JAVAD

TRIUMPH-LS

Start ! Lock Interference Screen PrtScn A/V Battery Stop
Warnings   Help

3G   CPU   3   LS   15:24

Collect   Stake   Coord. Sys   Localize

CoGo   Setup   Points   Files

Tags & Codes   Support

Thursday, June 26, 2014   10:54:39

Set Up   Collect   Stake   On/Off   Mute   Light   ← User defined →

U1   U2   U3   U4

USERS GUIDE TO THE TRIUMPH-LS

Version 20160930

E

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www.javad.com

Introduction

Congratulations and thank you for purchasing the TRIUMPH-LS, the next generation and revolutionary innovation in high precision GNSS surveying from Javad GNSS. The TRIUMPH-LS contains the most advanced set of GNSS hardware and

TRIUMPH-LS

engineered technologies with the TRIUMPH 2 chip at the heart of it all. Refer to this USERS GUIDE while familiarizing yourself with the TRIUMPH-LS and be sure to check for digital updates to this document on the website.

What's in the box?
Item Check List

Before starting, check that all of the following items have been included with your TRIUMPH-LS. If anything is missing, contact your dealer as soon as possible.

Depending on the options that you've previously configured with your purchase, your RTK kit may contain either one, or the other of the two antennas listed here:

UHF antenna 400-470 MHz, 2.5dB, RT Angle, SMA (optional, if UHF module is installed)

OR

Antenna 868-928 MHz, 5dBi, Swivel, SMA (optional, if FH915 module is installed)

8GB microSD (w/ adapter)

Tweezers

USB Cable, A/microB

1/4" to 5/8" Adapter

SMA-TNC Adapter

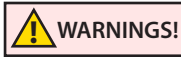**Ext Power/Charger**

AC Power Cable

Power Cable

AC Power Adapter*

Charging kit
(shown assembled)

* Plug shown is for USA

Conventions

This manual uses the following icons, symbols and styles:

⚠️ **WARNINGS!**   Cautionary alerts to prevent damage to equipment or loss of data
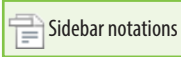
📑 Sidebar notations   Supplemental information

www.javad.com   Indicates an active link in the PDF

Localization (p. 192)   Active Cross-reference link in the PDF

*See (*p. 5*) TCP Client*   Branched reference

The ***Quick Start Guide to the TRIUMPH-LS*** should be read and studied before reading this ***User Guide to the TRIUMPH-LS***. This manual is intended to cover topics not covered in the *Quick Start Guide to the TRIUMPH-LS*.

This manual is also being rapidly released for new and existing RTK surveyors that have purchased the TRIUMPH-LS eager to get up to speed and at work in the field. Accordingly, it is being released in stages of development as new features get added and others further refined.

More detailed information on many subjects pertaining to the use of the TRIUMPH-LS can be found in the back of this guide including trouble shooting and where to find help.

Charging the TRIUMPH-LS

When the TRIUMPH-LS is turned off and charging, the four LEDs will keep you apprised of its charging progress for both of the individual battery packs as illustrated below.
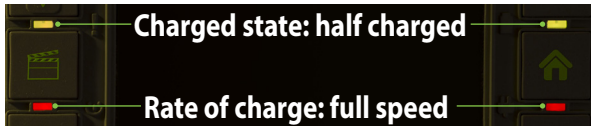
As noted and shown below, all (4) green LEDs first appear at 90%. Interrupting the charging and then resuming will have no effect until the discharged state is less than 8 volts. To reach maximum charge, allow an additional 20 minutes once all green is seen.

Battery Pack-1 / **Battery Pack-2**

Charged state: almost empty

Rate of charge: full speed
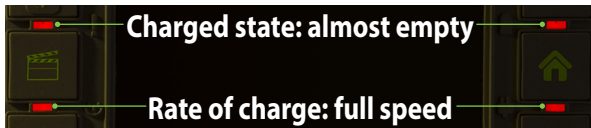
When the **TRIUMPH-LS** is powered off and is being charged, the top (2) LEDs indicate the state of the (2) charged battery packs and the bottom (2) LEDs indicate the rate of charge. If the bottom LEDs are blinking yellow or red, it indicates that temperatures are over 40° C and that charging will resume once cooled. A complete charge takes about 5 hours when LS is cool.

Charged state: half charged

Rate of charge: full speed

Charged state: half charged

Half speed used to help get temp under 40° C
half speed : Rate : full speed

Charged state: fully charged
Green light will first appear at about 90% complete
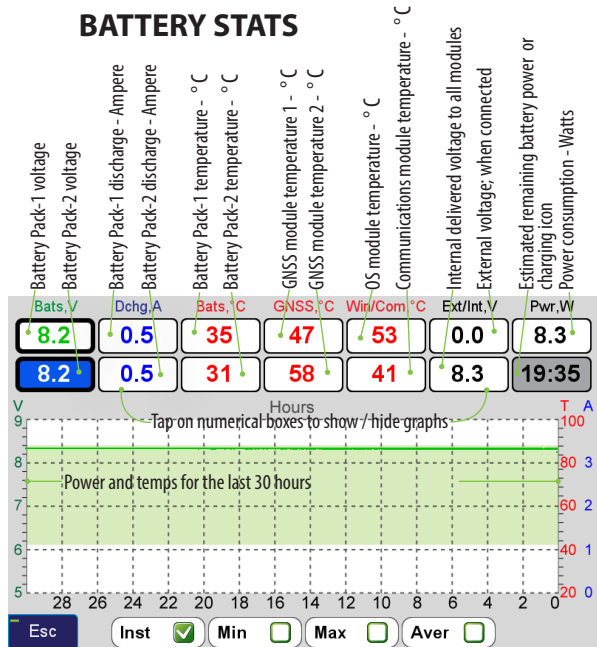
Rate of charge: stopped

Monitoring the Temperatures and Batteries

When the TRIUMPH-LS is turned on and not charging, the upper right and lower left LEDs give you a quick indication as to the status of the two battery packs. For more detailed information regarding the status of the two battery packs as well as other internal conditions and behaviors during the previous 30 hours, tap on the battery icon or press the Battery hardware key.

BATTERY STATS

Bats, V		Dchg, A		Bats, °C		GNSS, °C		Win/Com °C		Ext/Int, V	Pwr, W
8.2		0.5		35		47		53		0.0	8.3
8.2		0.5		31		58		41		8.3	19:35

Column headers (top to bottom labels):
- Battery Pack-1 voltage
- Battery Pack-2 voltage
- Battery Pack-1 discharge - Ampere
- Battery Pack-2 discharge - Ampere
- Battery Pack-1 temperature - °C
- Battery Pack-2 temperature - °C
- GNSS module temperature 1 - °C
- GNSS module temperature 2 - °C
- OS module temperature - °C
- Communications module temperature - °C
- Internal delivered voltage to all modules
- External voltage; when connected
- Estimated remaining battery power or charging icon
- Power consumption - Watts

Tap on numerical boxes to show / hide graphs

Power and temps for the last 30 hours

Hours: 28 26 24 22 20 18 16 14 12 10 8 6 4 2 0

V: 9, 8, 7, 6, 5   T: 100, 80, 60, 40, 20   A: 3, 2, 1, 0

Esc

Inst ☑ Min ☐ Max ☐ Aver ☐

Check for Instantaneous, Minimum, Maximum and Average graphs

Introduction

Data Storage

In addition to the internal solid state data storage on the TRIUMPH-LS, you will also want to use the provided microSD card as a backup for your field data. Updates to the system will automatically use the microSD card as a backup if present.

Mobile Telecommunications

If you work in areas with good cell coverage that also happen to have Real Time Network (RTN) services from area base stations, you may wish to purchase a data plan through your local telecommunications provider. Take care to properly orient the SIM card as it will only work when it's been oriented as shown below.

microSD

Use the provided high-speed microSD card. Replace with Class 10 or better

Card Installation

Use the provided tweezers to install and remove these tiny devices and to help mitigate oily fingerprints on the contacts

SIM

While handling, take care not to damage the circuitry printed on the underside of the card

Align the card exactly as it is shown on the rubber port cover

Insert the card with the leading edge exactly as shown on the rubber port cover

Fully insert the card into the recess

These are Push-Push style card slots; to remove the card, fully insert the card again

WARNINGS!

Some warnings that are displayed may be expected; for example, in the office with the TRIUMPH-LS powered on and near your computer you may receive a warning about

High Interference!, or when you first receive your instrument, there may be a warning that level and compass calibrations are necessary. Pay attention to the messages, even if they're expected. Did moving the receiver away from the computer eliminate the **High Interference!** warning?
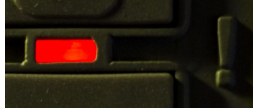
The TRIUMPH-LS is a remarkably sensitive instrument to your invisible environment and can help you stay alert to problems as soon as they arise. Listen to it.
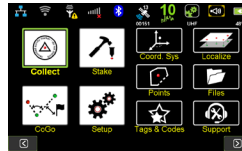
Sun Screens

Sun screens were developed to improve screen visibility when in very strong direct sunlight. These alternative high contrast screens are available anytime with a push of a button.
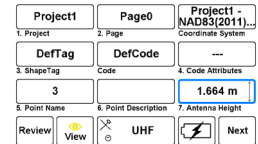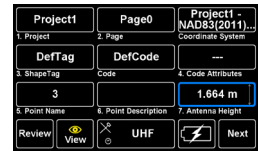
Sun Screen₁

Sun Screen₂

Not every screen has three alternate contrast settings though you'll still need to cycle through them three times to return to the first screen setting. The Home screen is such an example.

Sun Screen₃

Attaching an External Radio Antenna

When purchased with an internal UHF or FH915 radio, the TRIUMPH-LS comes with an external radio antenna. Maintaining a *Link Quality* (LQ) at or near 100% is crucial for good performance with the RTK system.

When doing RTK surveying, the reception of your base station's corrections by the rover can be enhanced using an external UHF antenna. Begin by attaching the external antenna. In this image, we see the 2.5 dB gain antenna attached to the TRIUMPH-LS.

For the purposes of this discussion it is assumed that you have already attached the external UHF antenna, are in the field, the LS is powered on, that it's setup as the RTK rover, the RTK base is on and the UHF radio is broadcasting corrections.

Even when the external UHF antenna is attached, the default internal UHF antenna will be used until you configure the LS to behave otherwise. From the Home screen tap on the UHF icon to bring up the UHF status screen. Notice the Received Signal Strength Indicator's (RSSI) value before proceeding to tap Configuration, select External Antenna and tap OK.

Anytime the UHF communications are interrupted; such as in this example, it will take a few seconds up to a minute or so for them to be reestablished.

OK 100%

The Correction Status button shown in the Stake and Collect Action screens. When green, corrections are being received. The bars above the icon graphically represent the RSSI while the link quality is displayed below the icon. A link quality of 100% indicates that all corrections are being received. Tap to open the UHF Status screen.

UHF

UHF			
Region	ALL	Data RX	RTCM 3.0
Output Power	--	Sent	--
Frequency	451.80000 MHz	Station ID	0
Protocol	JAVAD	Distance	4.39 ft
Modulation	D16QAM	LQ, Delay	100.0%, 0 sec
Ch. Bandwidth	12.5 KHz	Data link latency	0.4 sec
FEC, Scrambling	On, 255	Received, Lost	472(99.6%), 2
Link Rate	19200 bps		
Call Sign	--		
Antenna	Internal		
RSSI	Excellent(-32 dBm)		
BER	0E-0		
UHF State	ready, none		

Esc   Configuration >

The UHF Status Screen

UHF Configuration

Antenna Input

Internal ○   External ●

Power Management

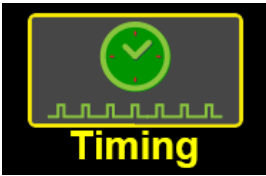Power On ●   Power Off ○

Spectrum Analysis

Scan/Manage Frequency List

Scan UHF Bands   Scan Manual
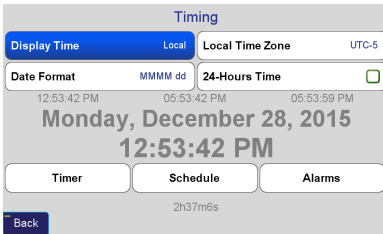
Radio ID: 28   FCC ID: WJ4LMR400

Cancel   OK

Timing

Tap on this icon to bring up the dialog for setting how time gets displayed in J-Field. Alternatively, you can bring up these settings by tapping on the date and time that is displayed at the bottom of the Home screens.

Time display is an example of a *global setting*. The default global setting is UTC, but once you've tapped on the Local Time Zone field, set it to your local time; e.g., UTC-4 for Eastern Daylight, J-Field will recall that setting regardless of your Setup or Project.

Aside from knowing at a glance what time of day it is, many files that J-Field writes are time-stamped including screenshots, photos, and audio files which can be very helpful during the job and well afterwards.

You can also schedule audible alarms for yourself, but don't forget to turn the sounds back on if you've set the volume on mute.

It is also possible to schedule your survey to begin at a fixed moment in time; for example, this would be handy if you're coordinating multiple static sessions across a large area and wanted them to all begin collecting data at the same time.
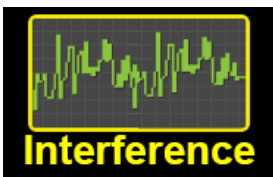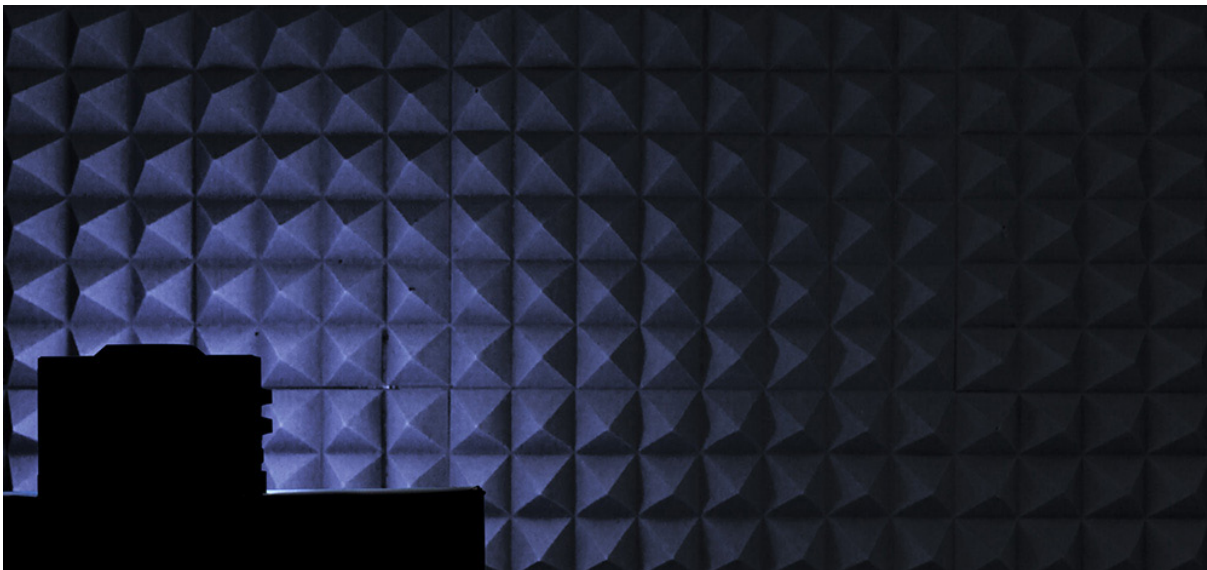
User Defined Buttons

The **U1** through **U4** *User Defined Buttons* can be assigned from *Setup* with the ***Assign U1-U4*** button:
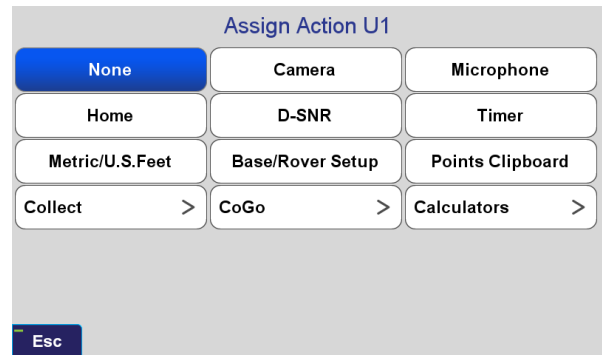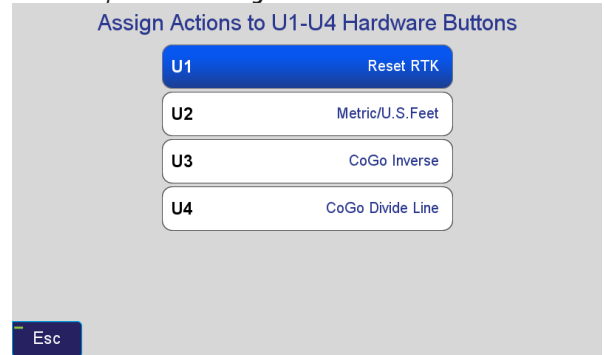
Assign Action U1 Screen - Available Options

UHF Interference

There are two separate spectrum analyzers in the TRIUMPH-LS. The following brief discussion will focus on the analyzer that scans all GNSS bands. The other scanner that will be discussed elsewhere in this manual deals with UHF bands.

