

ACTUATOR

Riding rollercoasters with CAN

For the "Arthur and the Invisibles" ride in Europa-Park Rust, inverters for e-motors by STW in combination with a control unit provide riding comfort. Both devices come with CAN.



"Arthur and the Invisibles" rollercoaster (Photo: Europa-Park Mack)

Each of the eight Arthur trains has four independent e-motors equipped with the Powermela-WRC frequency inverters. The host controller is connected to the Powermela components via the Powermela CAN network. Within this system every component can be clearly identified by its node identifier. The CAN message identifier includes the information of the node identifier. This ensures scalability without the need of additional measures at commissioning. The drive systems are indirectly coupled with one another without a rigid connection via transmissions in order to undertake dynamic adjustments via a control unit. In case of pure speed control, the drive systems would work against one another due to differing diameters in the drive line (e.g. worn drive wheels, manufacturing tolerances) or due to tolerances in the speed measurement, which is carried out via a resolver. Smaller wheels want to increase the speed, and larger wheels want to reduce it. On curves, the outer wheels operate at greater speed, and therefore a pure speed control is not practicable. Torque control alone is also impractical, as the drive systems could slip if there is no load. In addition, problems such as insufficient contact pressure (curves) or icing of the rails in the outer area may result.

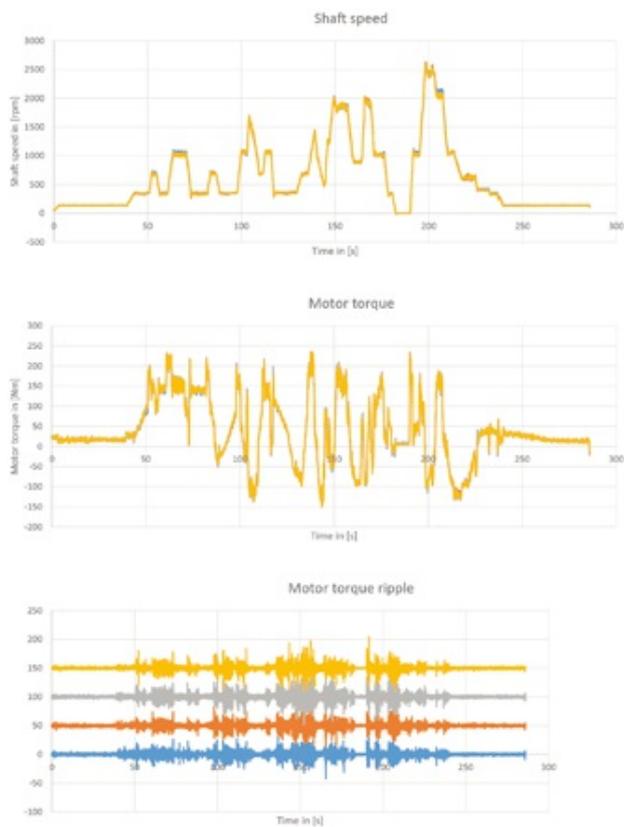
On many rollercoasters, speed, and acceleration are of primary importance. But riding comfortable is also decisive for themed rollercoasters in which impressions are left by both, the ride and the opportunity to experience the environment. The family-run company Mack Rides is the operator of Europa-Park Rust (Germany). This enables them to develop solutions for their customers, based on their practical experience. With the design and development of the steel rollercoaster for the "Arthur and the Invisibles" themed area, the focus was placed on the riding comfort in this Inverted Powered Coaster driven by e-motors. "Inverted" means that the trains hang under the rails, and "powered" describes the fact that the trains have their own drive system. In addition, Mack Rides also enable their Powered Coasters to run freely on downward sections.

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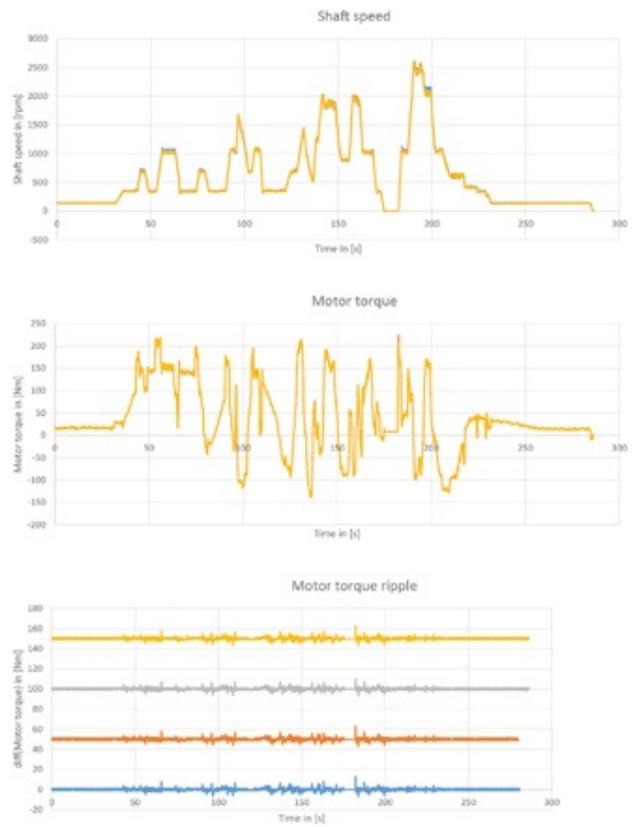


"Arthur and the Invisibles" rollercoaster (Photo: Europa-Park Mack)

Indirect load compensation



Direct load compensation



Benefits of the direct load compensation control (Photo: STW)

Indirect load compensation regulation could address this problem and be implemented in the control center control unit. However, this central version cannot be utilized due to the latency periods occurring in communication. The solution is therefore the direct load compensation control by means of ESX control components by STW. These components are freely programmable in C language and integrated into the inverter. This type of regulation ensures torque equality in all drive systems. The control unit also communicates via CAN network.

Temperature monitoring by means of PT1000 elements has been integrated into each e-motor, which is activated in case of overheating and reduces the load. Furthermore, certain error reactions have been defined within the ESX control components, so that the control center no longer has to concern itself with these issues. Each slave device can also take over the master role through simple re-configuration, so that each train can be safely traversed back at any time.

In parallel, all CAN messages exchanged between the master and slaves are recorded on a [TC3G](#), a telemetry product by STW, which provides two CAN interfaces (11-bit and 29-bit identifiers). The TC3G acts as a gateway and transfers the data to the control center. As a result, the functionality of the control circuit is checked and error incidents are documented and analyzed by means of Matlab/Simulink. In the opposite direction, the ESX control components can be re-configured or programmed. Another effect which has been achieved through the use of the inverters: The "Arthur and the Invisibles" dynamic rollercoaster is the first system which can recuperate and feed energy back into the network when braking.

Cooperation between the companies STW and Emis was required here for the technical implementation. During this joint development, a load compensation control was created. The result was a reduction of the occurring torque ripple to a quarter of the value of the indirect control, which has a direct effect on the riding comfort and associated riding experience.



The Powermela-WRC inverter is designed for use in mobile machines with IT networks and comes with two CAN interfaces (Photo: STW)

[CW](#)