CURRENT COLLECTOR TEST ON TRAINS

DEWETRON

THE MEASURABLE DIFFERENCE.

- > Synchronized recording of voltage, current, displacement, acceleration, GPS parameters, CAN-bus data and video images
- > DEWE-CAM-GigE to record the movement of both catenary (pantograph) and third-rail shoe current collectors time synchronous to the measurement data
- > TRION-VGPS-20/-100 module for highspeed GPS data
- > Graphic visualization of all parameters on screen
- > Rugged, mobile systems made for in-vehicle use
- > Creation of reports right on the train or afterwards in your office
- > Real-time power analysis

FURTHER INFORMATION?

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Figure 1: Close up of the pantograph of a metro train

Most trains in metropolitan areas operate from DC voltage, which is carried either by a third-rail along or between the tracks, or a catenary system of wires overhead. Testing the current collectors used on these trains is therefore an important task, which is undertaken typically when a new design is going to be put into use. This interesting data acquisition application requires a combination of a video camera and physical measurement sensors, including voltage and current. Displacement sensors are often used as well, along with accelerometers for measuring vibration.

GPS is used to plot the exact position of the train within the metro system, as well as to provide speed, distance, direction, and other important parameters. In this whitepaper, you will learn more about current collector tests. Since DEWETRON systems are used for current collector tests in major metro systems, this document follows a rather practical approach.

OVERVIEW

To support the recording of asynchronous data (e.g. video, CAN-bus, etc.) and to keep everything in lockstep together, the TRION-SYNC-BUS technology is used. Due to a high-resolution fast clock which is running in the background, the TRION-SYNC-BUS provides the timing backbone of every DEWETRON system.