We live in an increasingly noisy environment and without special equipment, this type of noise; electromagnetic interference, can largely go undetected - even when you're getting fixed positions! The sophisticated hardware and software containe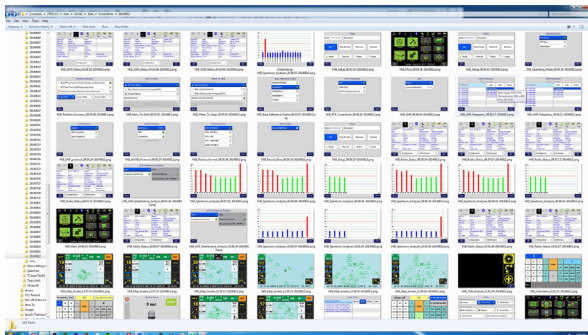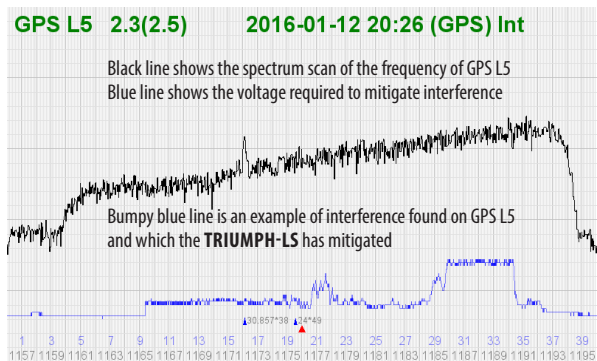d in your TRIUMPH-LS is not only capable of detecting, documenting and reporting the interfering signals across all of the GNSS bands, it is designed to mitigate their debilitating effects up to about 20 dB in strength. If the interference is too high, however, no mitigation effort can improve the receiver's performance when in such noisy places.

For the most part, the surveyor need not worry about interference with satellite signals as the TRIUMPH-LS is doing its duty for you, but there may be instances when your results begin falling beyond normal expectations. Being able to identify those physical locations as well as the magnitude of such interferences will aid tremendously in your evaluation of the quality of the data that you're collecting and the health of the receiver. When

such data is collected across large regions from many users, it could go a long way towards ensuring a cleaner environment and the safeguarding of our GNSS bands.

To filter its own harmonics which are generated from internal circuitries, individually each TRIUMPH-LS's Internal GNSS antenna is calibrated inside a very quiet place; an anechoic chamber. The unique calibration profile for your receiver is also stored on the Javad GNSS server as backup. Should you ever need to, your receiver's internal antenna calibration profile can be restored using an Internet connection.

GPS L5 2.3(2.5)   2016-01-12 20:26 (GPS) Int

Black line shows the spectrum scan of the frequency of GPS L5
Blue line shows the voltage required to mitigate interference

Bumpy blue line is an example of interference found on GPS L5
and which the **TRIUMPH-LS** has mitigated

Print Screen

Screen captures are easily facilitated with press of a single key devoted to this purpose allowing you to conveniently document your activity whenever you want. These screen captures provide and preserve a wealth of information for later reference and for sharing with others.
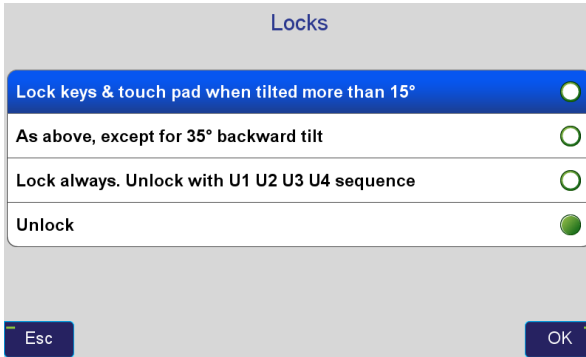
To enable easy retrieval, J-Field helps you keep track of screenshots by first, a clear file naming policy. Each screen's filename has a 3-character prefix which is the name of the receiver, it is then followed by the name of that screen and finally the suffix is its date stamp.

File storage is also handled very logically with screenshot images stored under the parent folder; ScreenShots and then grouped by day.

Introduction

Locks

Prevent inadvertent taps and key presses use this feature to define when and how they get locked.

Locks

Lock keys & touch pad when tilted more than 15°	⦿
As above, except for 35° backward tilt	○
Lock always. Unlock with U1 U2 U3 U4 sequence	○
Unlock	⦿

‾ Esc   OK ⁺

Mute

The TRIUMPH-LS makes various sounds all intended to keep you apprised as to the status of many different things and to help you interact with it.

There may be occasions when the noises are unwanted for example, long unattended static sessions or when making an audio note to self.

One thing to be mindful of is the relationship of the Mute setting (on or off) with a given *General Group* profile. In other words, the Mute button is not a global setting. It is specific to that particular profile and can be accordingly recalled anytime that the profile gets recalled.
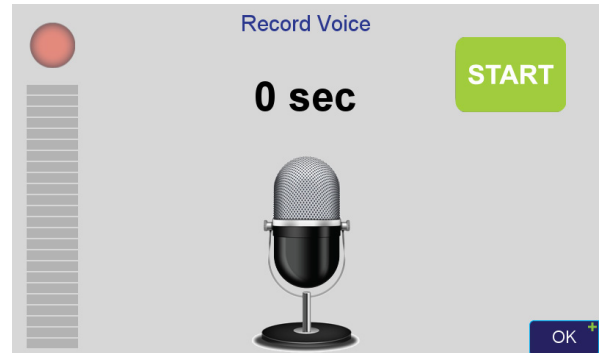
Record Voice

Save time in the field describing the feature with the voice recorder with just a tap from *Home* screen. Alternatively, instruct J-Field to automatically begin recording immediately with each location or just on select selected occasions from one of the many user configured white boxes on the Action screen.

You can immediately play back the audio notes with a couple of taps. From Home screen, Files, then if collected with points at the same time, tap the top row Audio Files to pick. You may want to mute your TRIUMPH-LS if you turn on auto record.

Record Voice

0 sec

START

OK ⁺

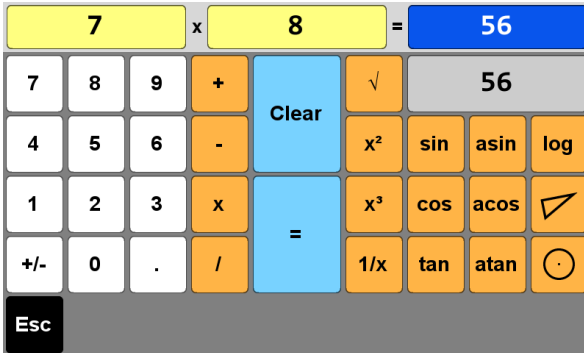| Files	
Collected With Points	Collected By User
❌ Delete Files >	
🎞 Full Backup and Restore >	
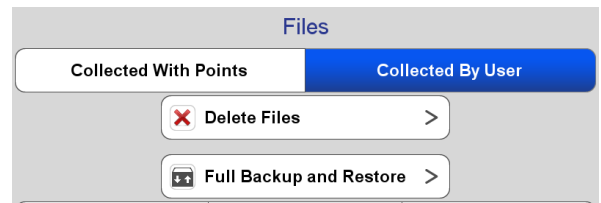
Calculators

Access J-Field's Calculators from Home screen. The Simple Calculator is able to quickly calculate the perimeter and area for two simple figures, a circle and a triangle. The triangle routine has the user enter lengths of three sides. Circumference and area of circles are determined by the user's entry of a radius value.

The operands *and* results can both be seen in the top row of yellow boxes.
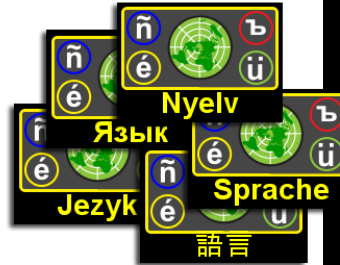
7			x	8		=	56		
7	8	9	+	Clear	√		56		
4	5	6	-		x²	sin	asin	log	
1	2	3	x	=	x³	cos	acos	◁	
+/-	0	.	/		1/x	tan	atan	⊙	
Esc									

Flashlight

The TRIUMPH-LS has a fantastic built-in LED flashlight on its bottom surface.

Press the Light key any time that the TRIUMPH-LS is turned on in operation.

Note that the flashlight will only work when J-Field is up and running.

Language

The TRIUMPH-LS has largely been developed for English speaking surveyors; however, plans call for J-Field to be translated into other languages.

Introduction
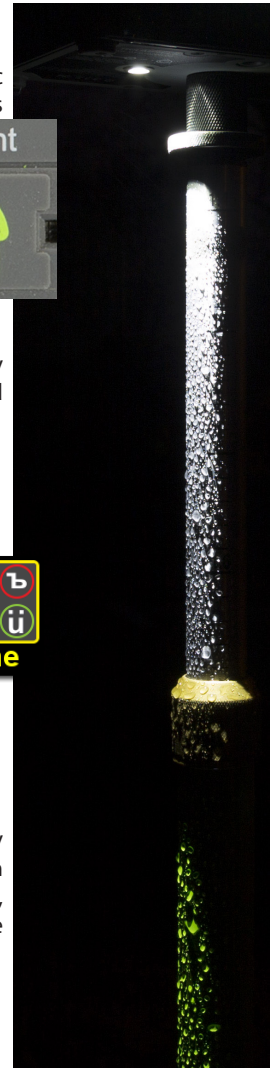
Calendar

Project files on the TRIUMPH-LS are represented in a chronological overview using a scrollable calendar.

You may elect to utilize the default Project naming schema out of ease of use and convenience and then later, rename it to your specific job filing system. Other aspects of the project can be examined once you've chosen and opened an existing project.

Camera

To activate either camera; forward or downward, tap on this icon found on Home screen to take photographs using one of the two cameras found on the TRIUMPH-LS. Alternatively, you can configure one of the *User Defined Boxes* available for the user's convenience on the *Stake* or *Collect Action* screens or via a user defined key; e.g., U1.
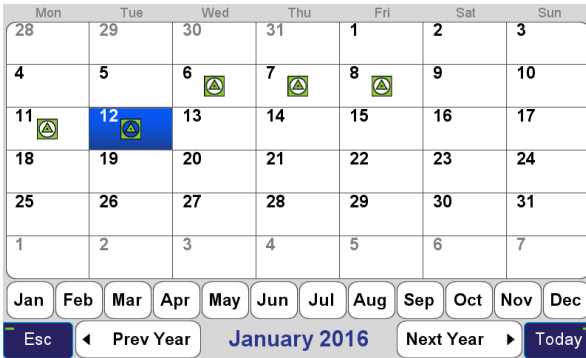
Downward facing camera is near the edge closest to the display screen

Forward facing camera is near the bottom edge between the SIM ports

File storage is handled logically with images stored under the parent folder; photos and then grouped by day.

GNSS Interference

Chart 1

-15	-12	-9	-6	-3	0	3	6

GPS L1: -1.1 (6.1)

GPS L2: 0.6 (3.2)

GLN L1: 0.6 (4.1)

GLN L2: 1.8 (4.1)
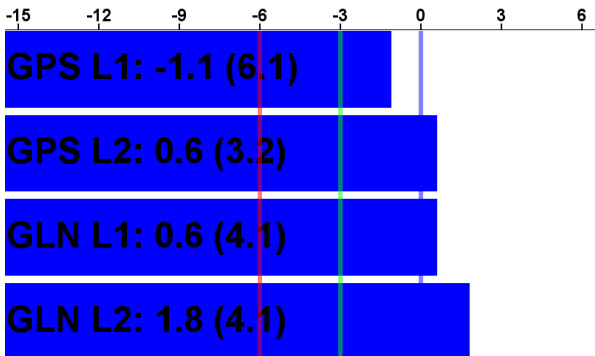
The D-SNR screen which tells you at a glance the general status of satellite signals in the (4) GNSS Bands used in RTK solutions

Blue shows nominal GNSS signal strength interference less than -3 db of the expected signal strength. In this example, the setting was in a fairly open urban area with mostly open sky above but with buildings, trees and overhead utilities within the surrounding immediate area.

Chart 2

-15	-12	-9	-6	-3	0	3	6

GPS L1: -5.8 (6.0)

GPS L2: -1.0 (4.0)

GLN L1: -10.2 (4.0)

GLN L2: -3.2 (4.0)
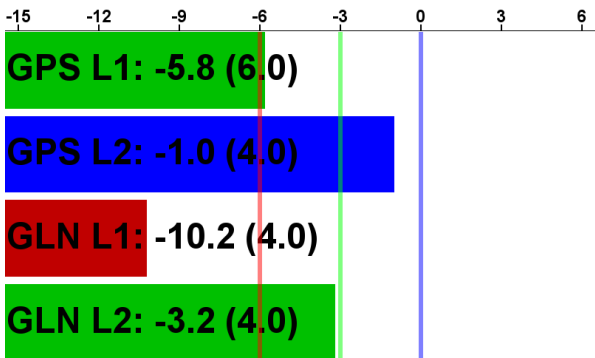
Green values indicate an area with interference greater than -3 db up to -6 db.

Red values indicate an area with interference greater than -6 db and though this interference level is high and will often be accompanied with the warning LED being lit. Its still possible that you may be able to obtain positions in such difficult environments; however, you'll likely need to remain in that location for longer periods of time.

Introduction

Field Setup
Setting Up the UHF Radio

Find your control point

Before you set up your radio, find your existing control or decide where your control station will be. For this discussion, it is presumed that you have previously done your recon, have found the optimal location for your RTK Base; i.e., as much sky as possible, as your base's corrections will otherwise

be curtailed if it's unable to receive signals from the same Space Vehicles (SVs)that your RTK Rover is able receive. Ideally, your base should be able to see all healthy SVs.

Set up your radio

Knowing where your RTK base is going to be set up to maximize satellite reception is the first step in setting up your radio.

Other criteria for your radio's location will be predicated on 1) mitigating the electromagnetic effects of the radio's transmissions on the GNSS receiver, 2) the practicable range of the Bluetooth connection between the RTK base and the radio and lastly 3) the higher the antenna, the further the line of sight distances will be allowed which is one element effecting the range of the rover while still receiving corrections.

