



Current Collector Test on Trains

Most trains in metro 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 video camera and physical measurement sensors, including voltage and current. Displacement sensors are also often used, 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.

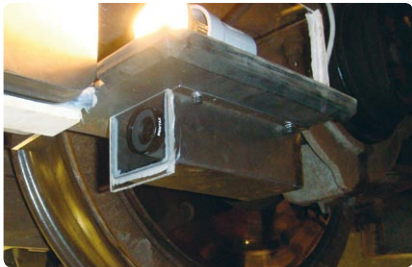
DEWETRON systems are used for current collector tests in major metros, including the New York and Washington DC metro system, as you will learn in this application note.

Key Features

- Synchronized recording of voltage, current, displacement, acceleration, GPS parameters, CAN-bus data, and video images
- DEWE-CAM is ideal for recording the movement of both catenary (pantograph) and third-rail shoe current collectors
- DEWE-VGPS sensor for high-speed GPS data
- Graphic visualization of all parameters on-screen
- Rugged, mobile systems made for in-car use
- Replay the data at any speed, forward or backward, for in-depth analysis
- Export the screen to AVI movie
- Create and print reports right on the train, or in the comfort of your office

Overview

In order to support the recording of asynchronous data, such as VIDEO, CAN-bus, etc... and keep everything in lock step together, we have a secret weapon: the ORION A/D card. With a high resolution fast clock running in the background, the ORION card provides the timing backbone of every DEWETRON system.

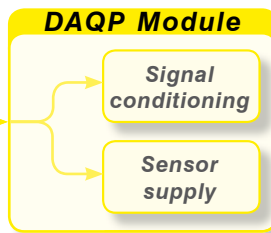


DEWE-CAM mounted to watch the pantograph OR the current collector shoe, as shown here (protective cover is used)

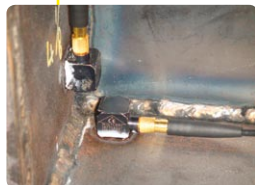
Many modern trains incorporate the CAN-bus - this is a convenient way to grab important parameters without having to attach additional sensors



Simple ON/OFF signals can also be acquired (isolation is available as an option for these inputs too)



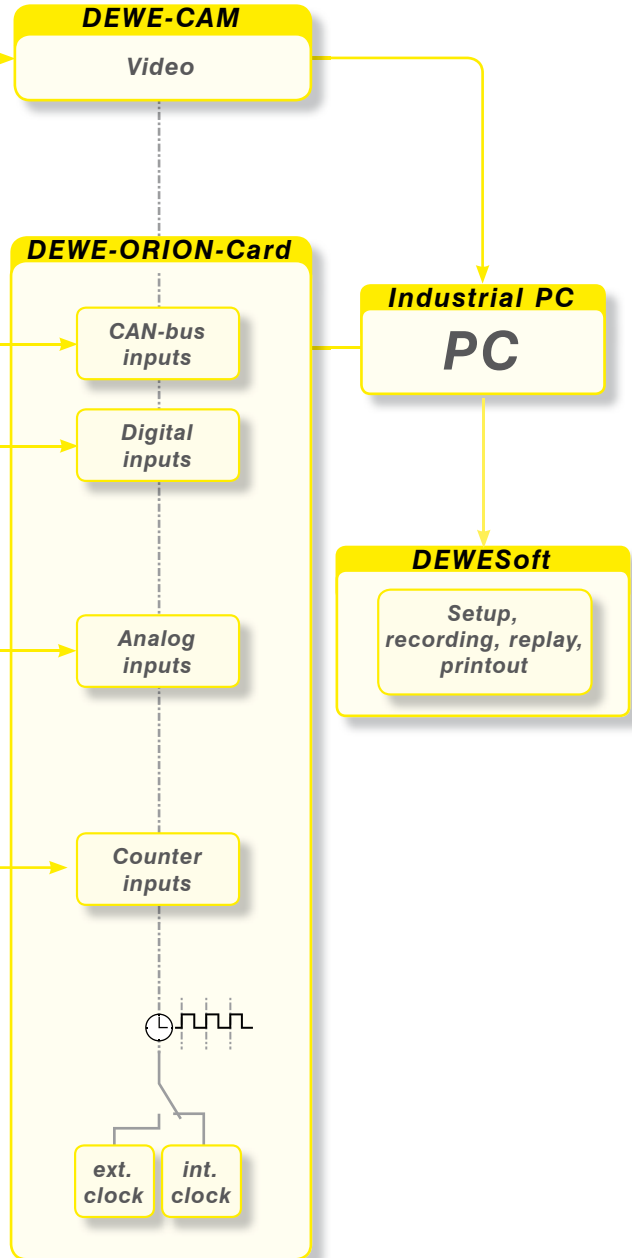
String pot (i.e. on the primary axle, to measure ride quality/suspension system)



Accelerometers (i.e., mounted to measure lateral and vertical acceleration)



All kinds of speed sensors, trigger probes, encoders, etc.



