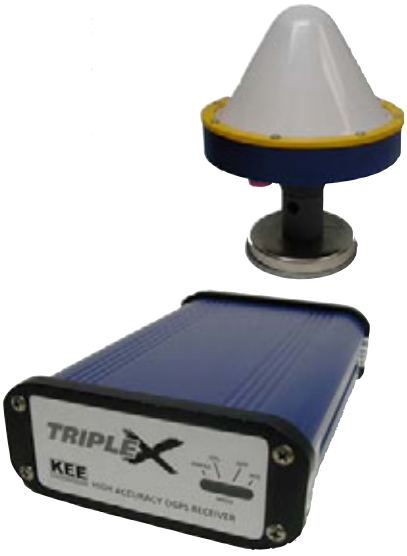


DGPS
What it all Means

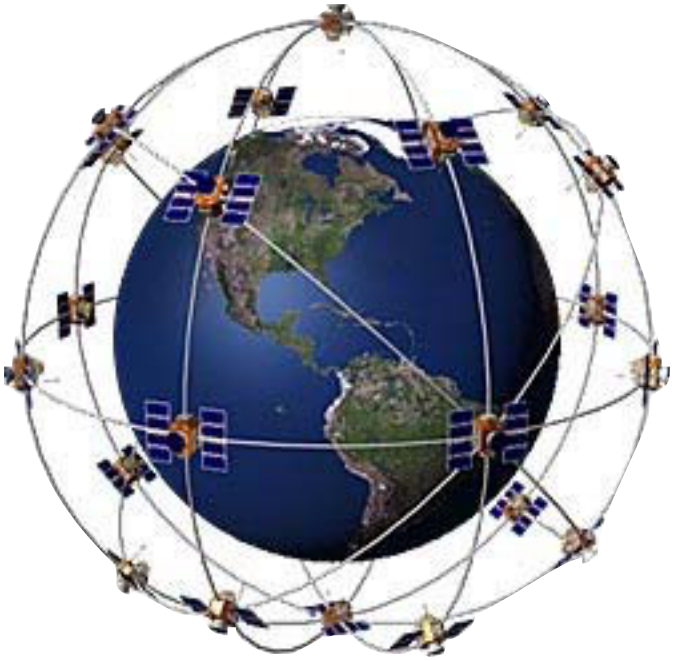
KEE TECHNOLOGIES
POWERING FARM PRODUCTION

Contents Page

1. GPS

What is GPS?
How does it work?, without being a geo-scientist.
What is differential?
What degrees of accuracy are available?

In this booklet we try to adress some of the frequently asked questions, so that dealer and customer knowledge of their pending purchases is increased to a level that their decisions are informed.



The GPS usage within agriculture has been building steadily since the mid 1990's, and 10 years on the adoption rate of farmers using GPS to enable cost savings on their farms is increasing rapidly.
It is thought that, over the next 5 years, every broadacre and row crop farmer will have and use at least three pieces of GPS equipment, of varying degrees of accuracy, on their farms.
With this in mind, and the release of the RTK precision positioning devices, an easy to read booklet, with easy explaination of GPS and its application for the modern farmer has been produced.
This is also for the dealer, who requires some basic knowledge of what is available, and what to advise his customers when they are purchasing equipment.

Raw Basic GPS

The Global Positioning System (GPS) is a satellite-based navigation system made up of a network of 24 satellites placed into orbit by the U.S. Department of Defense known as NAVSAT.The Russian government also put up a similar system called GLONASS. GPS was originally intended for military applications, but in the 1980s, the USA government made the system available for civilian use. GPS works in any weather conditions, anywhere in the world, 24 hours a day. There are no subscription fees or setup charges to use GPS.

How it works

GPS satellites circle the earth twice a day in a very precise orbit and transmit signal information to earth. GPS receivers take this information and use triangulation to calculate the user's exact location. Essentially, the GPS receiver compares the time a signal was transmitted by a satellite with the time it was received. The time difference tells the GPS receiver how far away the satellite is. Now, with distance measurements from a few more satellites, the receiver can determine the user's position and display it on the unit's electronic map
A GPS receiver must be locked on to the signal of at least three satellites to calculate a 2D position (latitude and longitude) and track movement. With four or more satellites in view, the receiver can determine the user's 3D position (latitude, longitude and altitude). Once the user's position has been determined, the GPS unit can calculate other information, such as speed, bearing, track, trip distance, distance to destination, sunrise and sunset time and more.