With regard to the first item, I asked Javad *how close is too close* when it comes to setting up the radio and here is his response:

> Hello Kelly,
>
> There is no hard rule. The effect depends on the power of the transmitter. Vertical or horizontal separation is the same. The further you are the effect is less. For 1 watt stay away a few feet. For 45 watt, stay away 20 feet. The further the better.
>
> Regards,
>
> Javad

In regards to the second point, I asked Vladimir Zhukov this question: "*What is the most practicable range of the communication between the T2 and the HPT404BT (shown in this example) afforded through Bluetooth ?*" and his answer:

> Hi Kelly,
>
> Up to 50 ft (~15 m) is the practicable range of the communication between TRIUMPH-2 and HPT401BT/HPT404BT.
>
> Actually in the field they keep reliable connection up to 130 ft (~40 m).
>
> So, > 130 ft is too far.
>
> Regards,
>
> Vlad

The last bit, the height or elevation of the antenna has two things relevant for you to consider; 1) power and 2) viewshed. If you have the base RTK kit that comes with (2) 6' SAE extension cords and the battery kit power cable , this comfortably adds another 5' or so plus the 1' pigtail. That's about a maximum of 18' between the 12-volt battery and the radio that's permissible.

The viewshed may take some study beforehand. An excellent program that may already be in the surveyor's tool kit (or should be) is *Global Mapper* which allows the user to easily determine line of sight from your DTM, LiDAR, or other elevation data; viewshed even has its own icon!.

Finally, if you don't have an FCC license for your radio, you really need to read Mark Silver's excellent article that appeared in the January 2014 issue of *The American Surveyor*: "**Sailing with the Pirate Surveyors**," which you can read here: **http://www.amerisurv.com/PDF/TheAmericanSurveyor_Silver-PirateSurveyors_Jan2014.pdf**

Once the radio is all setup - and make sure the antenna is connected to the radio - turn on the radio by plugging it into the battery cable if you're using the HPT404BT or press the power button on the radio if you're using the HPT401BT. Refer to *Appendix A* for an explanation of the blinking LED lights on the radio.

UHF Antenna Cable TNC/Pole Mount, 12 ft., Over-M (14-578117-06) standard 5/8" x 11 threads

Use whatever gear you have on hand to get the antenna up in the air. Shown here is a half section of GPS pole mounted on a tribrach adaper

⚠️ MAKE SURE THE ANTENNA IS ON THE RADIO BEFORE POWERING THE RADIO!!!

1-watt radio HPT401BT with standard mounting bracket attached clipped onto the tripod leg.

This radio has an integral battery and no other power source is needed in the field for the HPT401BT.

If there is no data for transmission, for example when charging the HPT401BT's attached battery, the antenna need not be on the HPT401BT; however, if the TRIUMPH-2 was on and nearby, its Bluetooth connection will continue to send transmission of corrections, so it's safest to keep the antenna connected to the radio.

Shown in the photo on the left, is the HPT401BT with its Standard Mounting bracket that comes with the radio.

Shown in the photo below, is the HPT404BT with its Standard Mounting bracket that comes with that radio.

Both brackets conveniently clip onto the tripod leg clamp assembly.

Standard bracket

Setting Up the RTK Base

Previously mentioned at the beginning of this discussion was setting up your RTK Base on a known coordinated position. It's also worth noting that the RTK Base could alternatively be up on an autonomous position with all RTK collected points adjusted subsequent to post processing; a subject not included in this article.

Once the base is set up, power on the TRIUMPH-2 and if recording data, be sure to press the record button.

Refer to *Appendix A* for an explanation of the Blinking LED lights on the TRIUMPH-2.

A Note About Antenna Heights

Antenna Heights are measured to the bottom surface of the receiver. Slant heights are measures from the tip of the pole on the ground to the arrow on the side of the receiver. When using the 1/4"x20 to 5/8"x11 adapter, its height, 0.025 m, will need to be included in the antenna height measurement.

This is a typical prism pole. Notice the brass adjustment threads are unscrewed so that the center of his prism corresponds with the pole graduation.

The prism height here is 5.00' and the graduation on his pole is also reading 5.00'. The top surface of the pole is less than 5.00'.

This is the TRIUMPH-LS on the same prism pole. The brass adjustment is unchanged, however the prism nodal point is not the same as the TRIUMPH-LS ARP (even with the 25mm adapter).

Here you can see that the measured height is about 4.86 feet instead of the 5.00 feet the pole is reading. Subtracting actual height of 4.86' from the measured height of 5.00' results in antenna height offset of -0.14' that is needed to correct the graduation readings.

Internal Antenna Offsets

There may be scenarios where the actual height of the top surface of the Rover or Base pole may not match its height graduation readings. By subtracting the difference between the actual height and the graduation reading and entering them into the *Vertical Height Offset* field found in the Antenna Height entry screens, you'll be able to correct the readings from graduated poles.
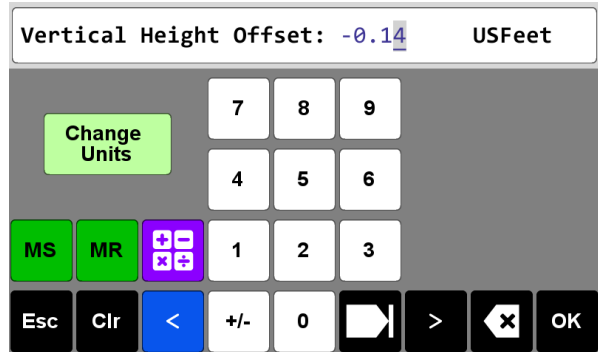
Set Up the RTK Rover

At this point, you should have pretty much everything prepared and all that's left for you to do is get the rover connected to the monopod, turn it on and confirm your communications between the rover and the base.

This is also where the benefits of having an external UHF antenna attached to the TRIUMPH-LS can be seen allowing your signal gain to increase without worry in exceeding your licensed maximum effective radiating power, typically 35 watts ERP.

Having previously attached the TRIUMPH-LS's *external* antenna to the UHF port located on the left side (as viewed facing the screen display), proceed to configure the external antenna. Otherwise, the TRIUMPH-LS's *internal* UHF antenna will ably perform in receiving corrections.

From the Home screen, tap on the UHF icon to bring up the Radio Status screen. Look for your received signal strength indicator (RSSI) value. It is a measurement of the power

present in a received radio signal. These values take several seconds to be populated in the table, so be patient. You should also see your Received, Lost values being updated.

To switch configuration between Internal and External UHF antennas, from the *Radio Status* screen tap on *Configuration*, tap chosen antenna, then tap OK; alternatively, press the + key.
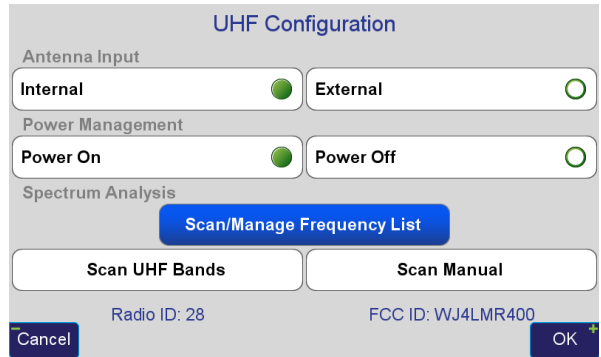
The re-initiated radio communications will be seen in the UHF Radio Status screen; i.e., their respective RSSI and Received, Loss values, and as noted earlier will take several seconds to be populated in the table, so be patient.

Most generally, you will benefit from increased Radio Signal Strength Indications whenever the external UHF antenna has been attached and configured; however, there may be certain environmental circumstances where there can be little or no increase as shown in the examples on the right. Before deciding upon the day's UHF frequency for broadcasting corrections, or later if you find reason to suspect performance degradations, bring up the Radio Status screen and tap on Interference. Here you will be able

to select from two different methods for scanning local UHF interference.

For most day to day purposes, check the Frequency List Scanner and then tap Scan. This method then will focus exclusively on those frequencies that you've entered from your FCC license (or the default values from the factory settings). This is a quick and robust analysis tool to help you choose what channels to avoid and the channels to use for your own needs.

The channel that your rover is tuned to will be displayed in red. If your radio is already on and broadcasting nearby, you'll see its graphical RSSI. Note that when returning to the UHF Radio Status screen the communications will once again be re-initiated so expect a little delay of several seconds before Received, Lost, RSSI and the other dynamic values become updated.

UHF			
Region	ALL	Data RX	RTCM 3.0
Output Power	--	Sent	--
Frequency	451.80000 MHz	Station ID	N/A
Protocol	JAVAD	Distance	N/A, no base coord.
Modulation	D16QAM	LQ, Delay	100.0%, 0 sec
Ch. Bandwidth	12.5 KHz	Data link latency	4.7 sec
FEC, Scrambling	On, 255	Received, Lost	994(99.8%), 2
Link Rate	19200 bps		
Call Sign	--		
Antenna	Internal		
RSSI	Excellent(-25 dBm)		
BER	0E-0		
UHF State	ready, none		

Esc

Configuration >

Back

>>
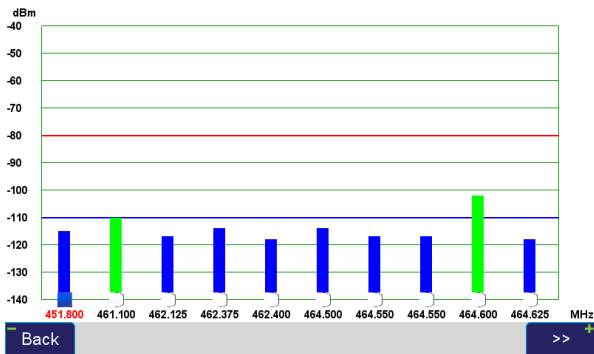
How To
Connect With 3G

SIM Card Configuration

Depending on the options that you purchased with your TRIUMPH-LS, you may or may not have received an RTK Base receiver and UHF radio. Or, there may simply be occasions when working in an area with good cell coverage and available Real Time Network (RTN) services you'll prefer to survey using a local Virtual Reference Station (VRS) or get streaming corrections from a local CORS instead of setting up an RTK Base. Either way, you'll first need to obtain a Subscriber Identity Module (SIM) card from a mobile communications provider. This document does not in any way endorse one such provider over another, so check with other RTK surveyors in your region and what will work best for your locality and general cell coverage.

If you've never gotten a cell phone before, you'll be happy to know that you still don't have to; however, you will need to purchase a data plan (no voice communications). Most providers offer them but you'll need to be specific

in your request for only their data plan. So long as you are only receiving streaming RTK data corrections, you should be able to get by with the cheapest plan. Currently, one example is offered by AT&T at $15/month for 250 MB. If you do decide to go this route, be sure to use your WiFi connection for J-Field updates and not your SIM connection.

Your SIM card should be installed before proceeding. If you haven't already done so, insert your SIM card as outlined earlier ().

Disable the Wifi Adapter only if you are presently wirelessly connected to your local WiFi network. Tap on the WiFi icon along the top of Home screen, then Configuration and finally, tap the WiFi OFF. The reason for doing this is because of the hierarchy of connections afforded the TRIUMPH-LS and in the order as shown across the top of the Home screens. This means that a WiFi connection maintained within its range of coverage will be utilized before the 3G connection should both means of communication be enabled at the same time.

WiFi				
Access Point	M25	RTN Status	CONNECTED
MAC Address	20-E5-2A-16-76-36	APN	ODOT
Auth. Mode	WPA2-PSK	APN Protocol	NTRIP Client
Signal Quality	Excellent (-45 dBm)	IP Address	156.63.133.115
Wlan State	Connected	TCP Port	2101
IP Address	192.168.1.6	Mountpoint	ODOT_VRS_RTCM3
Subnet Mask	255.255.255.0	GGA	Enabled
Default Gateway	192.168.1.1	Data	RTCM 3.0
DHCP Server	192.168.1.1	St. ID, Distance	N/A, N/A, no base coord.
Lease Obtained	1/12/2016, 16 : 56 : 21	LQ, Delay	--, --
Lease Expires	1/13/2016, 16 : 56 : 21	Data link latency	0.3 sec
DNS1		Received, Lost	--, 0
DNS2		Internet access	YES

Esc	Network >	RTN >	Configuration >

WiFi Adapter	
Auto IP (DHCP) ☑	DNS 1 0.0.0.0
IP	DNS 2 0.0.0.0
Net Mask	Adapter Name: TIWLNAPI1
Gateway	MAC Address: 00-18-D7-50-92-80
Power Managment	
WiFi ON ○	WiFi OFF ●
FCC ID: TFB-TIWL1-01	
Cancel	OK

As previously mentioned, to ensure that your J-Field updates don't gobble up your data plan's monthly allocation, you may already have turned your SIM card off.

Gray bars will be seen in the top row if the SIM has been disabled. Tap on the 3G/4G icon along the top of the Home screen, then Configuration and finally, tap the 4G LTE Mini Card *ON*. Check the effect of these steps thus far; return to the Home screen. You should see the WiFi icon grayed out and that the 3G icon is showing one or more blue bars on your TRIUMPH-LS.

With blue bars showing in the 3G icon and the 3G status screen also showing signs of life, we can move to the next step in getting your Triumph-LS up and running as an RTK Rover using a cell connection.

When you're done surveying, don't forget to turn off the connection. It may save you some expense. It will also reduce battery consumption.

GSM			
Power	On	RTN Status	CONNECTED
Active Slot	SIM 1	APN	ODOT
SIM Card	READY	APN Protocol	NTRIP Client
Operator	AT&T, 3G	IP Address	156.63.133.115
Network	REGISTERED, -87 dBm	TCP Port	2101
3G Network	REGISTERED	Mountpoint	ODOT_VRS_RTCM3
3G Link	Active	GGA	Enabled
IP Address	10.39.65.131	Data	RTCM 3.0
Subnet Mask	255.0.0.0	St. ID, Distance	498, 6.30 ft
Default Gateway	0.0.0.0	LQ, Delay	100.0%, 0 sec
		Data link latency	0.9 sec
		Received, Lost	104(100.0%), 0
		Internet access	YES

Esc   Configuration   >   RTN   >

4G/LTE

SIM CARD 1	●	SIM CARD 2	○
PIN	0000	PIN	0000
Settings	>	Settings	>

Power/Data Management

4G LTE Mini Card On	> ○	4G LTE Mini Card Off	> ●
Cellular Data On	●	Cellular Data Off	○

FCC ID: N7NMC7700   IMEI: +PACSP0

Cancel   OK +

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Collect

Collect Prepare

Prj.2014-08-29 08.32.24	Page1	NAD83(2011) / Ohio South / ...
1. Project	2. Page	Coordinate System
DefTag	DefCode	---
3. Tag	Code	4. Code Attributes
1		5.577 ft
5. Point Name	6. Point Description	7. Antenna Height
Review	View	ODOT VRS | 25:00 | Next

Follow the steps below in the *Collect Prepare* screen, as they are numbered on the screen.

1. Project

Create or *Select* the *Project* and the *Coordinate System* for that project. Each Project has 10 *Pages*. Each *Page* can have its own coordinate system. The default coordinate system for each page is the coordinate system of the Project. You can think of a *Page* as a sub-project. You can perform your entire project in one *Page*, or break it into separate *Pages* if it makes the project organization better. Since each *Page* has its own coordinate system, you may want to use *Pages* to quickly transfer coordinates by copying or moving a point to another *Page* with the desired coordinate system.