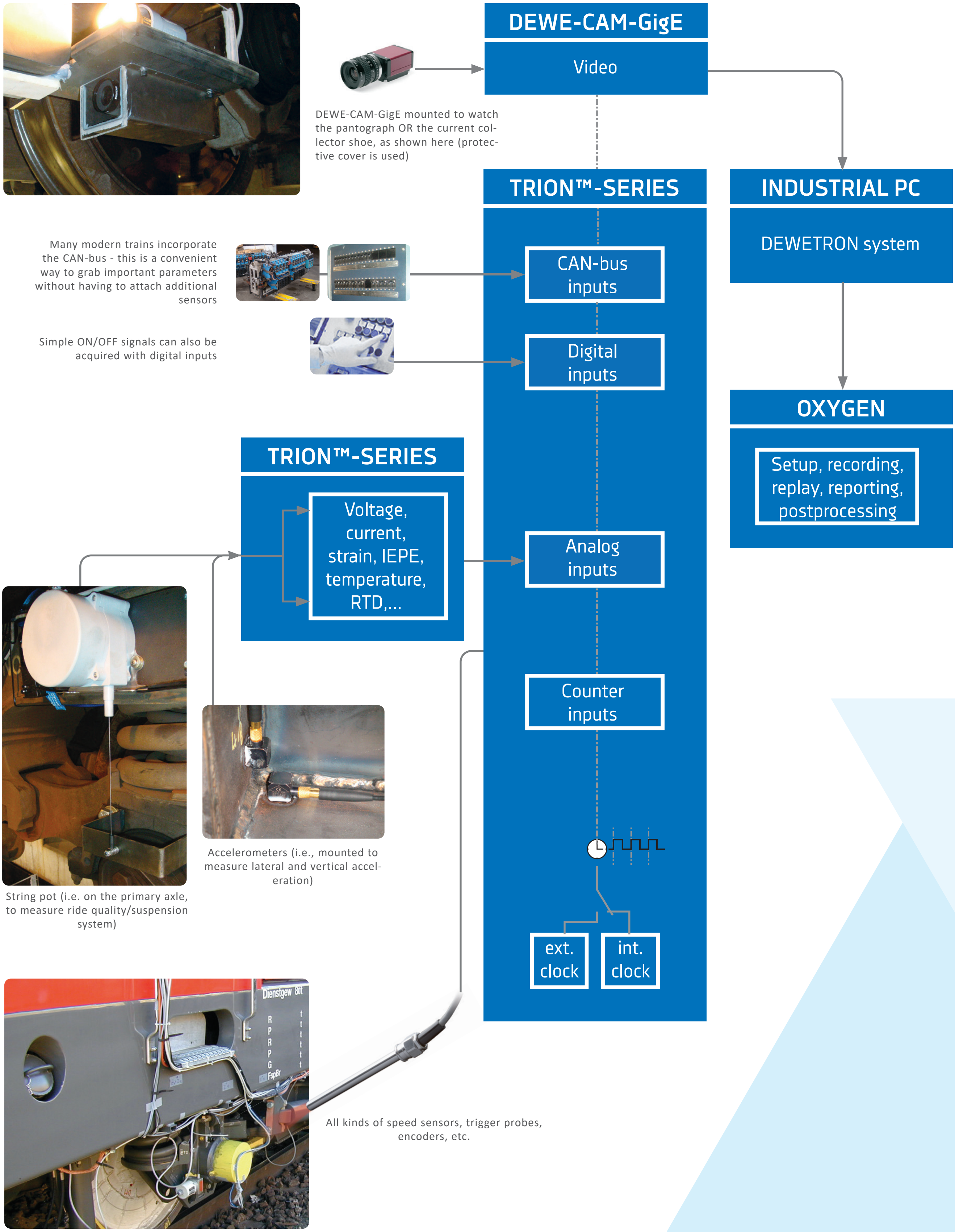

Figure 2: Overview of the test environment

APPLICATION: CURRENT SHOE TESTING

Testing either the catenary system or current collector shoe third-rail system is a challenge that you can easily take on with a DEWETRON system. One of the most useful tools in this application is video because you can analyze the performance of the current shoe as it impacts against the third-rail. Additionally, the performance of the pantograph as it is raised up to the catenary system, and back down on the train can be investigated. But video is most useful when it is synchronized with the sensor data, especially the voltage and current readings, as well as displacement and position. The DEWE-CAM-GigE camera with a high shock and vibration rating can be used to synchronize the video to your data.

VIDEO CAMERA MOUNTING

Since many tests in and around big cities are performed at night, mounting a light to shine on the current collector is just as important as mounting the camera. Typically, a steel bracket is made to mount near the shoe, but far away enough to avoid arcing, which will destroy the electronics.

If this plate is rigid enough, it can also be used to mount accelerometers (or a single triaxial accelerometer), in order to display and record the acceleration in all three axes.

A successful arrangement is to mount the camera below the plate where it has an unobstructed view of the current collector - and to mount the light above. It should be possible to turn the light on or off from inside the train, simply by using the power cord. LED lights are the most rugged, and they cast a pure white light which enhances video recording. However, incandescent bulbs can also be used.

The camera should be hard-mounted to the plate and then protected with a metal box around it on all sides except the front, where acrylic glass is fitted so the camera will not get wet or struck by stones or debris.

Finally, the entire assembly is protected by adding acrylic glass (or a similar material) on the sides, filled with expanding foam to protect it and wrapped up in strong tape for added rigidity.