How accurate is GPS?

Today's GPS receivers are extremely accurate, thanks to their parallel multi-channel design. 12 channel receivers are quick to lock onto satellites when first turned on and they maintain strong locks, even in dense foliage or urban settings with tall buildings. Certain atmospheric factors and other sources of error can affect the accuracy of GPS receivers.
GPS receivers are accurate to within 15 meters on average, and this is not accurate enough for agricultural applications, so the signals from the satellites must be “corrected”. This is known as differential correction.

There is only one manufacturer of GPS products in agriculture, at this point of time, who receive signals from the NAVSAT and GLONASS system simultaneously. This is TopCon, the receivers can view nearly 20 satellites at any given time.

Sub Metre

Sub Metre correction is derived from five possible sources.

1- Omnistar VBS, recognised as accurate to less than one metre 95% of the time. This is a signal broadcast from base stations via strategically placed satellites, which corrects the raw GPS satellites. Available worldwide, it is recognised as the benchmark in sub metre corrections. This is a subscription based signal, paid yearly to OMNISTAR.

2- Marine Beacon, commonly regarded as accurate to less than two metres 95% of the time .This signal is derived from Marine Base stations (BEACONS) that transmit the correction signal to Marine Beacon capable receivers. It is restrictive in distance from the base transmitter, although there have been reports of acceptable signal receivers of up to 500kms from the transmitting base.The signal will deteriorate and be less accurate the further away from the transmitting base station that you travel.
This signal is free to the end user.

3- WAAS, is only available in North America and parts of Europe. This is a signal that uses numerous land based transmitters and satellites to transmit corrections. It is regarded as sub metre, with the accuracy closer to the Marine Beacon status.This is a free signal, and compatible WAAS receivers must be used.

4- EDIF, is utilising technology in the form of software to enable the GPS to determine its own accuracy of position. Whilst it is better than autonomous signal (raw GPS), it does require resetting as satellite constellations change.The accuracy is around the same as the Marine Beacon signal.This signal attracts a one off cost and is only available on receivers manufactured by CSI, such as the KEE Triple X.

5- Starfire, SF1,is a signal provided by John Deere, and is widely recognised as a sub metre signal that has "pass to pass" accuracy of 30cm.
Pass to pass accuracy is measured by travelling past the same point within 15 minutes.

HP

HP is an industry standard terminology for the “HIGH PRECISION” signal derived from the Omnistar service.

The GPS engine used is a dual frequency, rather than the standard sub metre, which is single frequency, and is therefore retailed at a greater cost.

The HP signal is a sub 10cm signal, which means that the scatter plot will be within 10cm for a minimum of 90% of the time.

In trials conducted over the past year a “pass to pass” accuracy of less than 5cm (2 inches) was experienced, which seems more than acceptable for the majority of broadacre applications.

This accuracy gives the operator the ability to come back to the same guidance lines (within 10cm) year after year.

The “nudge” feature within PRO Steer ensures accurate repeatability without the problems that base stations sometimes incur.ie: range, power demands, damage etc.

The HP signal is not confined to a small area, so large farmers are able to roam the farm from one end to the other without signal failure

The HP signal covers the same area as the VBS signal. It is a yearly subscription, and farm packages are available to allow more than one unit to be subscribed under the one license.
(Omnistar is to be contacted for more exact costing)

John Deere also has a 10cm repeatable signal that is referred to as Starfire 2(SF2) receiver. On the JD web site it is stated that ,
”Pass to pass accuracy of this signal option is +/- 4 inches.”