The Collect function is used to collect and store RTK Points, Lines, Curves, Trajectories and GNSS static data. To begin using Collect, open the Collect Prepare screen by pressing the Collect icon on the Home screen or by pressing the hardware Collect button in the bottom row of buttons on the TRIUMPH-LS.

2. Page

Page1

2. Page
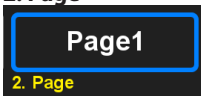
Select the *Page* that you want to store the points in, and the Pages that you want to be shown on the map. The *Show/Hide* feature of *Page* is another reason to use *Pages*. The coordinate system of the selected *Page* will be shown in the box to the right of the *Page* box in the *Collect Prepare* screen.

3. ShapeTag, Code

DefTag   **DefCode**

3. Tag   Code
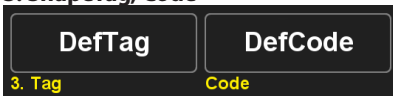
Select the *ShapeTag* and the *Code* for the next point.

4. Code Attributes

---
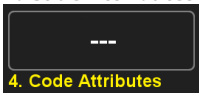
4. Code Attributes

Enter *Code Attributes*, if any.

5. Point Name

1
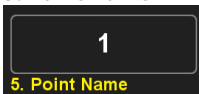
5. Point Name

Enter *Point Name*. The *Point Name* will be auto incremented.

6. Point Description

6. Point Description
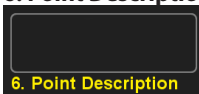
Enter the *Point Description*, if any.

7. Antenna Height

5.577 ft
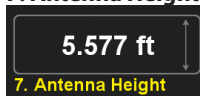
7. Antenna Height

Enter the *Antenna Height* (Vertical or Slant).

In the bottom of the *Collect Prepare* screen there are five buttons:

Review
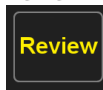
Review

To view and edit the points in the current *Project*. The *Review* screen will be explained later in this document.

View

View

To select which point attributes to be shown on the map and set screen parameters.

Battery

25:00

Shows the estimated remaining battery time in HH:MM format. Tap it to see details about the battery operation and temperature history in different parts of the unit.

Next

Will take you to the *Collect Action* screen to collect *Points*, *Lines*, Curves, and *Trajectories*. The *Collect Action* screen can

also be reached directly by the hardware button:

Action Group Setup

The button in the bottom center is for the *Action Group Setup* menu. The name of the current *Action Group* profile is shown on this button. The icon in the top left corner indicates rather *Tilt Compensation* is in effect. Under the icon, letter *L*, *T*, and clock symbol represent *Lift*, *Tilt*, and *Timed* modes.

Tilt Compensation – On
Lift mode – On
Tilt mode – On

Tilt Compensation – Off
Lift mode – Off
Timed mode – On

Tap this button to open the *Action Group Setup* screen and modify the collection parameters.
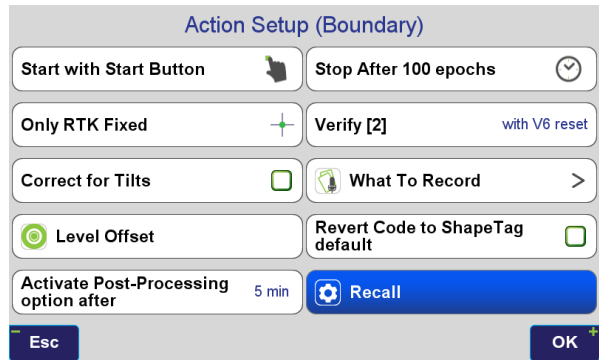
Here options are given to set:
- How to Start
- How to Stop
- Position Accuracy
- Verify Settings
- Correct for Tilts
- Record GNSS
- Revert Code to Tag default
- More Settings
- Level Offset

How to Start
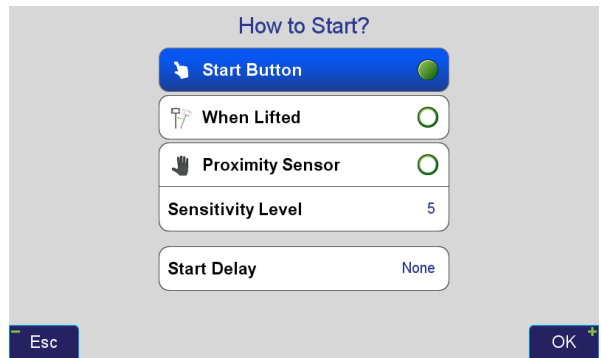
How to Start sets the method used to start the collection of data. The following options exist:

Start Button

> 🖱 **Start Button** ⬤

Data collection begins when the *Start* icon is tapped or the hardware *Start* button is pressed.

When Lifted

> 🚩 **When Lifted** ◯

Data collection begins when the tilt of the TRIUMPH-LS is less than 5º and the unit is stationary for 3 seconds.

Proximity Sensor

> ✋ **Proximity Sensor** ◯
>
> **Sensitivity Level** 5
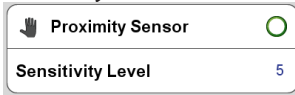
Data collection begins when your hand gets within a few inches of the proximity sensor located between the U1 and U2 hardware buttons. The *Sensitivity Level* determines how sensitive it is.

Start Delay

> **Start Delay** None

Delays the start of data collection for the selected period of time.

How to Stop

> **How to Stop?**
>
> 🖱 Stop Button ◯
>
> 🚩 When Tilted ◯
>
> 🕐 After 600 epochs ⬤
>
> **Auto Accept** No
>
> **Auto Re-Start** NONE
>
> ▬ Esc   OK ✚
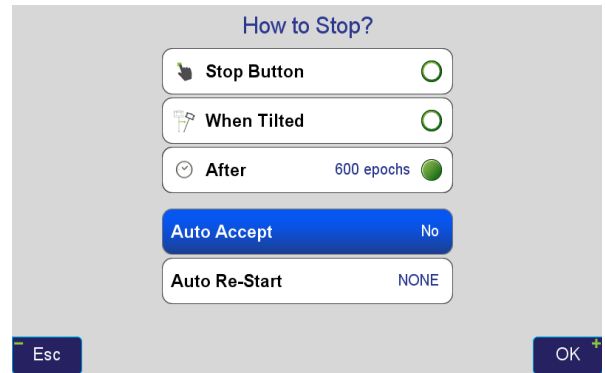
How to Stop sets the method used to stop the collection of data. Here the following options exist:

Stop Button

> 🖱 **Stop Button** ◯

Data collection stops when the *Stop* button is re or the hardware *Stop* button is pressed.

When Tilted

> 🚩 **When Tilted** ◯
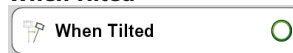
Data collection stops when the TRIUMPH-LS is titled more than 15º.

After

> 🕐 **After** 120 epochs ⬤

Data collection stops after the specified number of epochs have been stored.

Auto Accept

Auto Accept	No

You can specify the RMS level for the final result to be accepted automatically and you will not be prompted to *Reject* or *Accept* the solution.

Auto Re-Start

Auto Re-Start	☐

Will automatically re-start another collection as soon as the current one ends. It is like automatically tapping the *Start* button.

Auto Accept Settings

Required Accuracy	5 cm
HRMS	○
VRMS	●
3D RMS	○

Cancel   Apply

When **Auto Accept** is opened a **Required Accuracy** can be selected. The Required Accuracy can be a HRMS, VRMS or a 3D RMS accuracy. If the selected accuracy is less than or equal to the *Required Accuracy* the point will automatically be accepted, otherwise it will be rejected. You will not be prompted with the *Accept* and *Reject* buttons in this mode.

Position Accuracy

Position Accuracy

• Only RTK solutions in Fixed mode (sub centimeter level)	●
RTK fixed, Float & DGPS (sub meter level)	○
Accept all, including Standalone (few meter level)	○

Accept PDOP	All	Accept HRMS	All	Accept VRMS	All

Esc   OK

Position Accuracy is used to set the RTK solution mode. The options include:
* Only RTK solutions in Fixed mode
* RTK fixed, Float & DGPS
* Accept all, including Standalone

Options are also included to set the maximum allowable PDOP and instantaneous HRMS and VRMS values. When these values are exceeded data will not be stored. Finally the minimum number of Fixed RTK Engines can be specified. This setting only takes effect when Fixed mode is selected.

Verify Settings

Verify

Verify [1R]	Auto

Verify is discussed in the *Quick Start Guide to The TRIUMPH-LS* section of the manual.

Correct for Tilts

Correct for Tilts	☑

When this button is checked it is not necessary for the pole to be plumb to collect data for the point at the tip of the pole. Using the readings from the tilt sensors and compass, horizontal and vertical offsets from the TRIUMPH-LS to the tip of the pole are calculated and the correction offsets are applied to the RTK position. It is important for the *Antenna Height* to be correctly entered for this feature to work correctly.

The level sensors are sensitive to the internal temperatures of the TRIUMPH-LS. To fine tune the level calibration, a *Level Offset* calibration needs to be done. It is located in the *Action Setup* menu. It is necessary to reperform this calibration as the internal temperature of the TRIUMPH-LS changes. If the Correct For Tilts option is enable and the most accurate positions are desired, it is essential to monitor the Level Offset calibration and recalibrate when necessary.

Record GNSS

Record GNSS	☐

The GNSS data will be saved to a file when this option is checked. The data will be associated with the current point being collected. For the data to be saved the point must be Accepted. This data can be download from the TRIUMPH-LS using the USB cable and be found in \VS Data\Maps\ProjectName\Raw Data of the Storage Card or Mounted Volume folder depending upon which is specified in the Advanced Setup menu under Data Storage.

Revert Code to ShapeTag Default

Revert Code to Tag default	☐

When collecting a point, you may want to change the *Code* associated with its *ShapeTag*. This option allows you to keep the new *Code* for all subsequent points or revert back to the default *Code* after collecting that single point.

Level Offset

Level Offset is used to further improve the calibration of the levels and is found in the *Action Setup* screen:

Action Setup (Boundary)	
Start with Start Button	Stop After 100 epochs
Only RTK Fixed	Verify [2] with V6 reset
Correct for Tilts	What To Record >
Level Offset	Revert Code to ShapeTag default
Activate Post-Processing option after 5 min	Recall
Esc	OK
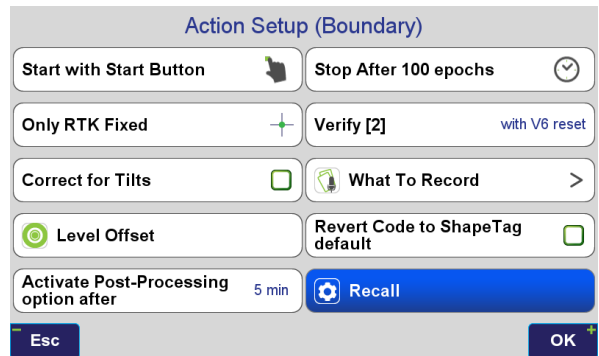
Level Offset is used to "zero" the level readings when the

TRIUMPH-LS is mounted on a pole and plumb. This feature will correct for any internal misalignment of the level sensor and also correct for any misalignment between the TRIUMPH-LS and the rover pole. It is also used to correct the fluctuations in the level readings that occur due to temperature changes. The *Calibrate Level* procedure should be done prior to calibrating the *Level Offsets* if the level readings are greater than 1.5° when the TRIUMPH-LS is level.

To calibrate the *Level Offsets* press the *Level Offset* button and the *Calibrating Level Offset* screen will open:
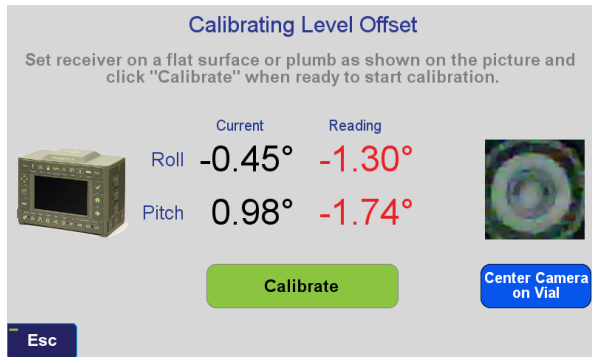
The black Roll and Pitch numbers indicate the current offset that is being applied to the internal level readings. These numbers are the calculated Level Offsets from the previous calibration. The red Roll and Pitch numbers indicate the readings of the levels after the Level Offsets are applied. The red numbers are the same values that are displayed on the Collect and Stake screens in the Heading and Tilt box.

With the TRIUMPH-LS mounted on the rover pole you are using to survey, plumb the pole using the pole's level bubble. Once plumb, press the Calibrate button. A 5 second delay before the calibration begins will occur to you allow you level and steady the rover pole and TRIUMPH-LS. The calibration takes about 1 second after it begins. The results will be presented and you are given the option to reject or accept the calibration:
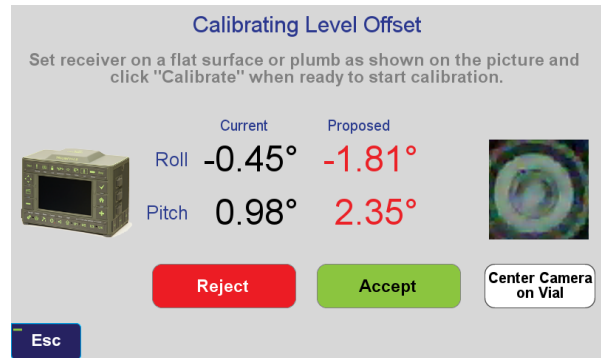
After pressing Accept, the calibration is stored and the current level readings should be very close to zero when the unit and pole are plumb:

Calibrating Level Offset

Set receiver on a flat surface or plumb as shown on the picture and click "Calibrate" when ready to start calibration.

	Current	Reading
Roll	-1.81°	-0.21°
Pitch	2.35°	-0.07°

Calibrate

Center Camera on Vial

Esc
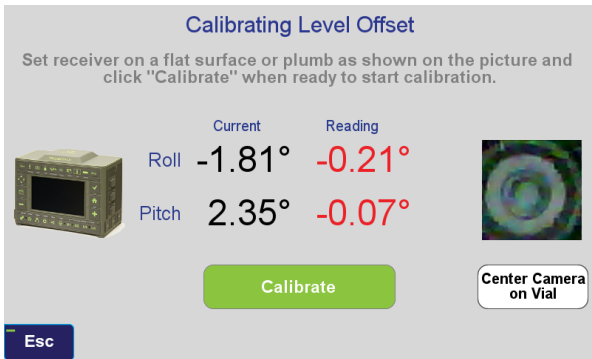
As the internal temperature of the TRIUMPH-LS changes, the Level Offsets will need to be recalibrated. A temperature/offset table is planned to be implemented in the future to reduce the frequency of needed *Level Offset* calibrations.

If a high level of accuracy is required when staking and collecting points and *Correct for Tilts* is used, it is important to always check that the calibration is correct prior to data collection and staking points. View the level readings when the rover pole is plumbed with its level bubble and verify that they are less than 0.2° (or your required precision). If they are greater than the desired reading a recalibration will be required. If the *Calibrate Level* procedure is done, a recalibration of *Level Offsets* will also be needed. Every tenth of a degree (0.1°) of inaccuracy in the level readings creates appropriately one-hundredth of a foot (0.01') of error in the horizontal position when the TRIUMPH-LS is used with a 5.3' high rover pole.

Collect Action
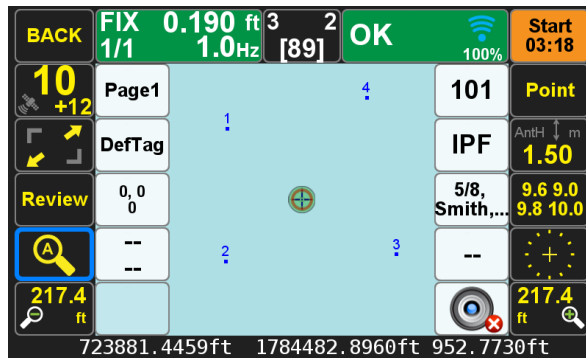
On the top row of the *Collect Action* screen (from the left to right) are the following buttons:

Back

BACK

Goes back to the previous screen.

