Advanced Technologies | White Paper

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Minimizing the impact of GNSS interference on critical infrastructure

Global navigation satellite system (GNSS) technology has become an integral part of our daily lives, powering everything from navigation apps on our smartphones to critical infrastructure in aviation, telecommunications and defence. But, as GNSS technology becomes prevalent, so does the presence of interference—both intentional and unintentional—which can overpower weak GNSS signals, leading to degraded accuracy or complete signal loss.

Intentional interference, often in the form of jammers, is a growing concern for GNSS users. Jammers are devices designed to deliberately interfere with GNSS signals. They can be purchased online and used to disrupt GNSS-dependent systems. For example, in the aviation sector, where GNSS is crucial for navigation and landing procedures, interference from jammers poses a significant threat to aircraft and passenger safety, as it can lead to navigation errors and potential accidents.

Unintentional interference can come from nearby communication towers and other electronic devices. These sources can emit signals that interfere with GNSS frequencies and, although not intentional, the interference can be dangerous, affecting the accuracy of critical GNSS-based applications.

The impact of GNSS interference is not limited to navigation. GNSS signals are also used for precise timing, which is essential for synchronizing telecommunications networks, financial transactions and power grids. Any disruption in GNSS signals can lead to cascading effects, causing widespread outages and financial losses.

Growing reliance on always-available, resilient GNSS solutions

Because GNSS technology operates in critical areas of global infrastructure in industries like autonomous navigation, telecommunications and defence, the availability of continually operating, highly reliable GNSS solutions is paramount. The need for antennas that are designed to improve the reliability of GNSS reception despite the vulnerabilities of the GNSS system to jamming and interference has never been more important.

The AJ977XF addresses this need by combining a level of interference immunity with multi-band GNSS support. The AJ977XF is an advanced triple-band GNSS antenna specifically designed to maintain reliable signal quality in interference-prone environments. Using cutting edge techniques and a unique design that minimizes sensitivity to signals near the horizon, this antenna enables GNSS reliability where signal resilience is essential.



Primary applications of the AJ977XF

The AJ977XF's anti-jamming capabilities make it ideal for environments where GNSS signals are often compromised by interference sources located close to the horizon, including:

Defence and critical infrastructure: Provides secure and resilient GNSS in high-stakes environments, such as military zones and critical infrastructure sites (airports, seaports, bridges, central banks) where intentional jamming is a recognized threat.

Marine navigation: Essential for vessels navigating through interference-prone waters, minimizing the risks of GNSS signal loss due to shore-based or onboard RF interference (SATCOM). Examples include harbour and port navigation, and search and rescue.

Timing applications: Vital for financial transaction systems, telecommunications, and power grid operations where antennas are often close to powerful interference sources, enabling reliable timing and synchronization.



Technology solutions in the AJ977XF for robust signal reception

Low-elevation angle nulling to suppress peripheral interference

The AJ977XF is a low-elevation angle nulling antenna (LEANA), which uses a stacked helical phased array design to create a "null zone" at low elevation angles, reducing its sensitivity to signals near the horizon. This nulling effect can provide up to 20 dB of attenuation, effectively filtering out interference from ground-based sources, such as jammers or communication tower transmitter sidebands. This feature is invaluable for applications where signals from the periphery threaten to overpower GNSS.

Triple-band multi-constellation GNSS coverage

Supporting L1, L2 and L5 frequencies (and analogue signals in the other constellations), the AJ977XF ensures reliable GNSS reception by maintaining access to multiple GNSS bands and constellations (e.g., GPS, Galileo, GLONASS, BeiDou). This multi-band design ensures that even if one frequency band is affected by interference, the antenna can continue receiving signals on others, thereby improving positioning accuracy and resilience.

Extended filtering (XF) technology for out-of-band interference protection

Tallysman's XF filtering technology provides the AJ977XF with strong out-of-band rejection, blocking interference from non-GNSS frequencies such as LTE, 5G and nearby satellite communication. With up to 80 dB rejection of out-of-band frequencies, the antenna prevents these high-power signals from overwhelming GNSS reception, ensuring pure signal reception in areas where interference is prevalent.

Enhanced low-noise amplifier (LNA) with high output P1db

The AJ977XF's LNA is optimized with a high output P1dB to withstand close-proximity high-power in-band interference without saturating. This improvement makes the antenna suitable for high-interference areas, where strong RF signals may otherwise degrade GNSS signals. This resilience is particularly beneficial in timing applications that require GNSS antennas to operate near powerful transmitters, like cellular or broadcast towers.

Tackling today's GNSS challenges with the AJ977XF

The AJ977XF anti-jamming antenna combines innovative design with advanced filtering to address today's GNSS challenges. This multi-band antenna tackles these challenges in three prongs: low-elevation nulling, out-of-band eXtended Filtering (XF) and high-output linearity. Through these innovative methods, it delivers reliable GNSS signal performance in interference-prone environments. The AJ977XF is an ideal choice for defence, critical infrastructure, marine and timing applications where continuous GNSS is essential. With a low phase centre offset variation, unlike dynamically nulling antennas such as controlled radiation pattern antennas (CRPAs), it can also work well as reference station antennas where low phase centre variation (PCV) is important.



Real-world results

Often, the AJ977XF may be sufficient as a key component to a resilient GNSS system. As jammers and sources of interference can often be encountered at a distance, they effectively appear low to the horizon, which is where the null of the AJ977XF exists.

The AJ977XF antenna is designed for resilience in GNSS-denied and jamming-heavy environments, making it a reliable choice for both civilian and military applications. Tested rigorously at Norway's Jammertest events in 2023 and 2024, it has shown a 10 dB improvement in jamming mitigation compared to standard antennas, underscoring its resistance to interference.

This performance has been further validated in real-world conditions by customers operating on the periphery of active war zones and within contested areas where active jamming is present. The AJ977XF enables positioning in these hostile environments, making it essential for mission-critical operations.

Next steps: Connect with Calian for more information or to schedule a consultation to explore how the AJ977XF can enhance performance in interference-prone environments. Access to technical whitepapers showcasing the AJ977XF's performance and a detailed comparison with our standard HC977XF is available upon request.

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