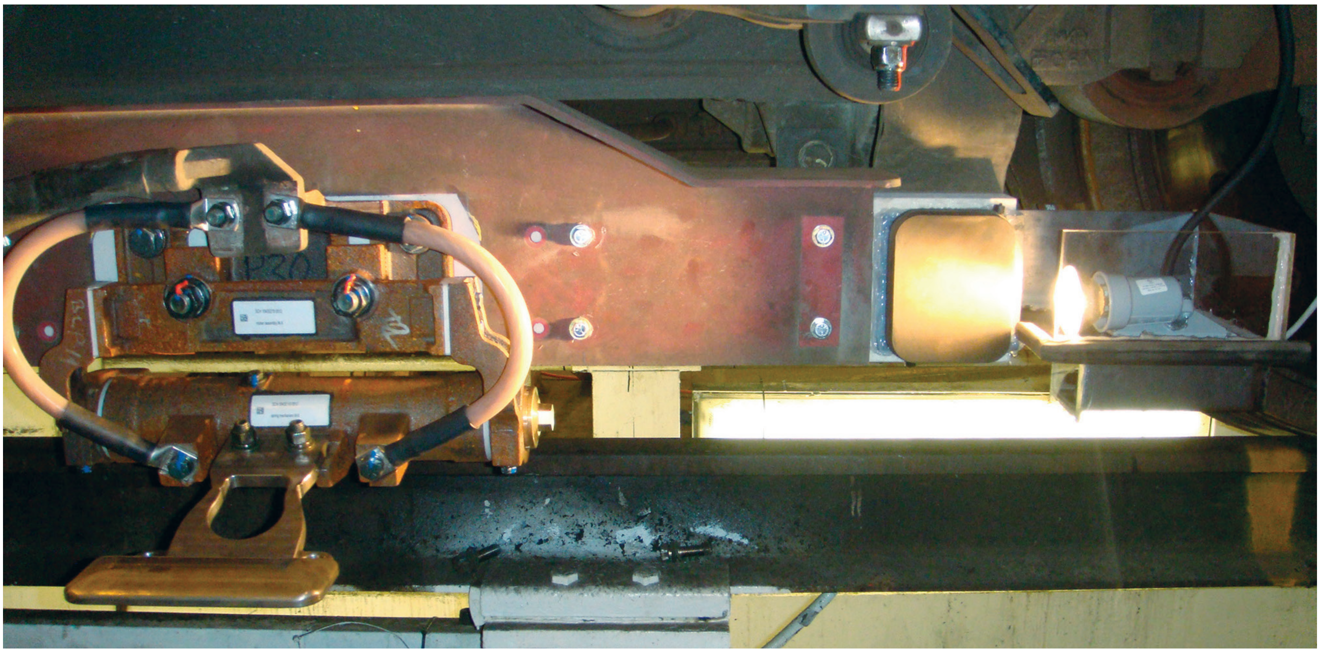

Figure 3: Side view of the mounting bracket with the camera and light source (right side of the photo), directly pointing at the current shoe (left side)

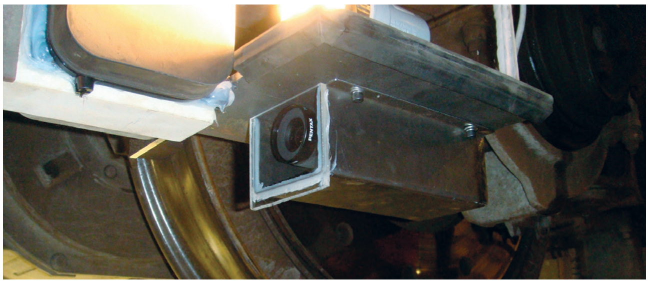

Figure 4: Camera protected in a steel box with acrylic glass material mounted to the front

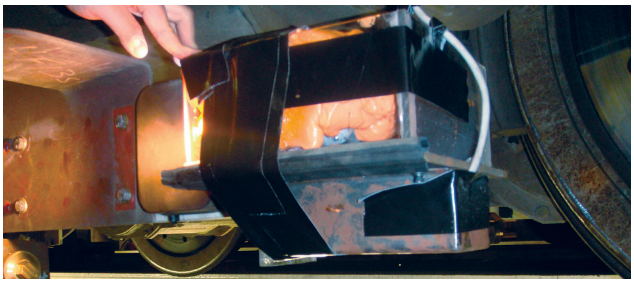

Figure 5: Back view of the camera assembly with tape that protects the video and sync from coming out of the rear

CURRENT SENSOR MOUNTING

You can use a commercially available AC/DC current sensor with sufficient amperage capability, and install it securely under the train to measure the current flow from each or any collector. The setup in OXYGEN is simply a matter of entering the scaling factor of Volts per Amps.