Solution Mode

FIX 0.039 ft
5/1

Shows the solution status (Fixed, Float, Standalone, DGPS) and the instantaneous horizontal RMS of the solution. Tap it to see the status of the six RTK engines. The number of fixed RTK engines/ number of required RTK engines is shown below the FIX label.

Heading and tilt

Shows tilt and heading numbers. If the coordinate of the selected page is "Global", it shows the True North heading, and if "Local", it shows the Grid Heading (shown within brackets). For the TRIUMPH-LS to collect data it must be level within 5° when Correct for Tilts is off and 30° when Correct for Tilts is enabled. Tapping this button will take you to the Quick Setup menu.

Communication

It shows *OK* if RTK corrections are received, or it shows the delay in receiving corrections. Next to that, the maximum allowable delay when *Extrapolation Mode* is enabled. The option for it is found in the *Advanced Options* screen. For correction rates greater than 1 Hz, *Extrapolation Mode* must be disabled. Tap this button to open Communication screen.

Start

Press this to start data collection. The hardware Start button also has the same function.

Satellite

Shortcut to Satellite Status screen; displays the number of satellites being used + the number of additional satellites tracked but not used.

Point/Line/Curve/Trajectory/Shift

This is below the Start button. Tap it to select which shape you want to collect. These features are explained fully in the built in help menu in the TRIUMPH-LS. Press the Help hardware button to access it.

Full Screen

Tap to get to the Full Screen mode where you can also turn on the camera and measure angles.

Zoom

Used to cycle the zoom mode between *Zoom Auto Scale* which shows the extents of the map; *1:1 Zoom* mode which sets the display at a 1:1 scale factor, *Zoom To Target* which dynamically scales the map to show the current position and the selected object to be staked (Stake mode) and manually / arbitrarily setting the zoom level controlled with the zoom in and out buttons.

Center

This button centers the map on the current position.

Zoom In/Out
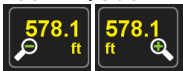
The *Zoom IN* and *Zoom Out* buttons are shown in the bottom right and left corners. They can be held down to zoom in and out faster. The "+" and "-" hardware buttons function the same.

User Defined Boxes (Whiteboxes)

There are 10 *User Defined Boxes* around the map. Hold them down to select which items you wish to shown in them. Tapping them allows you to enter a new value for the appropriate items, reset the statistics, take a picture etc.

One of the configurable white boxes is the *Base/Rover Statistic*. When doing RTK surveying, the associated screen can be called up with just tap. It conveys a good deal of information pertaining the Base and Rover as seen in the example:

Base	GEO: 39°16'45.30198"N 082°58'51.94585"W 755.5948		@2010.00
	GRID: 466285.5864 1832317.4580 866.2214		
Rover	GEO: 39°16'39.22631"N 082°58'51.41007"W 700.2113		@2010.00
	GRID: 465670.6242 1832356.3161 810.8324		
R▶B: 356°23'	616.19	↕55.39	
DUR: 131s	Sats: 7+4	UTC: 2016-04-01 21:54:41	
HRMS: 0.014	VRMS: 0.029	3dRMS: 0.032	95% Confidence Ellipse
HDOP: 1.004	VDOP: 1.751	PDOP: 2.019	
σh: 0.057	TDOP: 1.218	GDOP: 2.358	
θ: 60°6'6"	σ_a: 0.026	σ_b: 0.022	
ANT: HGT:5.679ft JAVTRIUMPH_LSA NONE			
Point: 101 [1/1] Pipe			
Capped			
Project: Beeler	Page: Page1	CC: 18.5+891	Units: ft

Reject / Accept

Accept or *Reject* displayed after data collection

Position

488149.477ft   1832337.261ft   610.737ft

On the bottom of the screen you see the instantaneous position coordinates. When you tap the Start button, data collection will start. When it is stopped (by the timer, manually or by Tilt), the average of all the epochs collected is shown on the bottom, and the RMS of solutions on the center of the map. Review them and tap *Accept* or *Reject*. The Point Name, Code, ShapeTag and Attributes can be modified at anytime before the Accept button is pressed.

Review Screen
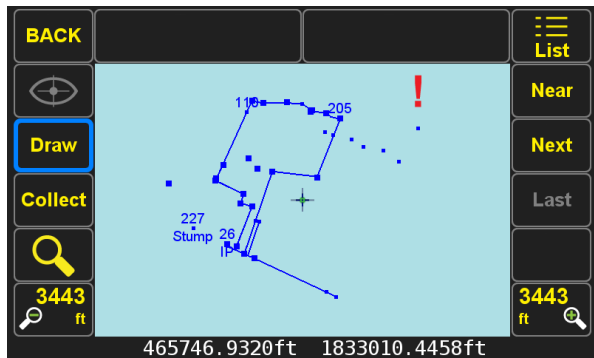
The *Review* screen is accessed by pressing the *Review* button in the *Collect Prepare* screen. To *Review* or *Edit* a point, first you need to select that point and center it on the screen. The *List* (select via list), *Near* (the nearest point), *Next* (next to the nearest point, and so on), and *Last* (the last point surveyed) buttons help you to identify and center your desired point on the map. Select a point on the map by moving the crosshair on top of it. The *Name* of the selected point is shown on the top of the screen and its coordinate in the bottom. In this screen you can also *Add* a point and *Draw* lines and circles. More CAD functions are currently being developed.

When you identify the point that you want to review or edit, tap the (*View Selected*) button which will take you to the *Edit* screen. In the *Edit* screen the distance and heading (True North or Grid North, depending on the coordinate system of the Page) from your current position to the selected point are shown graphically and numerically on the bottom of the screen.

In *Edit* Screen you can *Resurvey* the selected point, add photos or audio recordings and notes to it and edit it.

Collect Screens

Stake

Stake Out

What you will be staking, and the manner in which you will be performing your work is controlled by your selection of "Mode" which is listed as Item 3 on the STAKE prepare screen. The three modes, and their associated prepare screens are shown below.

Point Stake Prepare Screen: Used for all manner of point number based stakeout work.

SMITH FARM	Page3	NAD83(2011) / Ohio South / ...
1. Project	2. Page	Coordinate System
(Mode icon)	Create Point	Select Point
3. Mode	4. Build	
Path Length / All		5.09 ft
Sequence		5. Antenna Height
Review	View	UHF
			Next
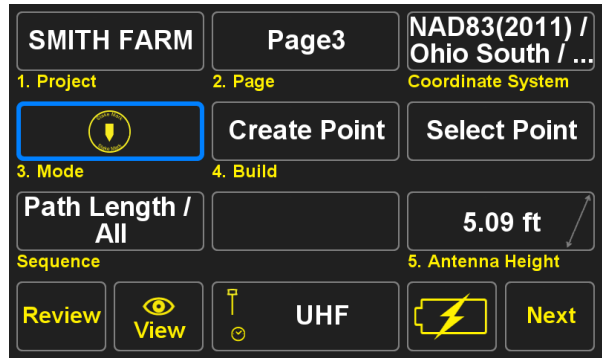
Stake Alignment Points Prepare Screen: Ideal for complex alignment and heavy construction tasks.

SMITH FARM	Page3	NAD83(2011) / Ohio South / ...
1. Project	2. Page	Coordinate System
(Mode icon)	Create Alignment	Open Alignment
3. Mode	4. Build	
Edit Alignment	Stake Line	5.09 ft
		5. Antenna Height
Review	View	UHF
			Next
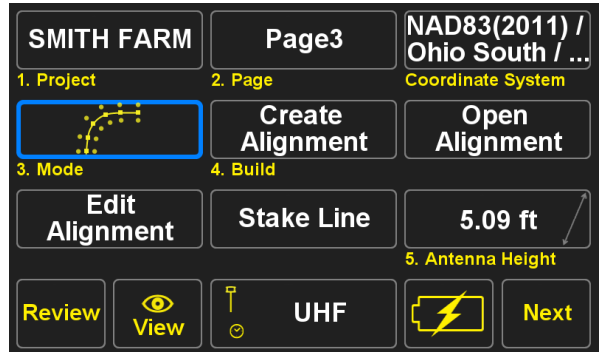
Stake Here: Staking tools useful for a wide variety of situations, ranging from simple to complex.

SMITH FARM 1. Project	**Page3** 2. Page	**NAD83(2011) /** **Ohio South / ...** Coordinate System
[icon] 3. Mode	**Create** **Alignment** 4. Build	**Open** **Alignment**
Edit **Alignment**	**Stake Line**	**5.09 ft** 5. Antenna Height
Review	👁 **View**	🗝 ⏱ **UHF**	🔋	Next

Pressing the **Sequence** button will present the Stake Points Mode screen where you select your desired method, and the type of points to be staked. The two types of points are **Design Points**, and **Surveyed Points** which are described below. Press Design points, or Surveyed Points to select the type of points you will be staking. For Design Points, you may also choose to skip points which have already been staked by selecting the check box.

Stake Points Mode

Design Points 🟢	Skip Already Staked Points ☐	Surveyed Points ◯ ⚙

Points Traverse

Nearest Point ◯	**Optimized Path Length** 🟢	Alphabetic ◯	From Map ◯

Use All Points On Page 🟢	Select Points to Stake > ◯

Max. Points in Sequence	10000 ☐

Reset Sequence

Esc   Stake⁺
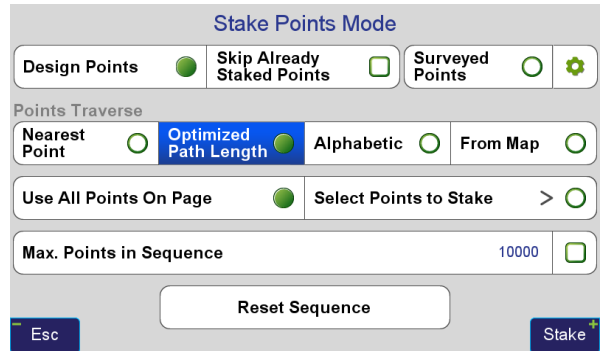
There are several methods that the user may choose to define how the order of the staking points is chosen. This is referred to as the "Points Traverse". Your individual work situation will dictate the most appropriate choice: The following descriptions are based upon the selection shown above of "Use All Points On Page". With this setting, when the user chooses any point in the data base to stake, **J-Field** will then proceed with staking the rest of the points on the particular page that the selected point is located upon.

Stake Out Points

[icon]
3. Mode

Staking Using Point Numbers

To configure **J-Field** to stake out point numbers, press the **Mode** button on the Stake prepare screen, so that the above icon is displayed.

Selecting Points: There are four separate modes you may select to define the manner that you will select points for staking. The current selection method which defines program behavior will be displayed on the Stake prepare screen in the following manner.

Nearest / All
Sequence

Path Length /
All
Sequence

Nearest / All
Sequence

Points Traverse

Nearest Point	Optimized Path Length	Alphabetic	From Map

Nearest Point, will cause **J-Field** to select the point that is nearest to your current location as the desired point to be staked. All of the points on the selected page will be then ordered for staking, based upon the distance from the user. If you are standing within a cluster of points to be staked, this option can lose its usefulness rather quickly, as the list order is based upon distance from originating selection. However, at any time you can return to the Stake Prepare screen, and press Sequence.

Nearest / All
Sequence

The Stake Points Mode screen will then appear, now press Reset Sequence as shown below. When you then press "Stake" at the bottom right corner of the screen, you will be returned to the map screen, with a new Nearest Point selected, and the entire staking list re-ordered based upon your new location.

Stake Points Mode

Design Points	Skip Already Staked Points	Surveyed Points	⚙

Points Traverse

Nearest Point	Optimized Path Length	Alphabetic	From Map

Use All Points On Page	Select Points to Stake >

Max. Points in Sequence	500 ☑

Reset Sequence

Esc   Stake

Path Length / All
Sequence

Points Traverse

Nearest Point	Optimized Path Length	Alphabetic	From Map
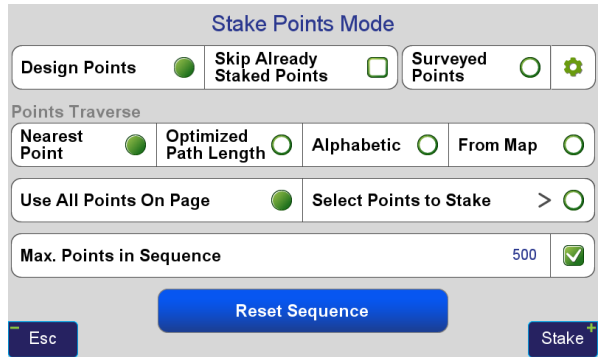
Optimized Path Length, will cause **J-Field** to select the shortest route through your selected points, based upon the selected starting location. The route will also be displayed on the map screen if the user has a check mark placed on the "Stake Linework" option, of the "View Attributes" screen.

Below is an example of without, and with "Stake Linework" displayed.

There may be situations, where you have too many points for convenience in your selected data set, and you may desire to limit how many points that the Stake Traverse list includes. This can be accomplished by setting the "Max Points in Sequence", which is shown below, to a value that works for your situation.
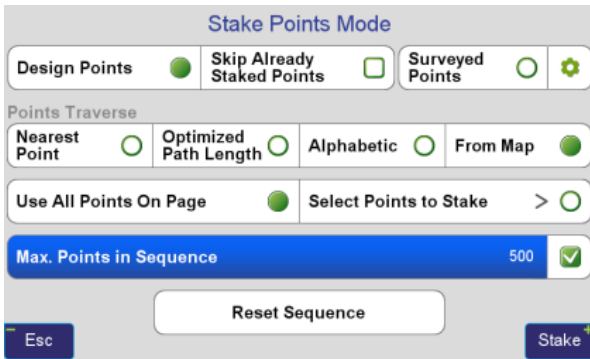
Alphabetic will cause **J-Field** to sequentially stake the next point in your list. This is the most common method users will be initially familiar with. The points are not selected from this Stake Points Mode screen. They are selected from the Stake Prepare screen, via the Select Point button. This button has two modes of operation. If the user simply taps the "Select Point" button, they will be presented with the list method of point selection.
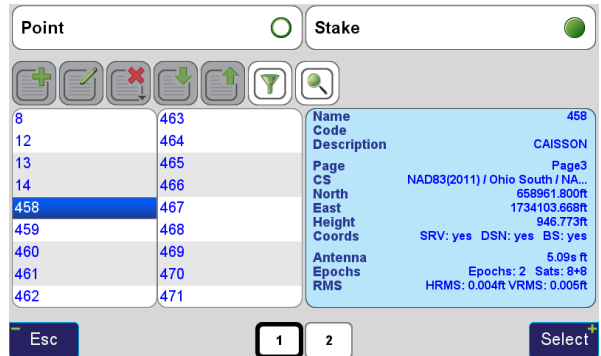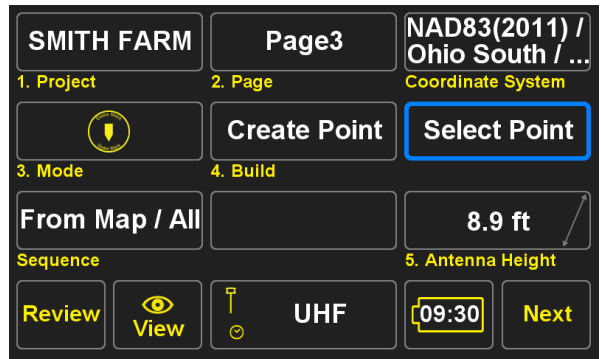
If the user presses, and holds the Select Point button for one second, a keyboard will pop up, and the user can type in the desired number to stake.
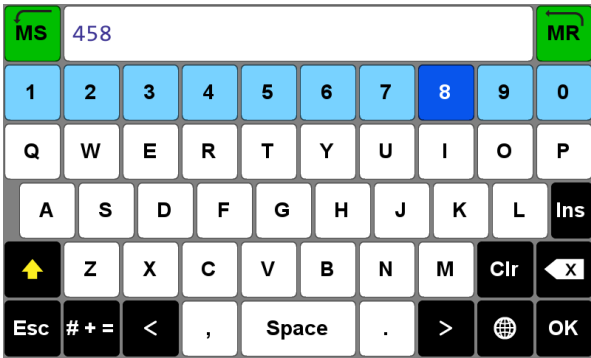
Keyboard screen:

MS 458 MR

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 0 |

Q W E R T Y U I O P

A S D F G H J K L Ins

↑ Z X C V B N M Clr ⌫ X

Esc # + = < , Space . > ⬤ OK

From Map / All screen:

From Map / All
Sequence

First map screen:

BACK | FIX 3/2 | 0.105 ft | 0 -1 [201] | OK 5 | Start

14

DTT ft 86.1 | 458 | CTT ° 202 | NEXT

South ft 79.7 | AntH ft 5.09 | Guide

West ft 32.6 | Ahead ft 86.1 | PREV

232.9 ft | Fill ft 30.1 | Right ft 0.612 | 232.9 ft

659041.602ft   1734136.245ft   947.932ft

Points Traverse panel:

Points Traverse

| Nearest Point ○ | Optimized Path Length ○ | Alphabetic ○ | From Map ● |

From Map will cause *J-Field* to stake out any point which is selected via the map screen interface. Use this method directly from the map screen. Pan the screen until the desired point "snaps" to the center cursor on the map. You will see the "Next" button turn active, press NEXT to select the point, and stakeout will then be in progress.

