# Tallysman

## Integrated (Smart) GNSS Antennas and Their Railway Applications

In a previous Railway-News article, **'Precise Positioning for Railway Vehicles'**, some of the fundamentals of Global Navigation Satellite System (GNSS) operation were described, including pseudo-random noise (PRN) code-based and carrier phase-based measurement methods for position calculations.

Also discussed was the use of real-time kinematic (RTK) corrections via base/rover GNSS receiver pairing to achieve sub-6cm accuracy. RTK accuracy is required to improve rail safety and productivity, especially in autonomous systems.

Briefly recapping, GNSS antennas require a stable phase centre, predictable phase centre variation, a design that mitigates multi-path and supports deep out-of-band filtering of interfering RF signals (e.g. 5G cellular signals). At the same time, the antenna must be capable of receiving GNSS and augmentation (correction) signals broadcast from medium earth orbits and geostationary satellites, respectively.

### Benefits of a Smart GNSS Antenna

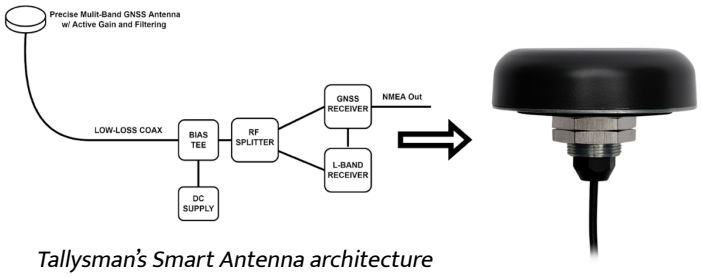
Traditional GNSS installations placed the GNSS antenna on the roof or a mast and ran a coaxial RF cable to the receiver. This design is suitable for installation where the antenna and antenna cable are not subject to RF noise. Today's installations are increasingly complicated, and often, sensors are collocated; therefore, both the antenna and RF cables are subject to interference from these sensors or vehicle communications (RF signals).


In a Smart Antenna, the GNSS antenna and receiver are in the same enclosure, often on the same PCB, and are shielded from these other sensors and RF noise. A smart antenna design provides the cleanest and purest signal to the receiver. With a clean and pure signal, the receiver can estimate the most accurate and precise measurements.

### Tallysman's TW5390 Smart Antenna Features

Tallysman's TW5390 smart GNSS antenna integrates the TW3972, American Association of Railways (AAR) certified GNSS antenna and the u-blox F9x family of GNSS receivers. The antenna has many key features such as multi-constellation, multi-band correction support (including L-band options), a low axial ratio that provides excellent multi-path mitigation, a precisely calibrated phase centre, Tallysman's eXtended Filtering (XF), a low-noise amplifier that ensures a low noise figure and strong signal to noise ratio (C/No).

The TW5390 smart antenna is based on the u-blox F9x chipset family. The key GNSS features of the smart antenna are that it supports the following: u-blox




*Tallysman's Smart Antenna architecture*

dual band professional grade F9x chip, optional u-blox D9S module (L-band corrections), RTK and PPP-RTK, integrated inertial measurement unit (IMU) (F9R), and offers several interface options (RS232, RS485, USB).

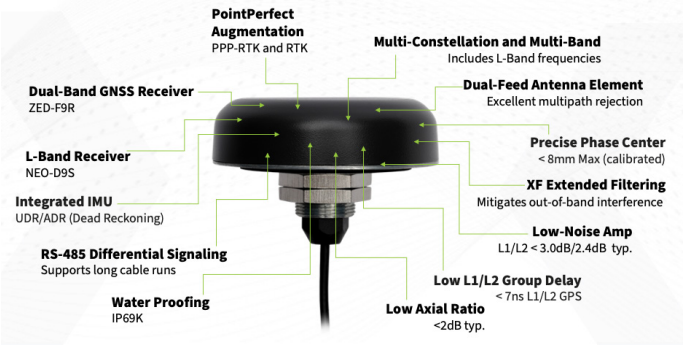
Multi-constellation and multi-band GNSS provide several benefits, but primarily, more observation on different frequency bands typically yields a more accurate and robust position estimate. An IMU can bridge short GNSS signal outages, such as when a train passes through a short tunnel or under a bridge. Choosing a receiver family that offers a variety of configuration choices can optimise performance, cost and flexibility.

Tallysman offers a TW5390 development kit that gives users a tested, robust, out-of-the-box smart antenna.

## GNSS Corrections: RTK and u-blox PPP-RTK

For this technical note, we will focus on the concepts of GNSS corrections without delving into the details. All raw GNSS measurements contain errors. These errors originate from satellite orbit and clock variations, atmospheric (ionospheric and tropospheric) effects, receiver errors and signal multi-path. In this discussion, we will describe two GNSS correction techniques: real-time kinematic (RTK) and Precise Point Positioning (PPP)-RTK.

RTK is a relative positioning technique that relies on cancelling or minimising errors by keeping the distance from the known base station to the rover short and then taking the difference of these measurements to cancel other errors. RTK requires a base station every 30 to 40km. The base station makes its observations and its co-ordinates available to the rover. The rover then computes its co-ordinates. RTK position estimates have a relative accuracy of around 10mm (short baseline), and the absolute accuracy is based on the accuracy of the base station. RTK solutions converge very quickly when the baseline is short; as the baseline gets long, it takes longer to converge, and the accuracy decreases.




*Tallysman's TW5390 Smart Antenna features*

PPP-RTK, on the other hand, is an absolute positioning technique that does not rely on a local base station. PPP-RTK has base stations that are used to track the GNSS satellites. The base station observations are sent to a central processing station, and the GNSS errors are estimated and then sent to the rover. The u-blox PPP-RTK service (PointPerfect) supports a typical accuracy of 20 to 60mm and a convergence time of approximately 30 to 40 seconds within the service area.

Both RTK and PPP-RTK need a communication system to transmit the correction data to the rover. For example, RTK can use a radio link from the base station to the rover or an Internet protocol (IP, NTRIP) message over cellular. PPP-RTK corrections can be delivered using two different technologies: broadcast from a geostationary satellite directly to the TW5390 or delivered over an IP link using the MQTT protocol.

## TW5390 Railway Applications

Tallysman's TW5390 multi-constellation and multi-band smart GNSS antenna supports RTK and PPP-RTK correction/augmentation technologies. GNSS augmentation technologies enable real-time sub-6cm positioning accuracy. These features and the features listed in the TW5390 features section make the smart antenna an ideal positioning product for railway applications such as locating rolling stock, tracking support vehicles and tracking rail side workers.

Contact Tallysman for the latest Smart GNSS antenna news.

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# *Precision at any speed*

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

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

AAR Certified GNSS Antennas

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