Tallysman

Precise Positioning for Railway Vehicles

Achieving Reliable Train Location with GNSS Solutions

TW3972

VC6050

VP6050

Government agencies in North America (e.g. US Federal Railroad Administration), Europe (e.g. European Union Agency for Railways) and other jurisdictions are looking to increase productivity and improve rail safety by applying new GNSS precise-positioning technology.

Mass-market GNSS receivers are built into cell phones, cameras and first-generation automotive navigation systems. These GNSS receivers use satellite PRN code signal timing to determine the difference between transmit and receive time and then derive the satellite's range to the GNSS antenna. Latitude, longitude, height (of the antenna) and time can all be estimated with range measurements from four satellites. With a clear sky view, this technique, known as code tracking, can provide horizontal positioning within a 2–3m diameter to a 95% confidence level.

But rail applications commonly require sub-10cm precision, only achievable with multi-constellation, multi-frequency receivers in real-time kinematic (RTK) systems or commercial, wide-area corrections services. Real-time RTK systems rely upon GNSS signal carrier phase measurements to achieve the accuracy needed for positive train control (PTC).

An RTK system consists of a base reference receiver at a known location, a rover (the train), and a communication system to transmit base station coordinates and GNSS observables to the rover. The RTK technique provides excellent performance (rapid convergence and accuracy) when the baseline (base to rover) is short (≤30km). In this case, the base and rover

receivers largely have common signal paths so that differencing techniques can be used to cancel many common errors, thereby providing for estimation of a distance vector between the known base station location and the unknown rover location.

An analogy would be to imagine the distance vector between base and rover as a measuring tape with imprecision of 1mm at the base station (VeraPhase / VeraChoke) and either 2mm (VeroStar) or 8mm (TW3972) at the rover (train). RTK accuracies are degraded without a clear view of the sky or in a high multipath environment. Also, GNSS signals usually become unavailable in tunnels or under bridges, so inertial navigation methods must be used to overcome temporary signal loss.

Because RTK systems rely on carrier signal phase measurements, the antennas must have a very stable phase centre (PC) and a predictable phase centre variation (PCV). In addition, the antennas should have a good G/T ratio (a sensitivity parameter) and provide high rejection of cross-polarised signals (LHCP) commonly resulting from reflected signals (characterised by the antenna axial ratio). Finally, the quality of the base station and rover antennas are paramount and mathematically limit the achievable accuracy.

When it is necessary to reduce multipath to an absolute minimum, a choke ring is the antenna of choice, providing the cleanest signals, albeit relatively expensive, large, and heavy.

Similarly, installing a rover on large metal vehicles (truck or train etc.) is also challenging because of the superposition of received signals in the metal surface of the vehicle, which compromise the 'purity' of the antenna response. Ideally, a rover antenna should be largely isolated from those metal surfaces and have its own ideal ground plane. Tallysman has the products, experience, and expertise to ensure that your GNSS antenna installation achieves RTK level accuracy and will enable you to achieve the benefits of precise train location.

We are meeting the needs of the railway industry with Tallysman's wide range of GNSS Precision Antennas.

The VP6000 (VeraPhase) and VC6000 (VeraChoke) family of wideband antennas cover all GNSS signals, including L-Band corrections. The performance of the VP6050 can rival the VC6050 (choke-ring antenna) in low multipath environments but is lighter and more compact. With a phase centre variation of +/- 1mm (yes mm), and strong multipath mitigation, the VP6050 is an ideal trackside RTK base station. The VC6050 choke ring antenna should be used when multipath signals are problematic.

The TW3972XF antennas are small, multi-band antennas that provide a PCV of approximately 8mm and are ideal for locomotive and hi-rail vehicle positioning. However, as above, the large reflective surfaces of these vehicles can be a problem, and engineering assessment can significantly improve the antenna performance.

The VeroStar, VSS6037L antenna, with a 2mm PCV, provides full GNSS and L-band coverage and is ideal for high-precision rail (rover) applications.

And it is equally important to know that RF interference represents a current and future threat because of continuous rollout of new close-by radio systems (particularly 5G and other cellular bands).

What is ok today may not be tomorrow.

Tallysman eXtended Filter (XF) products have prestigious rejection right adjacent to the GNSS signal bands to prevent saturation or intermodulation interference in increasingly difficult RF conditions.

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Tallysman's broad range of **GNSS antennas** – designed for the next generation of GNSS rail systems.

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European Rail Certified

- ✓ *Multi-constellation, multi-frequency*
- ✓ *Precise positioning*
- ✓ *Interference mitigation*

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