Second map screen:

BACK | FIX 3/1 | 0.039 ft | -2 0 [294] | OK 5 | Start

10

DTT -- | CTT ° -- | NEXT

North/So... -- | AntH ft 5.09 | Guide

East/West -- | Ahead ft 6.44 | PREV

236.6 ft | Cut/Fill -- | Left ft 88.0 | 236.6 ft

659039.897ft   1734144.937ft   960.378ft

Using either method, once the point is selected, the user will be then shown the Stake Map screen, and stakeout will be in progress.

FIX 3/1   0.049 ft   -2 0 [293]   OK   5

BACK   12   DTT ft 104   459   CTT ° 216   NEXT

South ft 84.4   AntH ft 5.09   Guide

West ft 60.6   Ahead ft 22.8   PREV

236.6 ft   Fill ft 17.6   Left ft 101   236.6 ft

659039.887ft   1734144.880ft   960.398ft

Start

---

the White Buttons, which are shown below and labeled "*Example White Button Pallet*" to be of any available content, and a location on the screen which best satisfies your requirements. Press and hold any of the White Buttons for three seconds, and a palette of available buttons will be presented. If you select the "None" option, the field will be a clear outline. If you press the clear outline again, the palette will return, and in this example I will press Right/Left to assign this function the my desired button location.

BACK   ---   -38 -1 325*   OK   5

3   DTT --   CTT --   NEXT

North/So... --   AntH ft 5.09   Guide

East/West --   Ahead/B... --   PREV

147.5 ft   Cut/Fill --   147.5 ft

Start

Staking Map Screen: There are several different screens which you may work with while staking. The primary being the Map view, which is shown below.

FIX 3/1   0.049 ft   -2 0 [293]   OK   5

BACK   12   DTT ft 104   459   CTT ° 216   NEXT

South ft 84.4   AntH ft 5.09   Guide

West ft 60.6   Ahead ft 22.8   PREV

236.6 ft   Fill ft 17.6   Left ft 101   236.6 ft

659039.887ft   1734144.880ft   960.398ft

Start
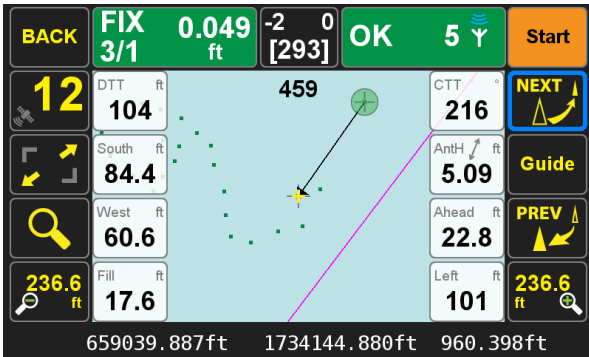
It is important that the user understands the purpose of what are known as White Buttons. White buttons allow the screen to be customizable by the user. The White Buttons shown on the above screen is simply what this author has chosen for his personal use. You may easily configure

None	VRMS	CTT	DTT
Audio Record	Photo Record	North/South	East/West
Cut/Fill	VHor	Station	Offset
Ahead/Back	Right/Left	Code	Point Description
Antenna Height	Sequence		

Esc

Example White Button pallet

The White Buttons which you select, and their location on the screen is unique to the Setup profile which you have loaded. You may therefore have different White Button layouts saved, dependent upon your specific setup profile.

Staking Map Screen GUIDE Command:

During Stakeout, when you press the GUIDE button, you will first be presented with a "looking down" grid view of your area. There will be a yellow line from your location, to your target location displayed on the screen. Your location will be depicted with a blue arrow, pointing the direction you are currently facing based upon the internal compass.
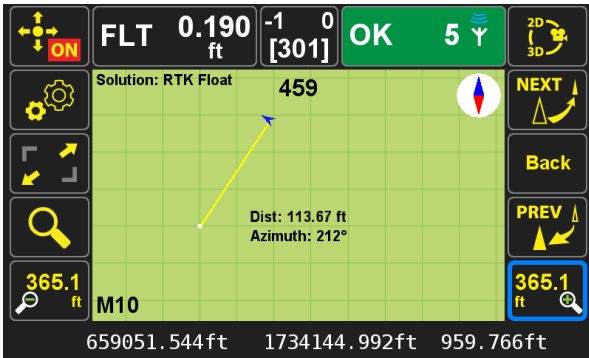
If you press the top right button. You can lock down, or permit free movement of this screen. When locked down, the users position will be centered on the screen.

There are more graphical options available if you press the Stakeout Guidance Settings button. Make changes to suit your needs.
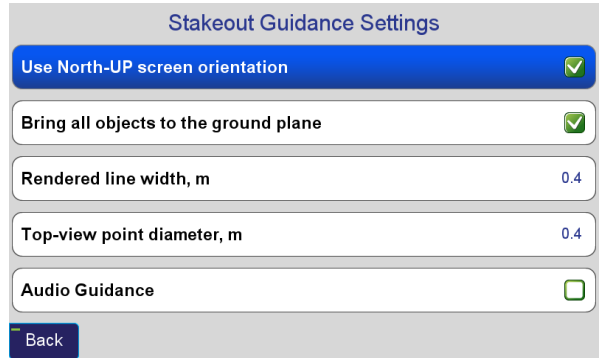
If you press the top right button, you will be presented with an animated view for stakeout. If you press the same top right button again, the points to be staked out will be overlaid onto a live video image. (live video cannot be captured in this format, and is not depicted herein).
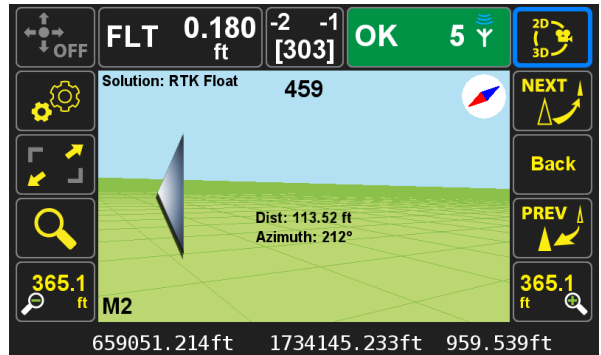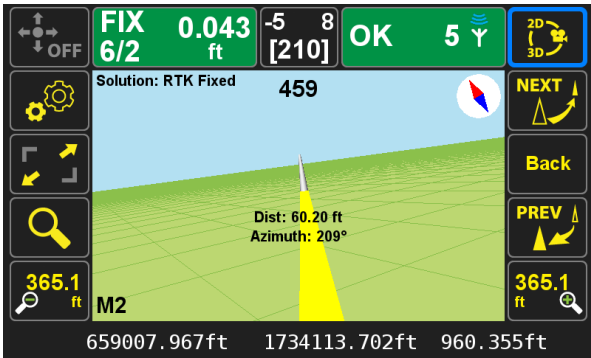
On the previous page, the bottom screen is instructing the user to turn to the left. The screen below is depicting the desired stakeout point.
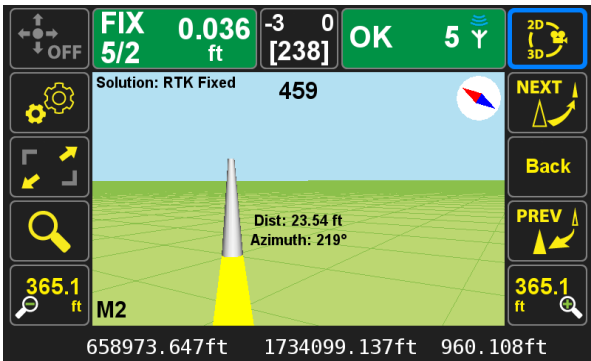
As you approach, you will see a "traffic cone".
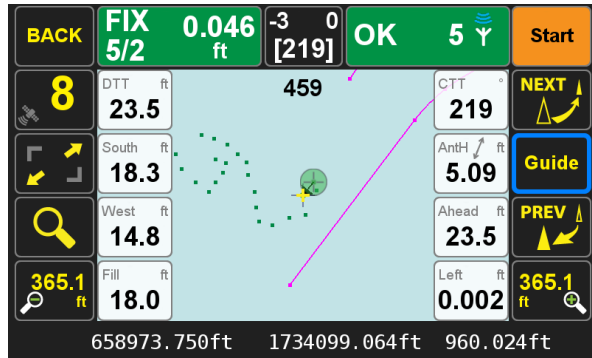
Pressing "Back" will return you to the map. As can be seen in the above image, the CTT (Course To Target) is 219 degrees. In the top center of the screen, you can see that I have aimed the LS at the desired point. My Left/Right value is essentially zero, and I need to move forward 23.5 feet to reach the point. The Left/Right and Ahead/Back values are based upon the internal compass, whereas the North/South, and East/West values are dependent upon your selected coordinate system.

BACK	FIX 6/2	0.059 ft	0 0 [199]	OK	5	Stop
7	DTT ft 0.039	459 3 / 5 0.033 ft 0.009 ft		CTT ° 263		NEXT
	South ft 0.005			AntH ft 5.09		Guide
	West ft 0.039			Ahead ft 0.017		PREV
1760 ft	Fill ft 18.3			Right ft 0.035		1760 ft
	658955.435ft	1734084.317ft	959.742ft			
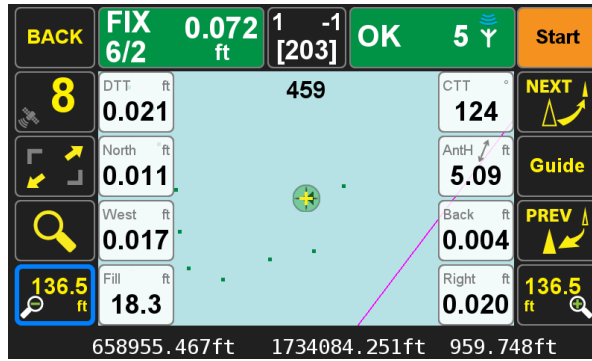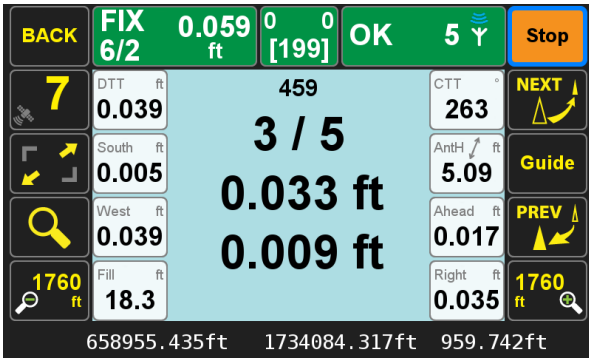
I have now reached the point, and I have set a hub and am ready to set the tack. To record this point, press the "Start" button, and measurements will commence.

BACK	FIX 5/2	0.043 ft	1 0 [14]	OK	5	Start
15	DTT ft 0.036	460 2 0.023 ft 0.014 ft		CTT ° 8		NEXT
	North ft 0.036			AntH ft 5.09		Guide
	East ft 0.005			Ahead ft 0.036		PREV
Reject	Fill ft 31.6			Left ft 0.003		Accept
	658928.254ft	1734087.822ft	946.411ft			
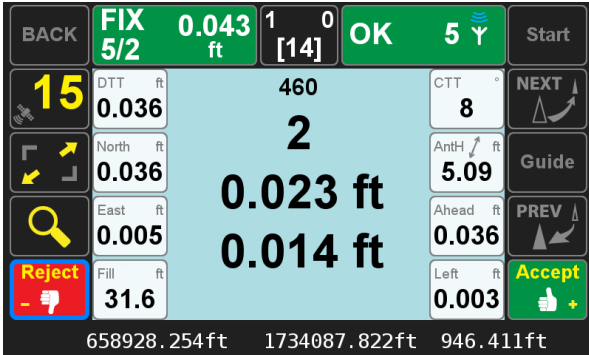
When completed, you will see the following screen. Depending on your needs for accuracy, you may set the tack 0.036' ahead as indicated. Press "Reject", re-plumb your rod, and press "Start" to repeat the measurement at the actual tack location. In my example, I simply pressed Accept. The results of which are discussed below.

At this time, please take notice of a very important fundamental aspect of how J-Field categorizes points.
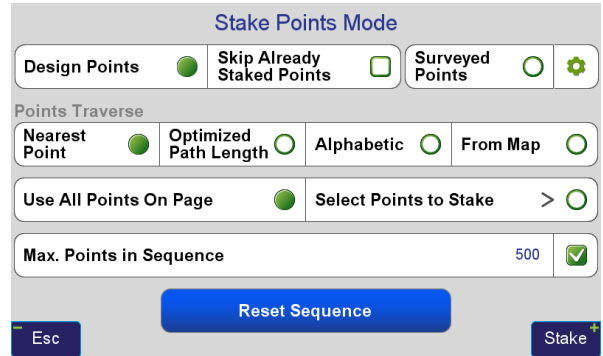
At the top of the above image, you see that there is a listing for Design Points, and Surveyed Points. This feature allows for easy separation of your data, and greatly simplifies what data will be exported out of J-Field, and which set of data is in your selection for stakeout. Surveyed Points are defined as points with actual survey observations tied to them. You have measured these point with J-Field. Design Points are points which have been imported into J-Field, or have been calculated, or manually entered using J-Field. They have no survey observations tied to them. Design Points possess an additional characteristic, and that is that the database structure of J-Field allows for a Design Point to possess two pairs of coordinates.

As an example, below is the point edit screen of a Design Point which has already been staked.

Below is the screen as it appeared when the point was shot, on the right is the Point information for this point.