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 then watch the performance of the current shoe as it impacts against the third rail, as well as the performance of the pantograph as it is raised up to the catenary system, and back down to the train. 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.

VIDEO camera mounting

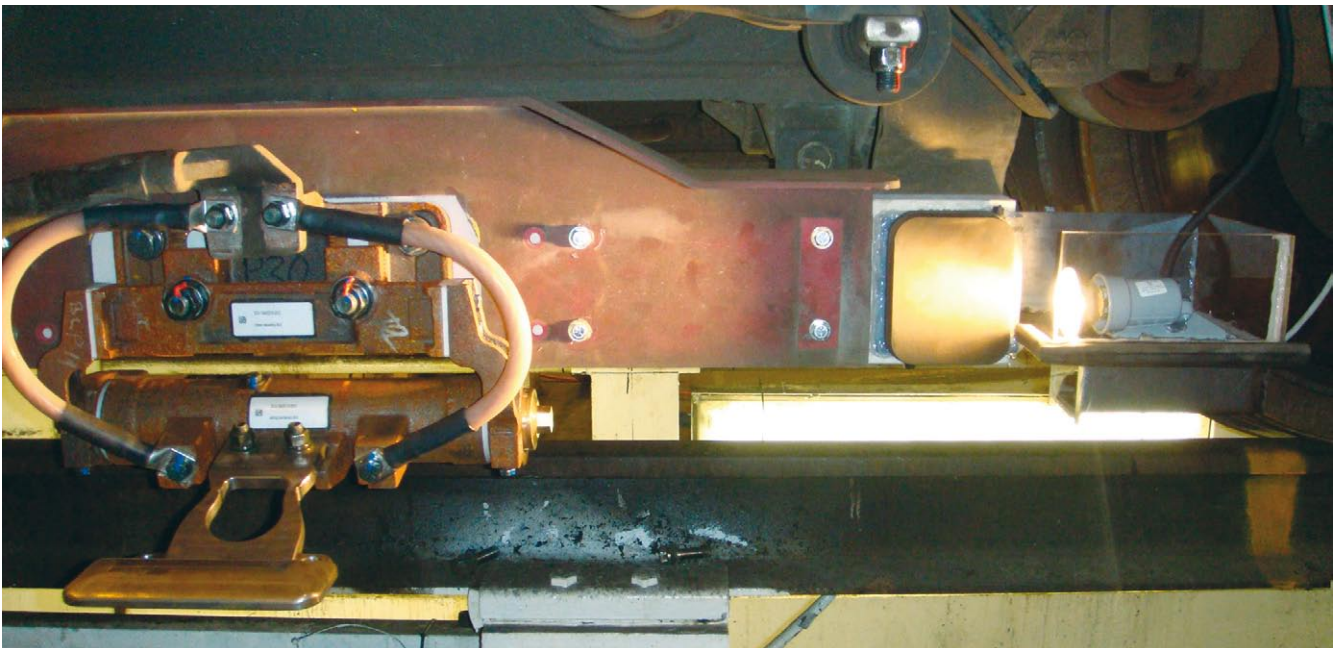
Since many tests will happen at night in and around big cities, mounting a light to shine on the current collector is every bit as important as mounting the camera. Typically, a steel bracket is made to mount near the shoe, but far away enough to avoid arcing, which will destroy the electronics.

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.

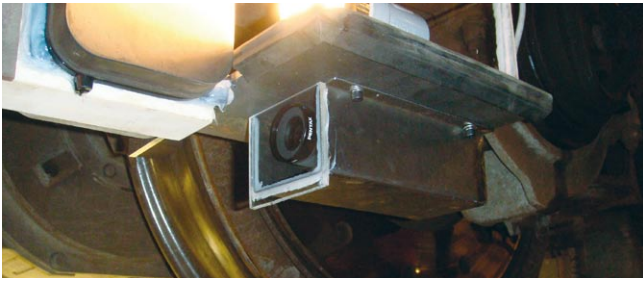
A successful arrangement is to mount the camera below the plate where it has an unobstructed view of the current collector - and to mount the light above. It should be possible to turn on/off the light from inside the train, simply by using the power cord. LED lights are the most rugged, and they cast 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 plexiglass is fitted so it will not get wet, or struck by stones or debris.

