Basic RTK Preface

This document can be used as a guide, or a script to assist authorized Thales Navigation, Ashtech Products representatives demonstrate the Ashtech Z-Xtreme RTK Super Station and TDS Ranger with Survey Pro CE software to a potential Customer.

RTK – Demo Preparation

Preparation is the key for all successful product demonstrations. Organize your equipment prior the demo, preferably the day before. Use this time to test your gear, this will ensure the system is complete and operational. Collect a new/current almanac in both receivers, this helps ensure a quick initial position fix from cold start. Configure the RTK Base and Rover units, including the cabling systems inside the receiver bags. Have your RTK system ready to go. When you arrive at the demo site, connect the GPS antennas up and get started. Don't fumble around configuring your RTK system in front of a potential customer. Look prepared and professional.

RTK Pre-Demo Checklist

Charge all the system batteries, have "Hot-Spares"
This includes receiver batteries, the data collector and the base radio battery.

Perform a Mission-Plan; make you have a sufficient number of satellites for the RTK demo. Remember, RTK surveying requires at least five visible/common satellites.

Promote the ***"Instant RTK 5-6-7 Rule".***

Where: 5 = PDOP of 5 or less / 6 = 6 or more Satellites / 7 = Baseline lengths of 7 Km or less.

Print out the Mission Planning graphs from Ashtech Solutions. Have them with you for reference during the RTK demo. These planning graphs can be very beneficial to help educate your potential customer.

Scout - Recon a good location for the RTK demo.
Will the RTK demo be out in the Customer's parking lot, or does the customer prefer to demo the RTK system on a job site. Select a suitable location for the RTK Base station, this site should have good visibility to the GPS constellation and good line of sight the for the Pacific Crest radios.

What type of coordinate system will be used for the RTK demo ?
Local coordinates, i.e. N-5000m, E-5000m, 500m-Elevation,
State Plane NAD27, State Plane NAD83, or UTM coordinates,
What unit of measure are the coordinates: Meters, International Ft, or US Survey Ft.

Perform a **"Parameter Reset"** on the Base and Rover GPS receivers.
Both receivers retain the Base unit's WGS84 position from the previous RTK survey. When the receivers are moved to another project site (more than 500 meters) the receiver will compute a new autonomous position. If these two positions do not agree, this will trigger an audio alarm and visual display message on the GPS receiver's LCD display menu: "**Bad Base Coordinates".** Avoid this type of receiver alarm during the RTK demo.

The **Parameter Reset** function will reset the receiver's basic functions, canceling The alarm states, it also erases the receiver's previous RTK Base WGS84 position. These defaults include resetting the Baud Rate for the Serial Ports back to 9600. These are the default baud rates for interfacing the TDS Ranger and Pacific Crest Radios in to the Z-Xtreme RTK system.

Delete any unwanted data files from the GPS receivers PCMCIA memory cards.
This ensures you have sufficient receiver memory for the demo and avoids the Alarm State: "**PC Data Card Full"** during the RTK Demo.

Make sure the Pacific Crest Radios are set to the same Channel / Frequency.
The PDL Base radio has a push-button channel selector. If the Z-Xtreme RTK Rover has an Internal PDL – RXO radio, you can use the TDS Ranger to check and configure the Channel / Frequency selection. Alternatively, the Pacific Crest PDL configuration software can also be used to verify Channel / Frequency settings.

Nothing can sour the RTK demo quicker, then having to manipulate the radio channels - frequencies in front of a potential customer during the RTK demo. Make it look simple, if it looks to complicated – you may scare off the potential customer.

Pre-load any coordinates and Geoid models into the Ranger with TDS Survey Link software. Perform this function at the customer's office, before you adjourn outside. If you have a laptop PC, this task can be completed in the field before the RTK demo.

RTK Strategies and Coordinate Systems

TDS Survey Pro CE supports performing RTK surveys in local coordinates and State Plane Coordinate (SPC) systems including NAD27, NAD83 and UTM. One common theme with the TDS software, the Point Number, Northing, Easting, Elevation and descriptor data need to be pre-loaded in to Ranger data collector before the RTK survey can begin. If only a few control points are needed for the demo, the coordinates can be manually entered in to the Ranger. Larger coordinate files can be transferred with the TDS Survey Link software.