Figure 6: Current clamp

A Hall effect type current clamp is used here on the DC line just behind the current collector, underneath the train. It is securely tie-wrapped in place, and the jaws are prevented from opening accidentally. The clamp is set to run continuously. Typically a single 9 V transistor battery will run the clamp for days. For more convenience, use a clamp with an external power source, and the DEWETRON system can power it continuously.

ACCELEROMETERS

As mentioned previously, the accelerometers can be mounted on the same plate that holds the camera, if it is rigid enough. If the plate is not rigid it will bend and flex when the train moves at high speeds, which will lead to exaggerated acceleration readings.

Figure 7: String pot

String pots are a convenient way to measure suspension and body movements in a single axis per sensor and very precisely. TRION™ modules like the TRION-1820-MULTI can power the string pot and read back the change in voltage. Scaling into inches or millimeters can easily be done in OXYGEN.

Here, a bracket was made to mount the end of the string on the primary axle.

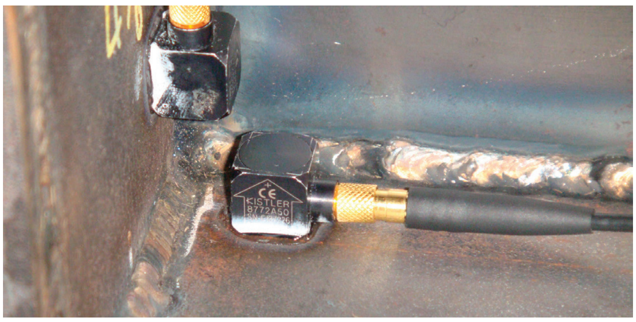

Figure 8: Accelerometers glued to a rigid plate

In this test, two accelerometers were used to measure vertical and lateral acceleration.

They were securely glued to a rigid plate.

THE RESULTS

In the picture below an exemplary OXYGEN screen with the test results of a current shoe testing can be seen. Data from all the different sensors, including video, can be shown and individually arranged on the measurement screen. Different instruments are available to visualize the sensor data in the most efficient way.

