Product**Review**

By Shawn Billings, LS

Shawn Billings is a licensed land surveyor in East Texas and works for Billings Surveying and Mapping Company, which was established in 1983 by his father, J. D. Billings. Together they perform surveys for boundary retracement, sewer and water infrastructure routes, and land development.

NavCom LAND-PAK

Who could have known that all of those R&D dollars spent by John Deere building the automated guidance system for those massive tractors performing precision planting, harvesting, etc., would so profoundly benefit the surveying community? NavCom, while not sporting the internationally familiar green and yellow, is John Deere's very own GPS navigation subsidiary and has made just such a translation from high-tech farming to high-tech land surveying with the LAND-PAK system. From my personal discussions with surveyors, manufacturers are struggling to differentiate their product offerings from their competitors. Hopefully these articles effectively highlight some of the more profound differences between receivers. It has been my recent experience that outside of a few features here or there, RTK receivers have become incredibly similar in function, form, and results. This really is good for the consumer. Likely, if you are buying a new system today, you will be safe in your purchase with regard to the function and the results of your new purchase. However, each receiver I've handled of late (and I've handled several) offers some distinct feature or set of features that makes it a real stand out from the competition. A savvy purchaser would do well to identify and understand these differences–what each system does above and beyond the norm–before signing the dotted line. Recognizing such features and how they might play into your work flow may signify a real advantage over time.

In the case of the LAND-PAK system, the buyer receives a full system, including the tribrach, carbon pole, batteries, antennas, cables, SD memory, cables, HI measuring tape, receivers and data collector with software and post processing software. Everything needed to perform an RTK survey is conveniently packaged together for the prospective buyer. RTK gear has become stunningly intuitive and the LAND-PAK system is no exception. Soon after reviewing the quick start guide, I was collecting fixed RTK data points on our test line within a couple of minutes of opening the cardboard shipping box. The SF-3040 is an "all-in-one" system, placing the receiver, memory, antenna and radio in a single unit atop the pole. The Sapphire receiver board is NavCom's own design, capable of receiving 66 channels of multi-frequency GPS, dual-frequency GLONASS, SBAS, and incorporates an additional channel for StarFire (more on StarFire momentarily). Memory is a user removable 2 gigabyte commercial grade

Real Time Kinematic (RTK) Global Navigation Satellite System (GNSS) surveying technology, when employed in suitable environments for suitable tasks, provides an incredibly profitable resource for surveying professionals. Performing a layout survey for development in this open field using RTK is an easy choice. However, a system such as LAND-PAK, which performs in marginal environments and includes a life-time autonomous subscription to a sub-decimeter correction service expands the functionality and potential profitability of the system.

Skyward view of the LAND-PAK rover. Visible are the antenna for the internal radio modem and three ports for hardwire interface and external power.

The Nautiz X7 is a rugged controller included in the LAND-PAK system and is loaded with MicroSurvey's very mature and capable Field Genius Software.

secure digital card. SD card memory makes wonderful sense for GNSS receivers. Downloads are simplified (no special software or cables) and capacity is ample. Communications are facilitated by an internal 1 watt UHF radio. Multiple correction formats are supported: CMR, CMR+, RTCM 2.3 and 3.1, and NavCom's proprietary StarFire and UltraRTK. Moreover the LAND-PAK supports NTRIP for mobile internet based correction. Communication with a data collector can be hardwired via serial or USB connection or Bluetooth.

Beyond the expected standard RTK features of the SF-3040 receiver, NavCom includes RTK Extend. Those of you who have used RTK in the past will really appreciate the power of RTK Extend. Perhaps you've found yourself in this scenario before: you're a couple of thousand feet from the truck, across a muddy creek, up a steep slope and back down again on the other side of a hill from the base station. You only need one shot, but as you get to the point you find you've lost radio contact with the base. As the latency ticks up, 10 seconds, 11 seconds, 12 seconds, so does your blood pressure. Storing raw data and post processing later, or relocating the base for better reception may be your only options, both of which are time consuming for a single shot on the fringes of your job. RTK Extend, as the name implies, extends the fixed solution for several minutes following loss of contact with the base. If you dance on the edge of your base station's broadcasting range very often, RTK Extend could really be a time saver. In testing, RTK Extend maintained a fixed solution for exactly ten minutes beyond the loss of contact with the base station. I observed a moderate degradation in accuracy (about 4 centimeters or 0.14 foot) in that ten minute span before the system defaulted to the next most precise solution method – StarFire corrected.

Already a competitive package of features, priced competitively with other systems on the market, NavCom ups the ante by including a lifetime subscription to their own global correction service: StarFire. Just as surveyors have for decades benefited immeasurably from satellite systems that were not originally designed with them in mind, StarFire is a fantastic space-based service covering most of the planet that was developed with precision agriculture in mind. NavCom advertises up to 5cm in horizontal accuracy with StarFire, which is almost good enough to perform boundary surveys. (On very large projects covered by rough terrain, I would be happy to know every monument was located geographically within 0.15 foot). Certainly, even if not quite good enough for precision work, there are very few topographic pick-up shots that couldn't be adequately located with this service. Perhaps the only significant logistical issue with StarFire is the amount of time required for the receiver to obtain such precision. One white paper from the NavCom website suggests that convergence (precision Nirvana) with the StarFire correction can occur in as little as 10 minutes, but may require up to 24 minutes. The product user guide is a little more conservative, stating convergence occurs in 30 to 45 minutes. So, in order to get that magic sub-decimeter performance, you may need to let the unit idle for a few minutes before getting all of the goody the units are capable of.