There are several distinct Projection Modes in TDS Survey Pro CE. These modes include Horizontal and Vertical projection settings. These strategies are described as follows:

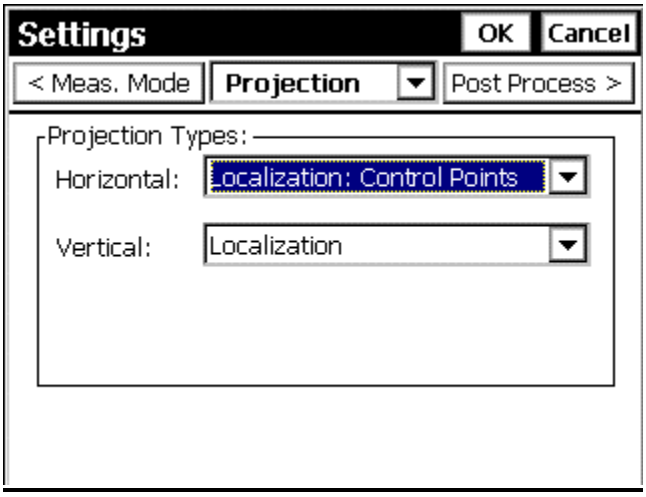
Horizontal Projections:

Localization: Control Points, Localization Calculator, or Mapping Plane.

Localization: Control Points method can work with any type of coordinates, local 5000/5000/500 coordinates, or known SPC27, SPC83, UTM coordinates. Setup the Base RTK system over the control point. Connect the TDS Ranger to Base RTK system. Specify the point number where the RTK Base antenna is set-up and then extract an autonomous WGS84 Base position with the "**TDS-Get function"**, the program will associate the WGS84 position to the RTK Base Station's Northing, Easting, and Elevation.

Once the RTK Base station is set-up and operational, the RTK Rover system physically occupies control points on the project site. During this process the RTK Rover system computes WGS84 positions relative to the RTK Base station, "fitting" these positions to the coordinate system. The goal of the TDS Localization is to determine the **Scale & Rotation** factors to transform the WGS84 positions to the coordinate system being used on the project.

After **"Solving and Accepting"** the Localization, it is highly recommended you perform a **"Check Control-Point"** procedure to validate the RTK coordinate against the known coordinates before continuing the survey, this procedure is similar to "**Checking your Back sight".**



Screen capture for Localization: Control Points

Localization Rules:

One Control Point, Scale Factor = 1.00000000, Rotation Angle = 0°00'00"

Two Control Points solves for Scale Factor, Rotation Angle suspect.

Three Control Points solves for Scale, Rotation Angle, but cannot generate residuals on the Control Points.

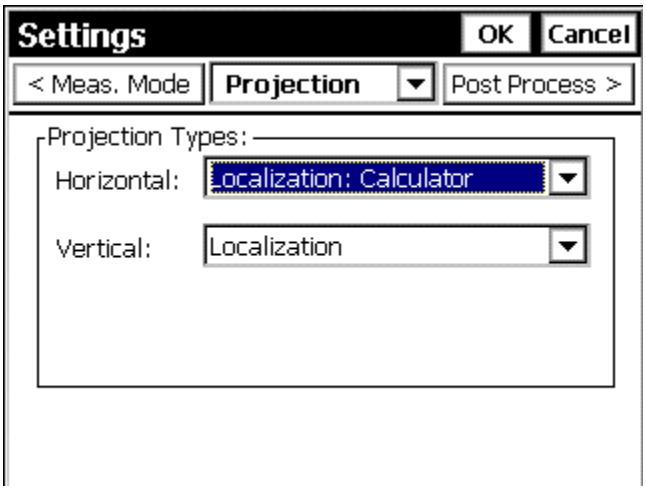
Four Controls Points solves Scale Factor, Rotation Angle and generates Residuals on the Control Points.

During the RTK Sales demo, it may appropriate to perform a single point Localization, But, in real practice, promote the concept of using multiple control points to determine the project true Scale and Rotation values.

Emphasize the Phrase: "Box the Job – Work inside the Box".

This concept surrounds the project site with the control points, we then work inside the constraint of these control points.

Localization Calculator – Supports manual entry of known scale, rotation, and origin for a horizontal site. This routine is useful if using more than one RTK Rover on the project site. The first RTK Rover performs the TDS Localization, Solves and Accepts the Localization. The Localization parameters: Base Station's Point Number, Northing, Easting, Elevation, Latitude, Longitude, and Ellipsoid Height , along with the Scale and Rotation Angle, all can be manually entered (Set) in to the Localization Calculator.