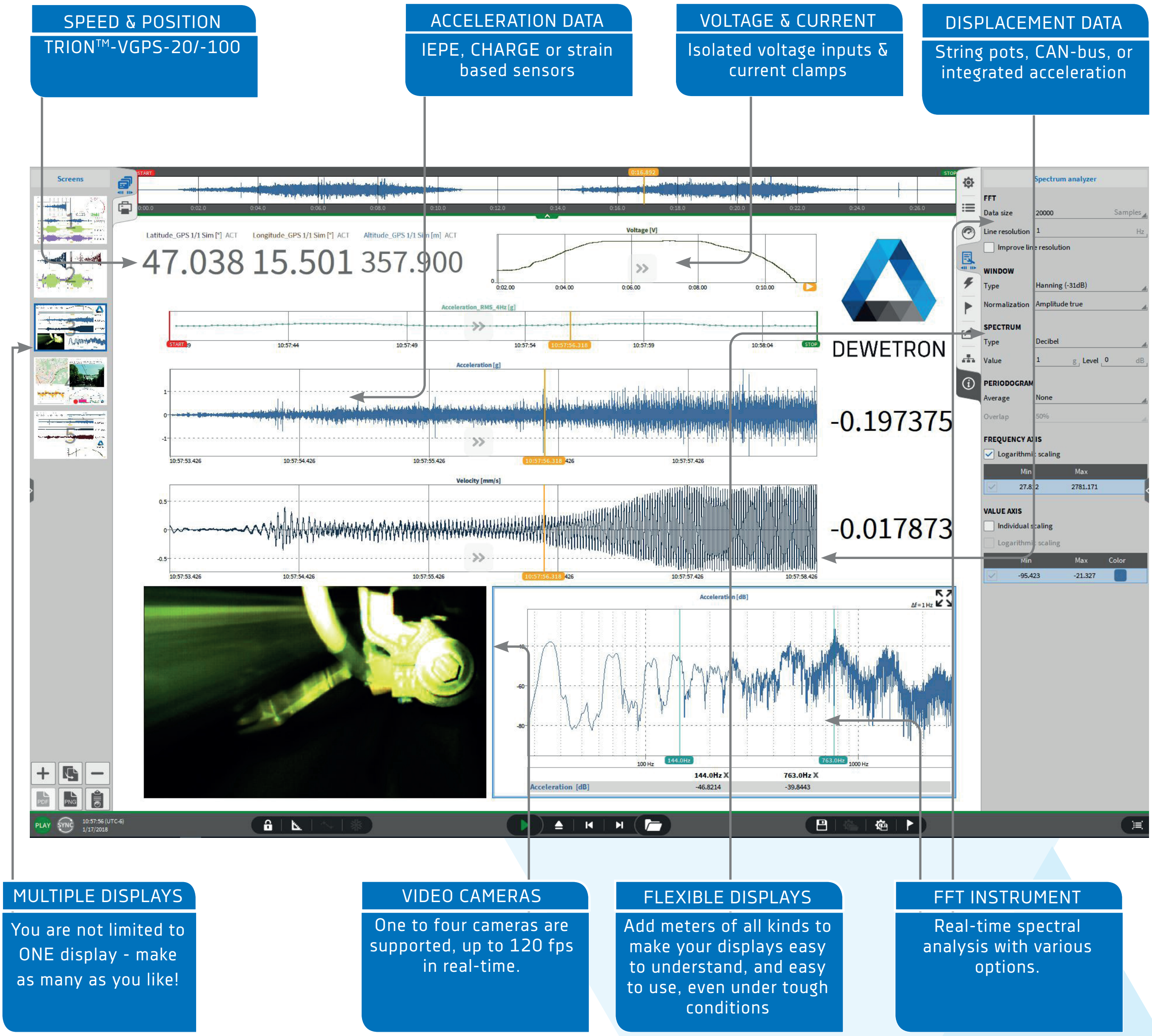

Figure 9: OXYGEN screen with the results of a current shoe test

When power is provided from the catenary system, a pantograph needs to rise up and make contact with the overhead wires. This current collector needs to ride along under the wires, maintaining contact, but not pushing up too hard against the system. Normally, this is a very high AC voltage (12 kV_{AC} to 25 kV_{AC}), which is converted to DC inside the train.