You will notice that Target, and Actual Coordinates are displayed, as well as the coordinate differences. This is useful for stakeout verification, and generation of cut sheets which will be explained further in the Section Entitled "Stake Points and Cut Sheets".

Staking Lines and Arcs

To configure *J-Field* to stake lines and arcs, press the Mode button on the Stake prepare screen, so that the following icon is displayed.

The purpose of this mode to allow easy staking of random points relative to a line or arc.

You can also use the Edit Alignment command to modify any existing alignments, or the Create Alignment command to create an alignment based upon design plan information. It is anticipated in this section of the manual, that the user is interested in simplicity.

3. Mode
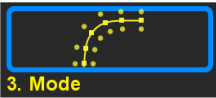
NOTE: More complex use of Alignments and Cross Sections is addressed in the section of this manual written by Mikhail Drakin (p. 60), which is where the Create Alignment, and Edit Alignment commands are most commonly utilized.

3. Mode
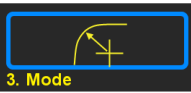
Stake Line

The basic starting point for all Line Staking is with the Stake Line button.
Pressing it will bring up the following screen.

Line By 2 Points
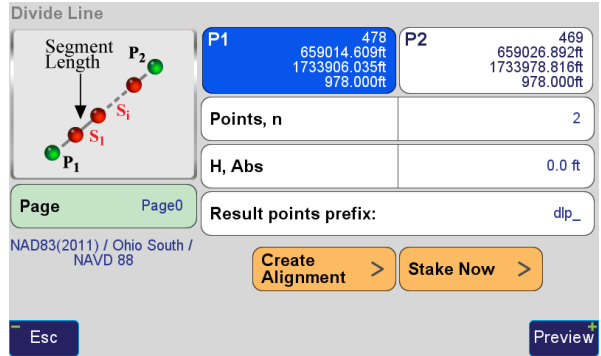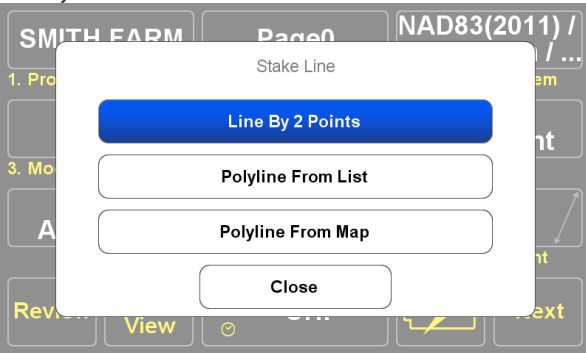
Press Line By Two Points to define a line based on two points. The Divide Line tool will then be presented. The first task is to populate the P1 and P2 fields which define the line.

If you press and hold either the P1 or P2 fields for one second, you can directly enter a point number via a pop up keyboard. Press enter to complete.
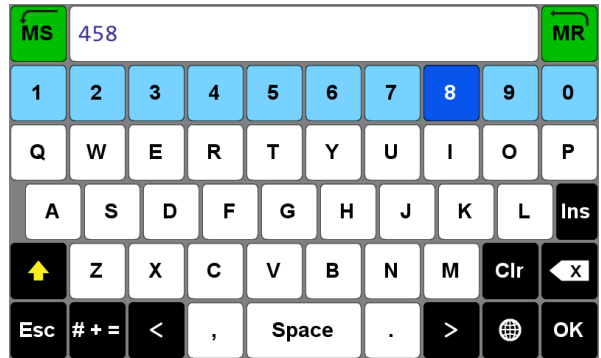
For more optional methods to define the line, just tap the

Stake Out Points

P1 or P2 field, and the Select Point Coordinates screen will appear.
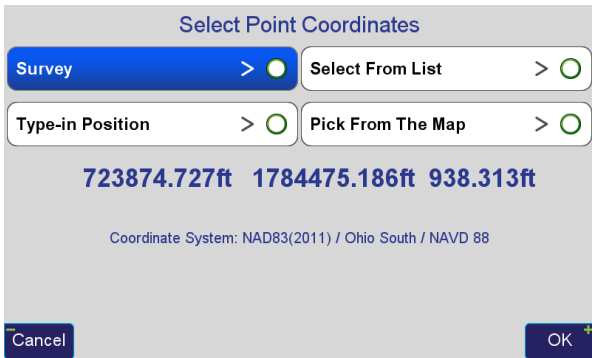
If you Select "Survey", you will be guided through the creation of a new point by performing measurements.
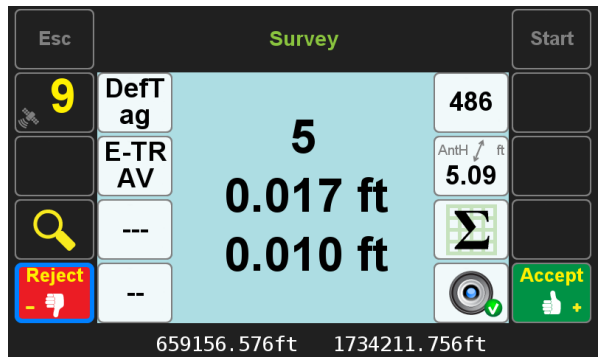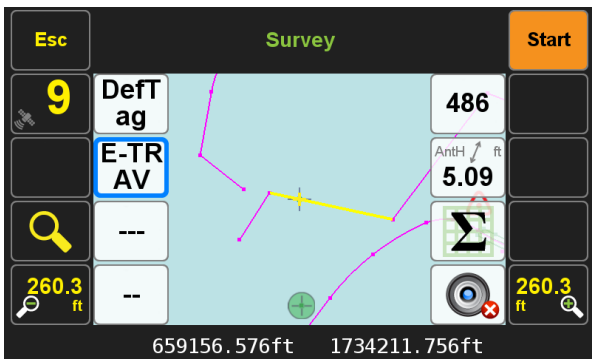
If you select "Pick From The Map", you will be presented with the point list to choose from.
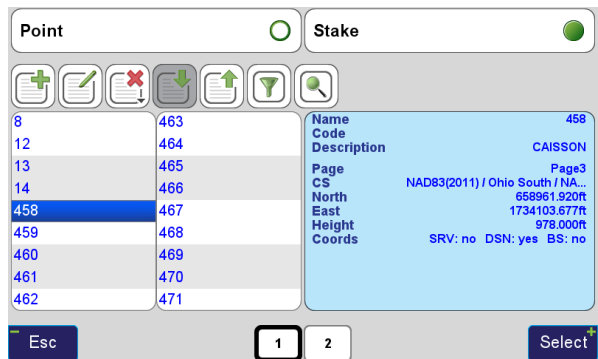
If you select "Copy Position From Map", you will be presented the Map View. Pan the screen so that the desired point snaps to the center crosshairs, and then press the top right OK button.
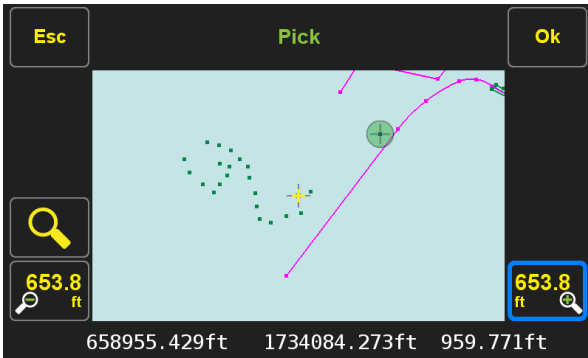
Once the P1 and P2 fields have been populated with the desired data, press "Create Alignment" if your intention is to stake the alignment at a later time. The alignment will be given a name, and staking will not proceed. If you desire to stake the line now, press "Stake Now", and you will be prompted to provide a name for the alignment.

Press OK, and staking will proceed.

Your current Station and Offset are displayed in real time at the top of the display. You will note that the White box values for DTT, North/East and East/West, as well as Ahead are not populated in this mode. The Left/Right White box indicates direction and distance to the line.

An alignment name will be suggested, based upon the point numbers entered. This alignment can also be used in the future by retrieving it with the Open Alignment command

Stake Line

Polyline From List:
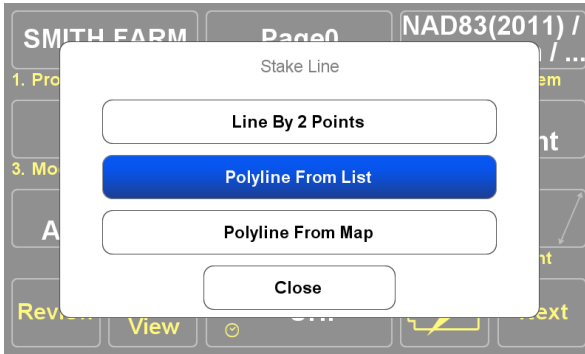
Press "Polyline From List" to select a polyline from the database.
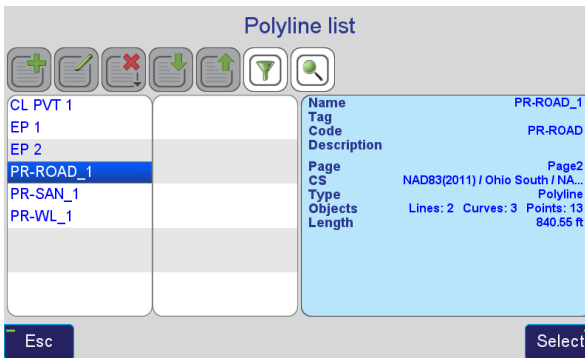
The Polyline List tool will then be presented. In this example,

I am selecting PR-ROAD_1. This polyline was drawn in AutoCAD. The drawing was imported into *J-Field*, and *J-Field* named the polyline based upon its AutoCAD layer name.

Press Select, and an alignment name will be suggested, based upon the last point numbers entered. Provide a memorable name, and press OK.

Press OK, you will then see the Preview Screen.

There are many additional configurations which can be made on this screen. For our purpose here, simply press Preview.

The final Preview screen will appear, now press Stake on the bottom right, then answer Yes to the Start Stakeout Question, and the Stake Map screen will appear.

Your current Station and Offset are displayed in real time at the top of the display. You will note that the White box values for DTT, North/East and East/West, as well as Ahead are not populated in this mode. The Left/Right White box indicates direction and distance to the line.

Stake Line

Polyline From Map:
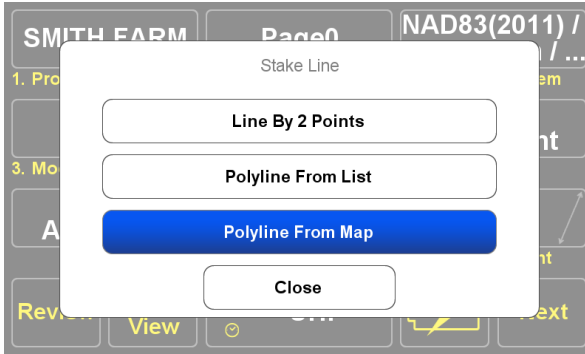
Press "Polyline From Map" to graphically select a polyline for stakeout. The map based selection screen will then appear. Pan the map so that you are "highlighting" the desired polyline.
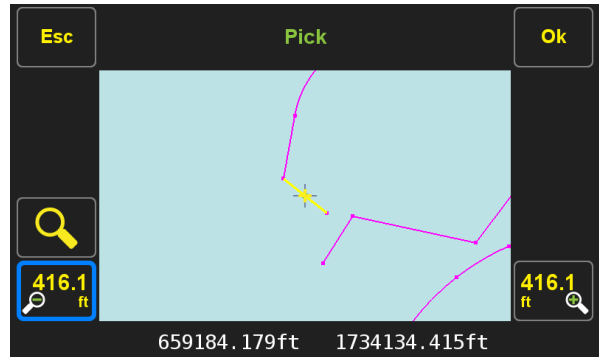
Press OK, you will then see the Preview Screen.
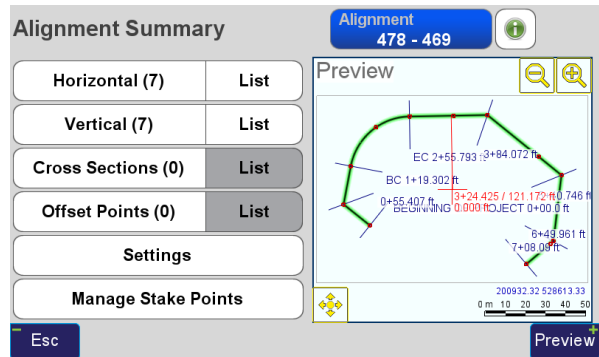
There are many additional configurations which can be made on this screen. For our purpose here, simply press Preview.
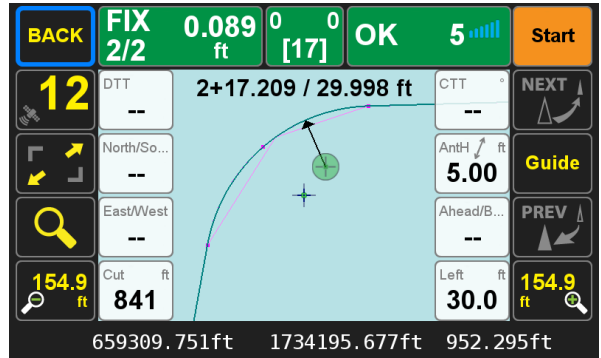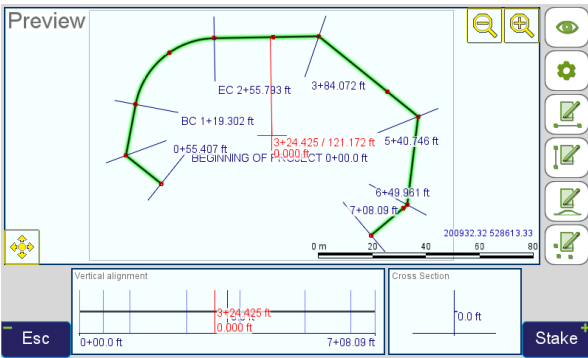
The final Preview screen will appear, now press Stake on the bottom right.
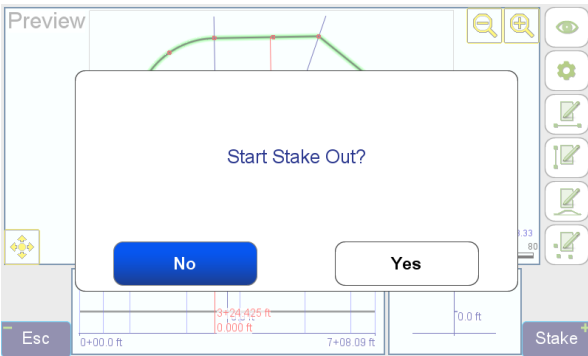
Answer Yes to the Start Stakeout Question, and the Stake Map screen will appear.

Stake Out Alignments

Contents
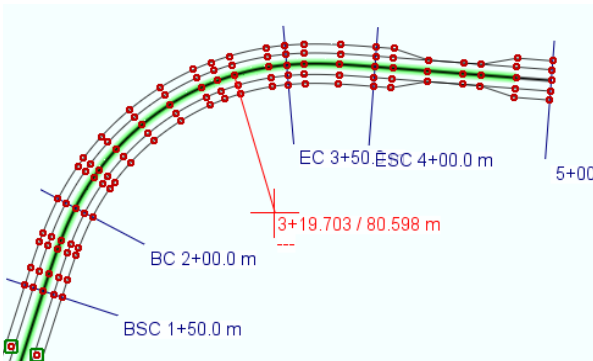
Stake-out alignments functions in Triumph LS allow to perform stake-out of simple roads or linear features with or without cross-sections based on projects designed beforehand. The system provides for keying in prepared data, doing simple editing, previewing the entered project and performing actual stake out.

Alignments are always specified in projected or local CRS (that is, "in meters/feet").