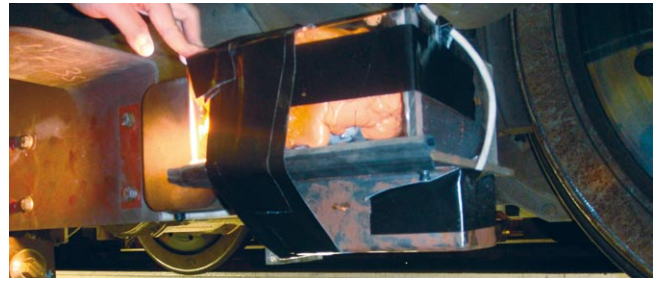
Finally the whole assembly is protected by adding plexiglass (or similar material) sides, filled with expanding foam to protect it, and wrapped up in strong tape for added rigidity.



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).



The camera is protected in a steel box, with plexiglas material epoxied to the front.



A view of this assembly from the back. Tape protects the video and sync cables coming out 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. Set up in DEWESoft is simply a matter of entering the scaling factor of Volts per Amps.



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, these 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.



String pots are a convenient way to measure suspension and body movements in a single axis per sensor, and very precisely. DEWETRON modules like the DAQP-LV-D or DAQP-STG-D can power the string pot and read back the change in voltage. Then it is easily scaled into inches or millimeters on the DEWESoft setup screen.

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



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

They were securely glued to the rigid plate.



Current Shoe Testing - The Results

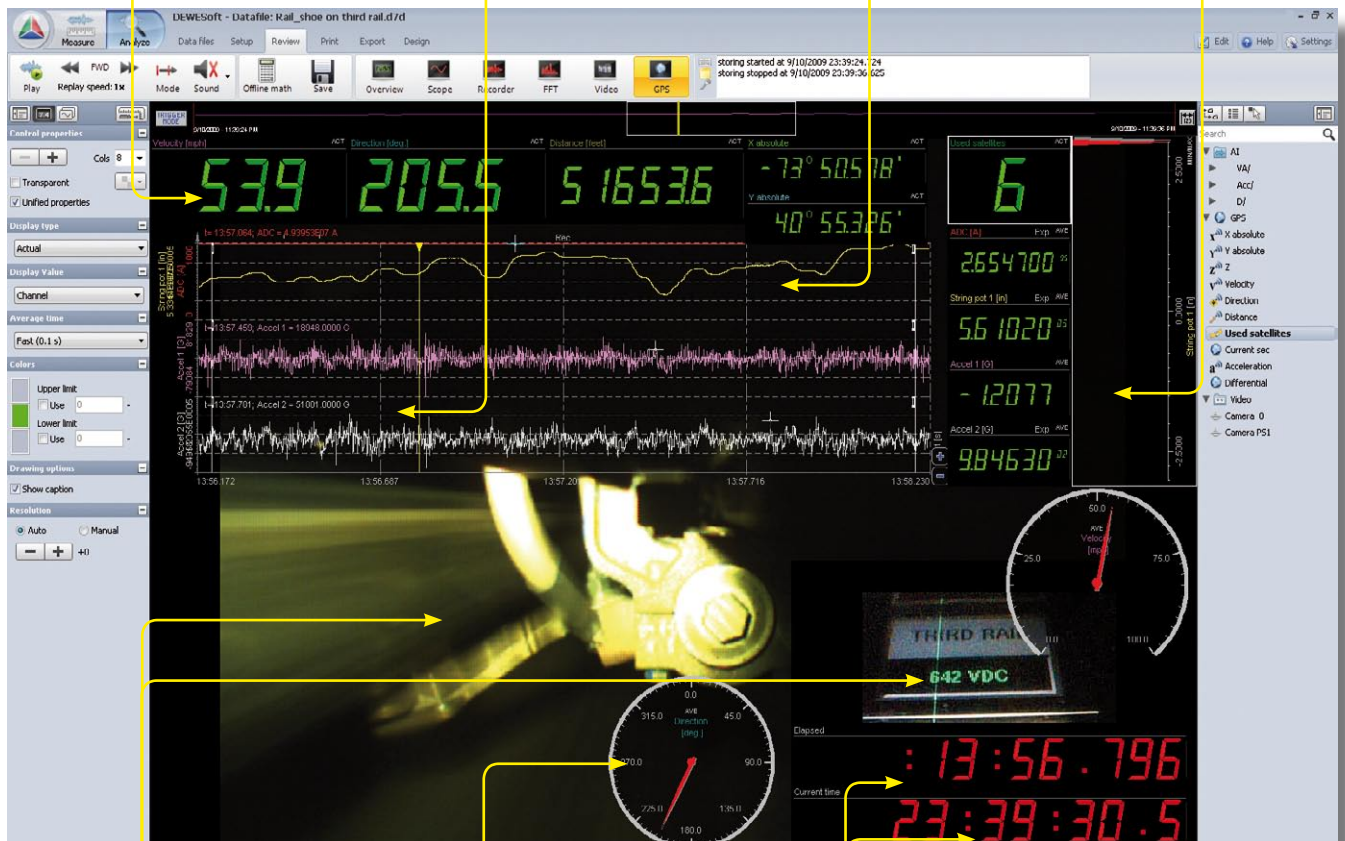
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Speed and Position
From the DEWE-VGPS, or built-in GPS sensor

