Wireless RTK Data Links:

WHAT TO LOOK FOR IN A DATA LINK FOR YOUR RTK SURVEY SYSTEM

Overview

Surveying is a tough business. There are no excuses. The highest precision and accuracy are required as a matter of course, and because time is money where real estate is involved, clients demand fast results. It is no wonder that GNSS Real Time Kinematic (RTK) survey systems, which can measure location with centimeter accuracy in moments, have taken over today's survey marketplace. This guide tells you what you need to know to select the best data link for your RTK survey business.

Choosing the right RTK surveying system also is a tough business. RTK surveying provides centimeter accuracy by constantly computing the error between the GNSS-determined coordinates of a fixed site with the site's known location and transmitting these errors as real-time correction message to nearby mobile GNSS receivers, thereby increasing their accuracy one-hundred-fold or better. The key element in any RTK system is a data communications link—most commonly some type of licensed, digital radio modem system—that reliably transmits the RTK corrections throughout the work site. Surveyors need a data link that is not only highly reliable, but one with high-enough performance to provide sufficient range in a wide variety of terrains and usage scenarios. And because surveying is a business like any other, cost is an object.

A typical data link system includes radio modem transmitters and receivers, antennas, cables to carry data to and from a GNSS receiver, and batteries to power the system all day in the field. While long communications range is an important consideration, maximizing the range of your RTK system depends on maximizing the performance of the entire communications system. A variety of fully integrated radio solutions are available that provide cost-effective service at various levels of system performance.

Key Factors

Paying attention to a few simple factors and selecting a data link system that suits your surveying and business needs will let you improve the performance, enhance the cost-effectiveness, and increase the user-satisfaction of your RTK survey system.

The key considerations in choosing a radio modem data link for RTK survey applications are:

- RF output power
- Receiver sensitivity
- Antenna gain and siting
- Feed-line loss prevention
- Battery quality

RF Output Power

The first radio system specification to understand is the specification for RF output power. A radio modem data link functions just like a miniature version of a large commercial radio or TV station, and the RF output power indicates the transmitter's basic ability to propagate the signal to further distances.

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Depending on the region or country, the RF output power is limited by regulations. In the U.S., the limit for RF power in survey itinerant operations is 35 Watts. In Europe, the regulations vary from country to country.

In general, the higher the RF output power, the better. The cost of higher RF output power is higher overall system power consumption. Larger batteries are required for operation, batteries may require more frequent recharging and/or replacement, and the integration of high and medium power radio transmitters may be more difficult.

Rule of thumb: Go with the highest power RF output available.

Receiver Sensitivity

The next fundamental system specification to understand is for the radio receiver sensitivity. The more sensitive the receiver, the better its ability to receive signals from distant transmitters. Receiver sensitivity is derived from the core design of the radio receiver. The true art in radio receiver design is to select and implement a design that optimizes the ability of the receiver to resolve very weak signals.

In addition to the sensitivity provided by its core design, the ability of a receiver to receive weak signals can be enhanced by other means. The most cost-effective approach is forward error correction (FEC). This is an advanced technology that improves receiver sensitivity by adding redundant information to the data signal in a manner that allows a receiver to detect and correct errors that occur from weak signals. Radio receivers designed for high sensitivity always include FEC.

In general, the higher the receiver sensitivity, the better. The cost of increased sensitivity comes from the higher quality components that are required, as well as the greater care required in tuning the receiver and verifying sensitivity performance.

Rule of thumb: Go with the highest receiver sensitivity available that uses FEC technology.

Antenna Gain and Siting

The next fundamental system specification to understand is for the radio receiver sensitivity. The more sensitive the receiver, the Antenna gain refers to the focusing of the RF energy - the signal either emitting from a transmitter or being picked up by a receiver. Gain is generally represented in terms of dB with respect to either a theoretical isotropic antenna (dBi) or a dipole antenna (dBd). Antennas measured with dBi gain rate are commonly utilized for general-purpose portable systems or mobile whip antennas, and those showing a dBd gain rate are commonly used for fixed base stations and higher-performance installations.

In addition, antennas are divided in two categories: directional and omnidirectional. Each type of antenna offers a different radiation pattern. Directional antennas (e.g., Yagi antennas) have an increased vertical radiation pattern with a decreased horizontal radiation pattern. High-gain omnidirectional antennas have an increased horizontal pattern with a decreased vertical pattern. Directional Yagi antennas allow the use of relatively low power radio transmitter to send data over long distances; they are ideal for point-to-point fixed location applications. Omni-directional antennas are recommended when the signal transmission between the transmitter and the receiver is constantly changing. These types of antennas are best for mobile point-to-point or point-to-multipoint communication systems.

Complementary to antenna gain is antenna siting. It is important to position any antenna to optimize line-of-sight within a communications system. Antenna gain will increase if the signal path is free of obstructions. Always place the antenna on the highest point available. At a minimum, set the antenna to at least ten feet above the terrain using an antenna mast.

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Rule of Thumb: Select the type of antenna that best fits your application and the one that offers the highest dB gain. In addition, set up your RTK base station in the highest possible elevation to minimize obstacles between the transmitting and receiving systems.

Feed-Line Loss Prevention

Also important to consider for system specifications is preventing feed-line loss. Decrease of the signal starts from the moment the signal leaves the transmitter. Most fixed RF data communication systems connect the radio to the antenna through a coaxial cable. This cable can be a source of signal loss (about 1 dB per connection, in addition to cable attenuation) and should be optimized for best system performance.

The feed-line cable is the source of at least two types of feed-line losses. One is when the connection of a coaxial cable to the antenna port of the radio acts as an impedance boundary reflecting the RF energy back to the transmitter. It is important to use coaxial cable and connectors that can minimize or eliminate the impedance mismatch. The second type of feed-line loss is the attenuation of the signal as it propagates along the length of the cable. Attenuation of the signal can be caused by the leakage of RF though imperfect shielding of the cable as well as resistance in the cable conductors.

Rule of Thumb: If direct connection of the antenna to the radio modem is impossible, use coaxial cable and connectors that are impedance-matched with the radio equipment, and make sure to use the shortest length of cable.

Battery Quality

All "12V" batteries output 13.8V when new but their maximum voltage drops with age. Batteries typically can be charged 300 times before rapidly losing the ability to output the 9V required by most radio modems for transmission. This can occur within two to three years of normal use. All batteries eventually reach a point in their lives when they can still output 9V during the radio's receive cycle but fail to deliver 9V during the radio's transmit cycle. The radio will receive properly but its transmit range will drop significantly.

Unfortunately, standard voltmeters cannot tell you if a battery's output voltage is less than 9V during the radio's transmit cycle because the transmit cycle (about 1/10 second) is too short. We recommend instead that you mark batteries with the date of first use and replace them after 300 charge cycles or three years, whichever happens first.

Rule of Thumb: Get a new battery after 300 recharges or 3 years and make sure the battery cable remains undamaged.

Note: All these considerations apply to all radio system setups, including the receiver.

For additional details on antenna height specifications and performance in different types of terrain, please read *The Guide to Wireless GPS Data Links.*

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