Screen Capture for Localization Calculator

From the **Survey | Base Setup…**
Base is not set: (Prompt)…

Tap **Setup …** Select Base Point… (Tap Pull-Down menu – Choose from list…)
Select Antenna for this receiver… **Setup Hr…**
Tap **Next >** button…

Manually Enter:

Latitude:	**39.034525178**	N Positive
Longitude:	**-077.285087388**	E Positive
Ellipse Height:	**75.084**	m

Tap **Set** button…
Next screen you'll observe is the **Current GPS Base Station** menu…
With the manually entered WGS84 Position,

Tap **Close** button…

Next, Select **[3] Survey – [D] Control Points…**

In the Control Point select **Utilities | Projection** button…

Next screen you'll observe is the **Projection** menu…
Select the **Localization Setup…** button…

Next screen you'll observe is the **Localization Calculator** menu…
Manually Enter:

Scale: **1.000000**
Rotation: **0.00000**

Base Station Local Coordinate:
North: **5000.000**
Easting: **5000.000**

The coordinates of the RTK Base should already be populated, specified the RTK Base Point in the **Survey | Base Setup** menu…

Next, Tap **Solve** button…
Next, Tap **Accept** button…

Next Solve the Vertical Projection…
Tap on the **Vertical** Tab in the **Projection menu…**

Next, Tap on the **Localization Setup** button…
Press **"V"** on the keyboard, or tap with the stylus under the **V** column adjacent to point 1

Next, Tap **Solve…**
Next, Tap **Accept…**

Base 1 is a GPS Control Point message displayed.
Tap **Close…**

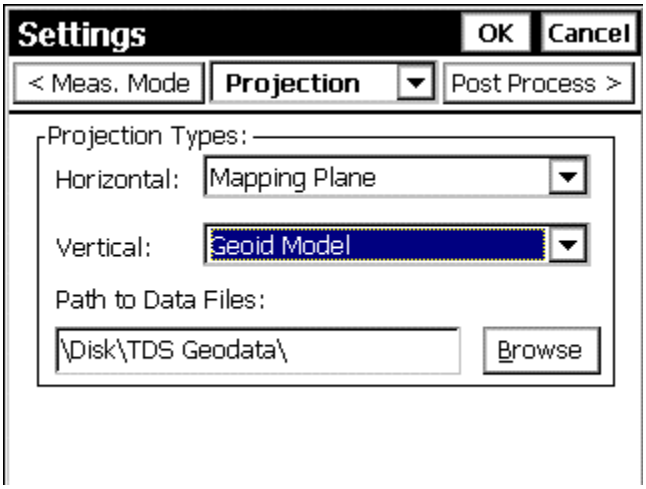
The Localization Calculator is also useful to re-enter Solved Localizations. An example of this may be working one Project 1 for a few days, physically move to Project 2 for a few days and then return to Project 1. If you documented the Solved & Accepted Localization from Project 1, these parameters can be manually re-entered and SET.
After manually re-entering the parameters through the Localization Calculator, Perform a Check Control Point to verify the RTK fits the Control – get back to work…

Mapping Plane requires you to know the RTK Base stations position relative to the WGS84 reference ellipsoid. With the Mapping Plane method set-up the RTK Base antenna on a known control point. The Survey Pro CE program will associate the selected point's Northing, Easting, and Elevations to the known Horizontal and Vertical projection for the selected mapping system

If the RTK Base coordinates are expressed in a known coordinate system, NAD83 Virginia North, meters for example, we automatically know the reciprocal WGS84 Latitude and Longitude position. The Survey Pro CE program uses the known Scale Factor and Rotation angle to transform the data back and fourth.

With the Mapping Plane method for RTK surveys, we broadcast the known position of the RTK Base station and utilize the known / published rotation parameters so the RTK Rover can work and display data in the known coordinate system. There is no requirement to visit control points with the RTK Rover and perform the Localization. Everything is based upon the known quantities at the RTK Base station. However, it is highly recommended you perform a "Check Control-Point" procedure to validate the RTK coordinate against the known values before continuing the survey, this procedure is similar to "**Checking your Back sight".**

To use the TDS Mapping Plane method select:



Screen capture from Mapping Plane

Vertical: Localization, Geoid Model, Ellipsoid Height

The Survey Pro CE software can also work with known Vertical Projections. Typically, we introduce Geoid Modeling functions to improve RTK derived orthometric elevations on the survey project. Horizontal map projections allow you to obtain accurate State Plane and UTM grid coordinates without the need for Localization. Geoid Modeling allows you to measure true elevations based upon mean Sea Level rather than Ellipsoid Heights, which are based on the WGS84 Reference Ellipsoid. When you combine these features, you are no longer required to Localize. All you need to know is the Base Station's horizontal and vertical position.

The TDS Survey Link software supports creation of a Geoid Sub-Grid suitable for use in the field with the Ranger data collector. The Geoid model data can be computed in Geoid96, EGM96 or the newest Geoid Model – Geoid 99.

See the Technical Support Notes on how to creating a Geoid Sub-Grid using TDS Survey Link software.