RTK

RTK is generally referred to as the sub 2cm, or sub 1inch accuracy signal. This system works by having two DGPS units operating together. One being the “Base” unit and the other being the “Rover” unit.
The Base unit has the co-ordinates “locked” and receives the normal satellite signal, measures the difference, and sends the corrections to the Rover via an external radio. Both of the DGPS units have radios and antennas for the transmission of corrections.
This system is widely regarded as giving the most accurate repeatable signal due to the Base and the Rover being in close proximetry to one another. Thus reducing the atmospheric changes that can distort satellite signals.
The Base station can be either be fixed, or be moved around from one spot to another. Each time it is moved, the DGPS has to be configured, and “locked” into position. It is important to have the Base DGPS antenna placed in exactly the same position each time you return to a spot, otherwise the repeatability will be lost.
The radios are the limiting factor to the RTK system, as typical reception is 5-10 km’s (3-6 miles), due to the “line of sight” capabilities of the radios. This is why the Base station must be able to be moved.
With some radios (operating on VHF signal) there is a yearly licence fee payable. This system gives far greater distance and less chance of dropping signal due to trees etc. For the small yearly licience fee, these radios are worth the extra cost. The transmitting radio antenna must be mounted as high as possible. HEIGHT IS EVERYTHING.
There are two types of RTK depending on the type of DGPS receivers used.
Single Frequency(SF) RTK, uses only the L1 band of satellite information, is cheaper, but signal can drop out easily from trees etc.
Dual Frequency(DF) RTK, uses L1 and also L2 bands. This gives greater accuracy, and also has less chance of the signal dropping. If the signal does drop out, the reacquisition time is quicker than the SF RTK system.

RTK Glossary

Range:

RTK range is the distance from the base station to the rover. It is generally accepted the nominal distance is around the 6mile/10km mark. After this the accuracy of the GPS progressively gets less acceptable.

The radio signal is possible to be received at 12mile/20km range, but the accuracy is no longer recognised as 1"/2cm, and dropouts of the radios will occur more often. Reaquisition of the RTK accuracy after a dropout will also take longer.

Base Station:

This is the reference station and must not be moved whilst the rover is active. GPS unit and antenna that is "locked" in position. The GPS looks at all of the satellites, and works out the difference in measurement from their signals, to that of where the base GPS is "locked" at.

The correction of the raw GPS signal is then broadcast from a radio, to a "rover radio/GPS".

It is imperative that the base station GPS antenna is placed in "exactly" the same position each time the base is moved(if it is a mobile base station) otherwise repeatability will not be achieved.

Rover:

This is the vehicle mounted unit (in the tractor/combine/sprayer.)

The corrected signal sent from the "base" GPS/radio, is received by the "rover" radio. The corrections are then sent to the "rover" GPS, thus correcting the raw GPS data being received by the GPS antenna.

The rover GPS can operate within the distances of the radio transmitter, and gain a high accuracy of differential correction positioning.

Repeater:

Radio repeaters are available, that can help send the signal from the base station to the rover, if the rover is in a "black spot" unable to receive the base signal. The repeater receives the base signal, and then "onsends" it to the rover, in a gully for example.

The repeater is not to be used to "extend" the distance of the signal from the base, but merely to fill in areas where the base signal is shielded from the rover.

The repeater comes with a small "whip" antenna, and can be permanently mounted to a vehicle parked on a high vista, to enable the forward projection of the signal. The repeater should be in "line of sight" of the base and the rover. It does not matter if the repeater moves, as it is only a transmitter.

Reaquisition:
This is the time that the GPS and radios take to re-establish contact and position after a dropout of signal.
This time can vary from, almost instant (if close to the base) up to 20-30 minutes if there are large distances involved, particularly with Single Frequency.

Radios:

FREEWAVE

Freewave radios transmit the correction data from the Base Station GPS to the Rover (vehicle GPS).
As the name suggests, there is no licence fee, so there are no ongoing costs.
The freewave radios transmit on a frequency of 900mhz, or thereabouts.
The downside of this type of radio is that they generally only output 1W, so therefore the transmitting range (distance) is usually only about 2-5kms
This distance is usually not considered sufficient in normal farming practices, but is fine if the user continually wishes to move the base station from one position to the next, when changing locations. (only used in North America)

Radios: UHF

The UHF radio is a known radio to most farmers as it transmits in the 450mhz range, as does their normal "CB" type radios.
This type of radio gives a greater range than the Freewave radio, and the output wattage is able to be increased to 2 watts or more.
With a slightly better range, (6-15 kms), this radio can also be used as a "mobile" base station, or can equally be used as a "fixed" base station.
The fixed base station, refers to the Base GPS being operated from one position, and not moved. The fixed base usually has a high gain antenna and low loss antenna cable, so the antenna can be positioned at a high point to get the upmost transmission distance.
The UHF system can drop out around trees, and in damp conditions may find the wet leaves and grass to be a type of reflector, thus reducing the range.

