Dewesoft products (SIRIUS and DS-CAM) provide an effective solution during impact testing.

INTRODUCTION

The Customer is developing and producing electronic control systems for moving objects. All products undergo several tests including impact testing on free fall drop-hammer. During the test the maximum acceleration in check points is measured and then compared to the limits.

MEASUREMENT

DATA ACQUISITION SYSTEM

- SIRIUSi 8XACC
- Camera DS-CAM-600c
- ICP shock accelerometers (4 pcs)

SOFTWARE

- Dewesoft X2

SETUP

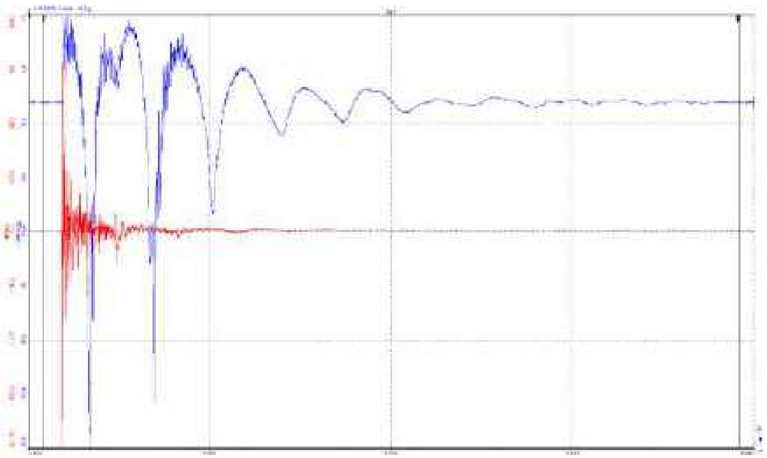
The test object (electronic components inside) is fixed on the plate through the cable rope shock absorbers. 4 ICP accelerometers are plugged to the SIRIUS. One of them was installed on the plate and measured the incoming impact. Another three accelerometers are installed on the test object in check points.

Also, the Customer decided to use a triggered camera during this test to check the behavior of the object during the impact. It was plugged to the PC and synchronised with the measurement by a sync cable.

ANALYSIS

Analyzed data:

- Incoming acceleration was compared with the predetermined one.
- Acceleration in control points was compared with the limits.
- Shock response spectrum was calculated to estimate the efficiency of the shock absorbers in the frequency domain.
- Synchronized video shows the object movement and shock absorber operation.



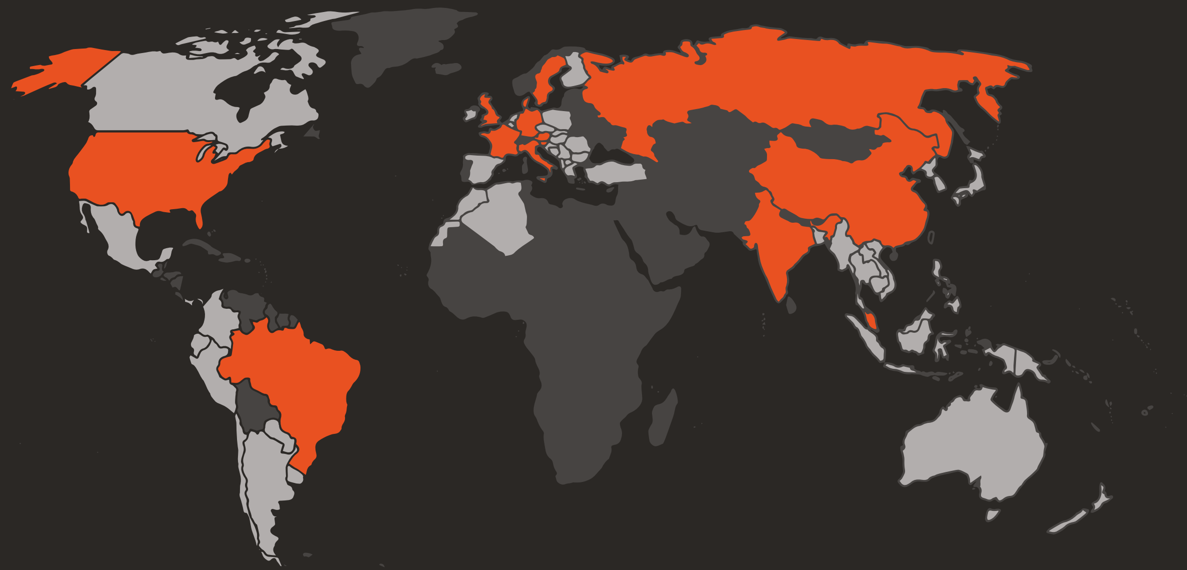
Incoming acceleration – red line. Acceleration in control point – blue line.

CONCLUSION

Using the high-speed video recording along with the measurement of magnitude of the impact and response of the object allowed us to compare the measured signal with the actual behavior of the object and the shock absorbers. This information is very important when designing objects with complex geometry and using shock absorbers in different planes.

NOTES

NOTES



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