Acceleration Data
From IEPE, CHARGE or strain based sensors

Voltage & Current
From isolated voltage inputs & current clamps

Displacement Data
From string pots, CAN-bus, or integrated accel



Video Cameras
One or more cameras are supported, up to 240 fps in real-time. Also IR and low-light cameras can be used

Flexible Displays
Add meters of all kinds to make your displays easy to understand, and easy to use, even under tough conditions

Time Displays
Show the actual time, elapsed time - or both - on the screen, anywhere you choose, at any size

Multiple Displays
You are not limited to ONE display - make as many as you like!

Watch a video replay of this test on-line: <http://www.dewetron.com/applications/transport/>

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, have 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, track time is sometimes hard to get in busy cities, and being prepared to work at night is important.

Pantograph Testing - The Results

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.

Voltage & Current
Display and record V, kV, A, kA...

GPS Track
Plots your exact position anywhere, precisely

Speed/Distance
From sensors, CAN, or GPS

Video Data
Capture the pantograph movement up/down



Useful Meters
Arrange any kind of meters on the screen as you wish. A few mouseclicks is all it takes!

Scope Displays
Here we show the AC waveform coming from the catenary system in an on-line scope display

Recorder Displays
You can see the kV_{AC} jump up from zero to 12937 in the recorder and digital meter

Multiple Displays
You are not limited to ONE display - make as many as you like!

Watch a video replay of this test on-line: <http://www.dewamerica.com/applications/transport/>

Application Notes

Since video was so critical to watching the behavior of the pantograph, it was important not to use an inferior camera. In this case, a good quality miniDV camera was used, which had a Firewire™ output. The camera was mounted onto the roof of the car just behind the pantograph, and the firewire cable and power cord for the camera were routed into the car and down to a temporary table where the DEWETRON data acquisition

system was set up. The Firewire™ was plugged directly into the interface installed inside the DEWETRON system, which brought the video directly into DEWESoft. A low-cost GPS tracked train location (lat/lon), direction, and speed, and provided an absolute time reference. The only other input was the high voltage, which was stepped down to a range that the DAQP-HV can directly handle (±20 V to ±1400 V range).

Data Analysis, Review and Reporting

Recorded test data can be replayed like a movie on the screen of the DEWETRON system. Would you like to watch some short excerpts from these tests on our website? Please visit this page:

<http://www.dewamerica.com/applications/transport/>

Of course, you can also export the data (or any portion of it) to a different file format, for detailed analysis. Formats include ASCII text, MATLAB®, DIAdem™, Excel®, and many others. You can also make print-outs directly from the DEWETRON system to any printer. Or copy the data file to your desktop computer and make the print-outs there, in full color, on any printer in your office. Please note that DEWESoft can be installed without any license for data replay, review, and export, on any computer. This means that you can review and print data comfortably, anytime, without having to occupy the DEWETRON measuring instrument for that task.



Test engineers watch the data replayed on the DEWETRON screen after a long night of testing.

Trust in DEWETRON

DEWETRON systems are ideally suited to these applications and COUNTLESS additional ones. The scope and breadth of the uses to which our customers put our measuring instruments is truly amazing. From testing a single component, the power system, or an entire train - even new car inspection, accident investigations, and all manner of static and dynamic tests, DEWETRON has the technology to ensure a successful test. You often have only one chance to get the data that you need - trust DEWETRON to help you succeed!

Re-inventing Data Acquisition

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