GPS: TOPCON

The Top Con range of GPS units offer some real benifits to the end user.
They can be used as a HP 10cm receiver, and then upgraded to RTK rover by upgrading the software, and adding a UHF antenna.
The rover GPS units come with an internal battery, so they are able to be operated without being connected to vehicle power.
The Fence Post base station is extremely convenient to use, as it also has an inbuilt battery, and also has a UHF radio and antenna built in.
The battery will last up to 6-7 hours, so this makes for an extremely mobile unit.
The fixed base station is not as compact as the mobile "fence post" unit, as the GPS, antenna, UHF antenna and GPS receiver are seperate items.

The TopCon RTK uses UHF radios. 2 watt for the fence post, and 35 watt for the fixed base station.

The other main benefit for using the TopCon RTK units, is that they also derive information from the GLONASS satellites, as well as from the NAVSAT satellites (USA).
This means the GPS receivers are seeing more satellites, and therefore will get better positioning, with fewer holdups due to low satellite numbers.

TOPCON:

Fence Post Base Station :
This is the easiest receiver to be used for a mobile base station. It is compact with the 2w UHF radio and GPS antenna built in.
This unit also has a inbuilt battery, which means that an external battery source is not required for jobs lasting less than 6 hours.

Fixed Base Station:
This is the UHF fixed base station. Complete with an external GPS antenna.
The 35w UHF antenna and radio are also separate, enabling the radio antenna to be positioned as high as possible to gain maximum range.

HP / Rover:
The GPS and antenna are separate items, but the GPS has provision for a UHF antenna to be fitted.
The GPS has the UHF receiver built into it.
This makes the upgrade from HP to RTK an easy physical option, by simply adding a UHF antenna.
NOTE:The software has to be upgraded to accept the RTK inputs. This unit also has an internal battery with option for an external power source.

Radios: VHF

The VHF radio system transmits in the 150hz spectrum and is generally accepted to give better performance in distance, and also has less dropouts due to trees and terrain.
The radios used in conjunction with PRO Steer transmit at 5w, requiring a small yearly subscription to be paid for the radio licience.
The base station is supplied with a low loss antenna cable and a high gain antenna. The antenna's are tuned to the base frequency to improve transmission of the signal.
The expected range is from 12kms and up to 20kms. However the distances achieved in the field vary due to localised features, such as trees, hills etc.
VHF signal is more forgiving around trees, thus resulting in less dropouts of the correction signal

GPS: NOVATEL

Novatel GPS receivers have been manufactured since the birth of global positioning. The units are used in the following configurations.
HP,
10cm signal from Omnistar gives the farmer 10cm repeatable accuracy, and requires a yearly subscrition for the signal.
RTK.
The Novatel GPS units are able to be configured as either Single Frequency (SF) or as Dual Frequency (DF) receivers.
The SF uses the L1 band of satellite information. This is a cheaper option, but signal dropouts increase dramatically from trees etc. The time taken to re-aquire the RTK signal also takes longer after a signal drop out (up to 20min), due to lesser performance in positioning.
DF uses L1 and L2 bands, thus giving better accuracy, and less chance of dropping signal. Reaquastion time to regain the RTK signal is also decreased.
The NOVATEL GPS units are capable of both, SF and DF.
It is recommended that DF is used if using RTK

NOVATEL:

HP / Rover:
The GPS receiver and antenna are separate items,
The HP unit is upgradable to be an RTK Rover by changing the GPS firmware, and adding a VHF radio and antenna

VHF Radios:
The 5 watt VHF radio is housed in its own separate housing. The power cable and antenna connections are shown with this picture.
The data cable connects directly to the Novatel GPS Indicator lights allow easy monitoring of performance.

Base Station:
The base station is supplied in separate modules, allowing for permanent installation. 100' low loss cable and a High Gain Antenna for the VHF radio come as standard. Also provided is a portable whip antenna for the VHF if the unit is to be used as a portable base station
The VHF is mounted to the GPS, and comes pre-wired and configured.
Simply plug and play.

Easy to use configuration software is also supplied.

Notes

Notes

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