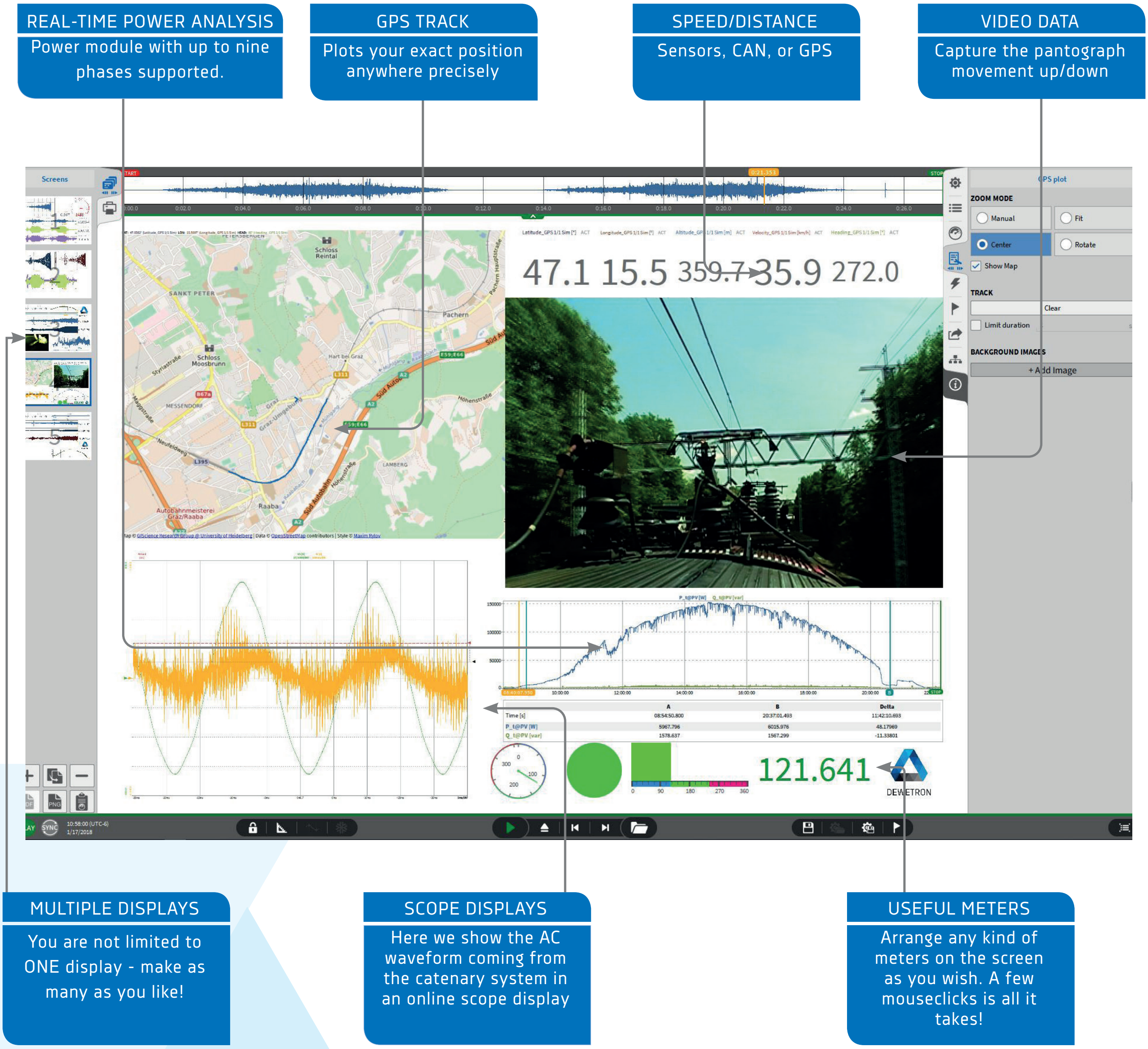

Figure 10: OXYGEN measurement screen

APPLICATION NOTES

In the final analysis, this test proved that setup was really the key to getting good readings. Since so many sensors were mounted to the outside of the train, several brackets had to be fabricated from steel to hold the camera, lights, accelerometers, and string pot. Planning ahead and leaving enough time to have these parts designed and made in a machine shop was mission-critical to the success of these tests. Also, having the DEWETRON data acquisition system on hand even before the brackets were available allowed the connection wires to be run along the outside of the train and into a window. Finding out that certain wires might need to be extended as early as possible, is a big help later on when it is time to connect everything. Finally, it is essential to be prepared to work at night as big cities do not tolerate downtimes of their public transportation system during the day.

DATA ANALYSIS, REVIEW AND REPORTING

Of course, you can also export the data (or any portion of it) to a different file format, for detailed analysis. The supported file formats are *.txt, *.csv, *.mdf4, MATLAB®, Excel®. Moreover, a DLL is available to import data files natively into 3rd party software packages. You can also make print-outs directly from the DEWETRON system to any printer.

Please note that OXYGEN can be installed without any license for data replay, review and export on any computer. This means that you can review, postprocess and print data comfortably, anytime, without having to occupy the DEWETRON measuring instrument for that task.

Figure 11: Test engineers watch the recorded data on the OXYGEN screen

THE EXPERT

RAFAEL LUDWIG

Rafael Ludwig studied electrical engineering as well as audio engineering at the University of Music and Performing Arts Graz and the Graz University of Technology. During his master studies, he specialized in acoustics and audio recording. After graduating, he worked as an acoustics engineer in the R&D department of a mechanical engineering company before he joined DEWETRON in 2017. At DEWETRON, he is an application engineer for automotive, e-mobility and power applications as well as for general test and measurement solutions.

FURTHER QUESTIONS? **CONTACT THE AUTHOR:**
rafael.ludwig@DEWETRON.com