In the **Job | Settings | Projection | Vertical:** menu…
Select **Geoid Height.**

The **Geoid Height** selection allows users of Survey Pro CE software to use a high resolution Geoid model to determine accurate RTK derived orthometric elevations on the project site. The Geoid99 model can produce accurate orthometric (MSL) elevations on the project. It helps this routine know the orthometric (MSL) elevation at the RTK Base point.

The **Localization** selection allows users of Survey Pro CE to use local known elevations to calibrate to the Vertical component of the RTK survey. In construction stake out surveys, knowing the orthometric (MSL) elevations on the project site are crucial. The vertical localization method allows to the RTK surveyor to calibrate to known elevations on the project site. Three Vertical control points are recommended for this approach, (three points define the plane), a fourth point will generate residuals on the vertical control. The resulting RTK derived orthometric (MSL) elevations will be accurate relative to the vertical localization.

To select Localization method:

In the **Job | Settings | Projection | Vertical menu… Select Localization.**

If the project does not require orthometric (MSL) elevations, the **Ellipsoid Height** selection allows users of the Survey Pro CE to work strictly on the WGS84 Ellipsoidal height model surface. The RTK survey will then be considered 2-D, Northing and Easting coordinates only. The resulting elevations will be Ellipsoid Height, relative to the RTK Base station.

To select Ellipsoid Heights:
In the **Job | Settings | Projection | Vertical menu… Select Ellipsoid Heights.**

Setting up the RTK Base Station Equipment

Pick a suitable location for the RTK Base station equipment. Make sure you have a clear view of the sky and clear line of sight for the Pacific Crest data link.

Set-up the tripod/tribrach combination, or the 2-meter Fixed Height tripod precisely over the survey control point.

Connect the GPS antenna cable to the Base GPS antenna and back panel of the RTK Base GPS receiver.

Place the Base GPS antenna and radio's transmit antenna mast / co-location bar on top of the tripod, or 2-meter fixed height tripod. Connect the UHF radio antenna cable's Type-N connector to the UHF antenna mount, connect the female BNC jack to the Pacific Crest PDL Base radio's BNC male connector post.

Using the supplied GPS receiver to PDL Base Radio cable.
Connect the RTK Base receiver (Port B) and the Pacific Crest PDL radio together.

Connect the power supply (Battery) to the Pacific Crest PDL Base radio.

Connect the RS-232 cable (PC Download) cable to (Port A) on the back panel of the RTK Base receiver, connect the DB-9 end of this same cable to the TDS Ranger.

Make sure all required cables are properly connected, turn on the power for the Base RTK receiver and the Pacific Crest PDL Base radio.

Setting up the RTK Rover Equipment

In this example, the Z-Xtreme RTK Rover features the internal PDL – RXO radio modem with the "All-on-the-Pole" configurartion.

Set up the RTK Rover pole, mount the GPS antenna, connect the antenna cable to the Z-Xtreme and the GPS antenna. Connect the RX radio antenna cable to the Radio port on the receiver's back panel.

Attach the RTK Rover pole accessories, these include the Heads-Up level vile, data collector bracket, compass vile.

Connect the TDS Ranger to the Z-Xtreme RTK Rover.

Turn on the power for the Z-Xtreme RTK Rover.

During the RTK Demo…

The RTK Rover radio frequency must set to the same radio frequency the Base Radio, The **"Receive Radio"** LED should be blinking green every other second. This is a visual indication, the radio system is functioning properly.

If the RTK Rover's "Receive Radio" LED is not blinking green, confirm the RTK Base radio is actually broadcasting RTK corrections. The PDL Radio's red POWER indicator LED should be illuminated, the red TX LED should be blinking, indicating the radio is broadcasting data. The PDL Base radio may be powered OFF. If so, turn the Base PDL Radio ON. Watch for the blinking green RX LED on the RTK Rover.

If this simple remedy does not work, the PDL Base radio and Internal PDL-RXO radios may not be on the same frequency. View the SET channel on the PDL Base radio by briefly pressing the Channel button on the front panel of the PDL Base radio. The SET channel on the Internal PDL-RXO radio must be viewed via the TDS Ranger menu:

Survey | Rover Setup | Settings | Receiver Settings | Rover Radio menu…

Confirm the Internal PDL-RXO radio channel matches the PDL Base radio channel.

Toggle the PDL Base radio on low-power, increase the spatial distance between the RTK Rover and the RTK Base station. If the PDL Base radio is TX in 35-watt (High Power) mode, you may be broadcasting right over the top of the RTK Rover. You may be over-driving the RTK Rover radio.

The equipment is set-up, your ready to start the RTK demo…