The lifetime subscription for the StarFire service practically pays for the units. About ten years ago, we were paying $800 per year for barely sub-meter corrections for our backpack GPS receiver. While I have no idea what the StarFire subscription would cost, it is conceivable that it could easily eclipse a couple of thousand per year. This feature definitely puts the LAND-PAK system in a category all to itself as this feature is automatically included in the upfront purchase price.

Testing the system around our Stumpwater Research Facility proving grounds, I was quickly impressed with the ability of the unit to fix in unbelievably difficult canopy. After verifying that the units work properly in all of the places RTK is supposed to work, I start taking it to places it shouldn't work. Contrary to what you may have seen in Smokey and the Bandit, as Burt Reynolds crosses the State line between Louisiana and Texas, East Texas isn't desert. The "Piney Woods" moniker is well deserved. In my experience pine trees are the worst type of vegetation one can attempt to use GPS under. Perhaps the needle length approximates the length of the L1 carrier phase of GPS signals or the density of the needles blocks the signal. Whatever the explanation, I'm always impressed by receivers that can perform, even marginally, beneath such canopy. The SF-3040 was able to fix and give accurate coordinates beneath our East Texas pines. It also fixed and gave inaccurate answers. I know some of you. Let this serve as a warning. If you use GPS under canopy you are playing with fire. Make sure not to be burned. Build enough redundancy in your work to verify questionable shots by reinitializing and taking a shot a few feet away and taping over to your point of interest. Don't trust the receiver to tell you with absolute certainty that the solution is fixed and therefore accurate. Any of

LAND-PAK base and rover are powered by two removable, hot-swappable batteries. The LED display indicates which battery is in use. The hard rubber bumper encircling the solid cased receiver gives a definite feel of durability should the unit fall over.

them can be wrong and absolutely depend on the discernment of the operator to recognize when extra care must be given. Having said that, and false fixes notwithstanding, a receiver that makes an effort to fix in such conditions can be extremely helpful. A unit that will absolutely not attempt a fix in difficult conditions will never provide results, whereas a unit that will attempt a fix in difficult conditions can provide results, but those results simply need to be carefully verified. Clearly, a potential right answer in unfavorable conditions is better than no answer at all.

The author had to work a little harder than usual in testing this receiver. As you regular readers know by now, we test the precision of every RTK system that comes through our doors by setting up the base and rover and collecting points every minute, comparing each stored epoch to the overall average, determining real world precision. As soon as the review was set up, it was apparent that three tests would need to be done to test this system's capabilities: first, conventional base/rover collection; second, RTK Extend; and finally, StarFire. A fourth, testing the UltraRTK (NavCom's 40km, long-range utility) would have been interesting as well, but was not possible in this review.

Because this sub-meter service is not my first rodeo, I knew to watch for one crucial issue regarding any correction service available, from terrestrial based Real Time Networks to space based augmentation services such as the Federal Aviation Administration's Wide Area Augmentation Service (WAAS), and NavCom's StarFire system: Datum. Here in the United States, we continue to use the NAD83 Datum, because (for those of us on the fairly stable North American plate) we have been able to perpetuate geodetic coordinates for decades with only minor adjustments. However, the GPS operates with respect to the geocentric WGS84 reference frame, which is maintained by the Department of Defense. However, the International Terrestrial Reference Frame, very closely approximates WGS84. The difference between NAD83 and ITRF is about two meters. Here in East Texas, this shift is largely in the vertical component (over four feet). Horizontally the difference is about a meter, or about two feet in Northing and two feet in Easting. The magnitude of this translation will vary geographically. Using a service that can give coordinates with a precision of 5cm on a datum that differs from the datum I'm working on by a meter illustrates the classic comparison of precision and accuracy. The wonderful precision of the service is lost due to datum differences unless those differences are accounted for in a datum transformation. For the record, this is why I believe it is still a bit premature to dispense with those ground points so many feel are becoming obsolete. Users still need to verify that service "X" is putting me in the same place that service "Y" did yesterday.

I can see some of you are getting this glazed look in your eyes and the guy in the back row is starting to nod off, so let me simply report this – in testing the StarFire service, it lives up to the claim of 5cm precision (1 sigma). After about ten minutes the coordinates began to converge to a repeatability of about 0.2 foot horizontally on most points and about a foot or less vertically. For the guy who wants to squeeze out the most utility from this service, a little homework will be required to translate the performance accuracy on his own coordinate system (unless he works in ITRF-based coordinate system). But the effort will be well worth the time. Software in the data collector and office make the transformations automatically, the user just needs to be educated well enough to set it up.

Concluding testing with the traditional RTK base/ rover configuration, I observed a 2D, 1 sigma precision of 1.3cm or 0.043 foot. Only four epochs exceeded 3cm, the worst being 3.1cm or 0.103 foot. Vertical results yielded a 1 sigma precision of 2.62cm, or 0.086 foot.

Data links between base and rover worked flawlessly, and I was very pleased with the level of control and available information presented from the data collector. It was apparent that NavCom had shared detailed commands for control and inquiry of their receivers to the two brands of data collection software I used with the system, namely Carlson and MicroSurvey. This is not always the case and was a welcome surprise. Likewise, the supplied manuals described numerous commands for those wanting to customize their experience.

The data collector included was a Nautiz X7 controller with MicroSurvey's Field Genius software. For those not already married to a particular data collector or software, this is an excellent, user friendly combination.

NavCom has produced a sturdy, feature rich system. The StarFire correction service causes me to ponder if a day is coming when RTN's will be made obsolete by highly accurate satellite based correction services that won't require expensive and sometimes difficult-to-maintain, cellular-based data connections. The LAND-PAK system packaging certainly makes buying a new RTK system a simple, cost effective, one-stop shopping experience.