Data Model

An alignment consists of the following elements:

Horizontal Alignment — definition of the alignment centerline (a curve) in horizontal plane, setting correspondence between station value (length along the curve) and (northing, easting) coordinates. The horizontal alignment has definite start (not necessarily zero) and end station values, and beyond these endpoints is implicitly extended by straight lines tangent to the curve at endpoints (Figure 1).

Figure 1

Stake Out Alignments
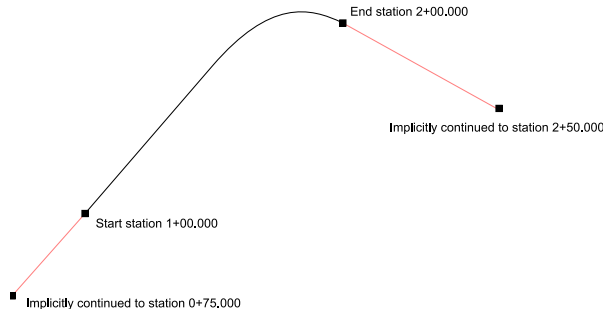
Horizontal alignment consists of *sections*, each section can be:

- **Straight line** — characterized by length and direction (azimuth/bearing)

- **Circular arc** — characterized by radius, start/end direction, arc length

- **Transition curve** — a curve connecting two sections of different curvature (two arcs, or a straight line and an arc), implemented as clothoid (Euler spiral); is characterized by start/end radius, start direction and curve length.

A special type of section is starting point, which defines reference point of the alignment (all other sections can be specified by relative position only, making moving of the whole geometry easy).

When the horizontal alignment has been entered, almost each point on horizontal plane can be assigned a pair of coordinates relative to the alignment — station value along the alignment, corresponding to the nearest curve point, and offset across the alignment. Looking in the direction of station value growth along the alignment, offset is considered positive to the right and negative to the left of the alignment.

If, for the given plane point, the nearest alignment point is cusp vertex (that is, there is no perpendicular from the given point to alignment), such point is considered having only corresponding station value and unsigned distance to the alignment, instead of signed offset.

Vertical Alignment — definition of the alignment centerline elevation, setting it as a function of station value (length along the *horizontal* curve). The vertical alignment may be absent at all, or if present, does not necessarily have endpoints equal to those of the horizontal alignment. Points on horizontal alignment not covered by vertical alignment are, in current implementation, considered to have zero elevation.

Vertical alignment also consists of sections (section endpoints are not related to horizontal section endpoints). Each section can be:

- **Slope (straight line)** — characterized by *horizontal* length and constant grade

- **Parabolic curve** — part of parabola defined by *horizontal* length and grades (vertical angles) at start and end

Much like horizontal alignment, vertical alignment also starts from special section "Starting point" specifying starting elevation and station value.

Cross-Sections — definitions of alignment geometry in vertical plane perpendicular to the alignment. Cross-sections can be specified at arbitrary station values along the alignment. Then, at each alignment point, cross-section is either computed as linear interpolation of nearest previous and nearest next input cross-sections, or is considered to be equal to the last cross-section, if the point is after the latter on the alignment. All cross-sections for one alignment have the same number of segments.

Offset Points - arbitrary points, which at time of alignment key-in are specified by station and offset

Stake Out Alignments

relative to alignment, and converted to actual coordinates at design points generation time. They can be used to stake some non-regular elements at or near the alignment.

After the alignment has been entered, it is converted, according to certain rules, into a set of design points, which are actually used in staking process. Design points are assigned station and offset values and code according to their position along the alignment.

Tutorial — Creating an Alignment

Let us illustrate process of defining an alignment with a simple example. The alignment will contain horizontal & vertical components, symmetrical cross-section with two segments to the left and two to the right, narrowing and widening back closer to the end of the alignment, and also two offset points (Figure 2).
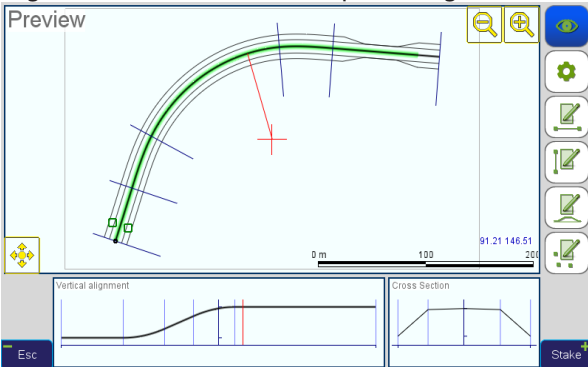
Figure 2

Create a new Project. All work with alignment is done within current Page, which must be assigned a projected or local CRS (e.g. WGS 84 / UTM). Go to *Stake-Out/Prepare* screen. Tap the **Mode** button to switch to the **Alignment Points** mode (Figure 3).
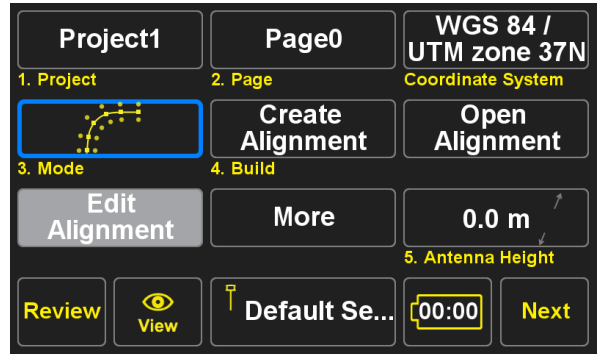
Figure 3

Tap **Create Alignment** to create a new alignment.

In the next screen, enter a name for the new alignment (e.g. "*Demo*" as in the screenshot) and tap **Done** (Figure 4).

Figure 4

The *Alignment Summary* screen appears, containing at the moment no meaningful data except for the alignment name (Figure 5).
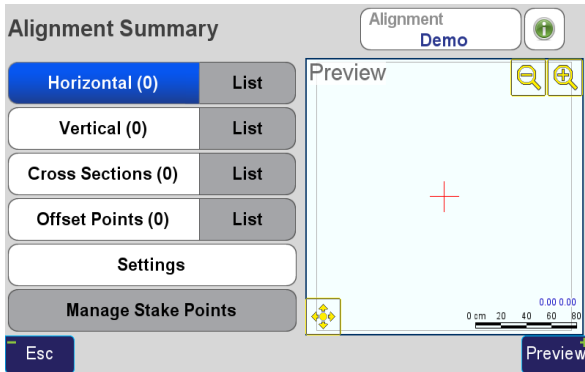
Figure 5

Preview pane to the right will reflect the current (horizontal) shape of the alignment when we enter one. More advanced preview with vertical alignment and cross-sections is available via the "**Preview**" button.

Use the "**Info**" 🛈 button to review summarized statistics about the alignment (like number of sections, length, area, etc).

Note: Any changes made in alignment editing screens are immediately applied to the current alignment. Use "***Alignment***" button to save current alignment under another name.

Entering all four alignment components mentioned at the beginning of the document can be done completely independent, but it is more convenient to enter them in the order displayed - starting from the horizontal alignment. For each component, left button ("**Horizontal**", "**Vertical**", etc) opens editing screen, and right button ("**List**") opens list of the existing sections/items (the list button gets enabled when there is at least one element of the given type).

Creating Horizontal Alignment

Let us start with entering horizontal alignment. Tap the "**Horizontal**" button to go to the horizontal section editing screen.
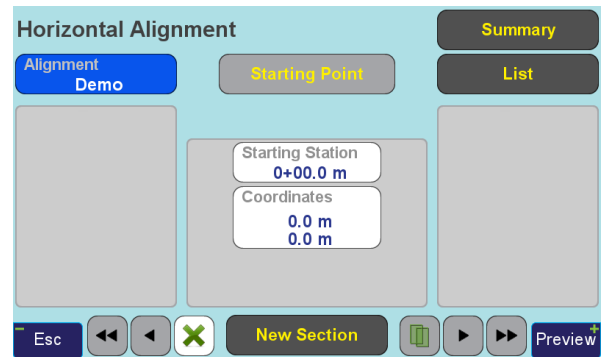
Figure 6

The screen opens at editing starting point (Figure 6).

Note: When an alignment component (horizontal/vertical alignment, cross-sections, offset points) is empty, first entering an editing screen implicitly creates an element of the corresponding component,

that is: entering horizontal or vertical alignment editing screen creates Starting Point of the type; entering cross-sections editing screen creates a cross-section and entering offset points editing screen created an offset point. If it is not what you desire, tap the "***Delete***" () button to delete the created element and leave the editing screen.

Station and coordinates are set to zero. Tap "**Starting Station**" and enter 100 m as start station value, as "1+00" (Figure 7).
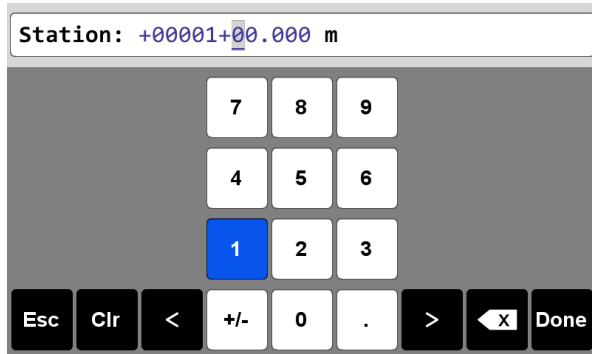
Figure 7

Note: 1. Station format can be set in Settings screen, called from the Alignment Summary screen. You can choose from "1+000", "10+00" and "1000" formats.

2. Station values can be both positive and negative - use normal "**+/-**" button on the screen keyboard to change sign.

Now we have set starting point of the horizontal alignment (Figure 8). We do not alter the point coordi-

nates, they can be easily changed later.
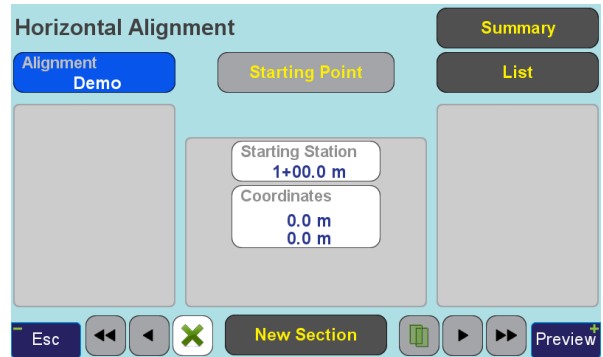
Figure 8

Tap **"New Section"** button to add first meaningful section. When there is no other data except starting point, new section is initialized to zero-length straight line pointing northward (at 0°) (Figure 9).
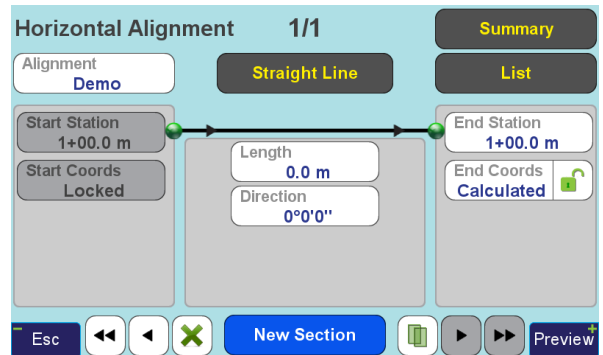
Figure 9

For our example, we will need a 50 m line at 18° az-

imuth. Note that to set section length you can either edit the "**Length**" field (set it to 50.0 m) or "**End station**" (set it to 1+50.0 m), the result is completely equivalent. Also tap "**Direction**" and set it to 18°, so the result looks as shown in Figure 10.
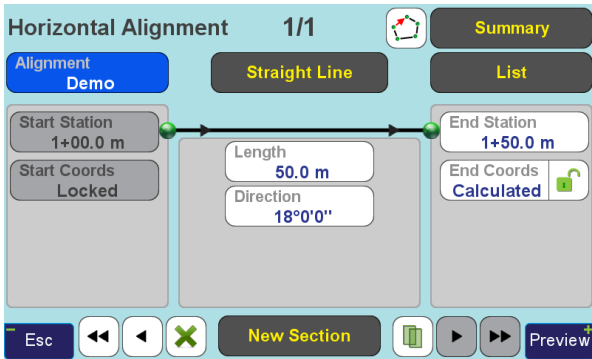
Figure 10

Note that in the left pane, you see data on the section start point, and in the right pane — data on the section end point. Start section and start coordinates are always defined by the previous section and cannot be edited. Editing other fields depends on the context.

As it has been already mentioned, all edited data is saved immediately. Now we can tap the "**Preview**" button to go to the *Preview* screen and look at what we have entered (Figure 11).
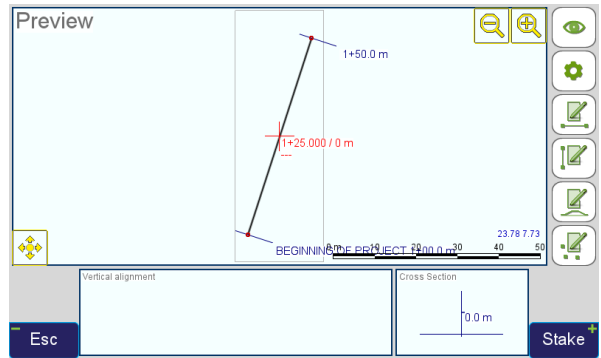
Figure 11

The picture is not too rich yet, especially "*Vertical Alignment*" and "*Cross-Section*" panels are empty. You can move around the created section (by pressing and holding screen while moving in the main preview panel) to see the system showing the corresponding station/offset values (shown in red near the cursor at the window center) and actual coordinates (shown in blue at bottom right) (Figure 12).
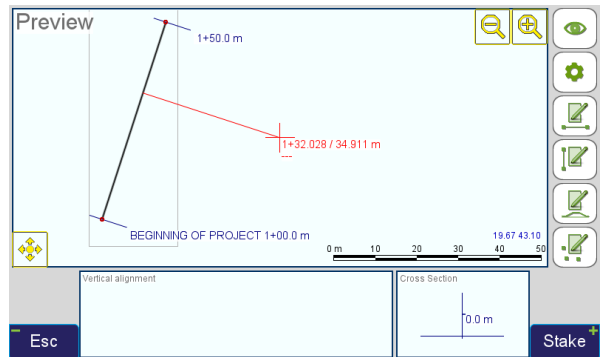
Figure 12

Now tap "**Esc**" to return to editing horizontal alignment. Tap "**New Section**" to add a new section to the end of the alignment. Note that the joint is kept smooth - new section is still a zero-length straight line, but directed at 18°, that is continuing the previous section. Tap the "**Straight Line**" button at the top to change section type. We need a transition spiral to gradually change road curvature, and type is changed as "*Straight*" "*Arc*" "*Spiral*", so tap the type button (now changed to "**Circular Arc**") once more to set it to "**Transition Spiral**". The screen now looks as shown in Figure 13:
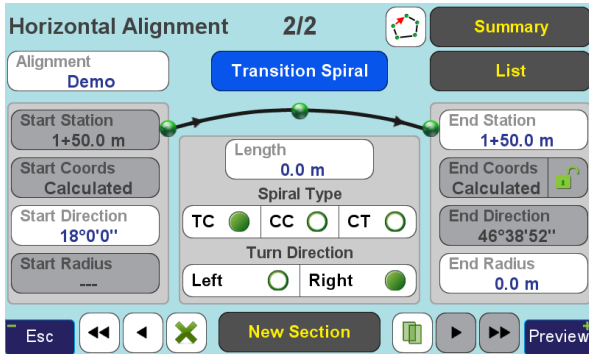
Figure 13

The "**Start Direction**" field still shows 18° — we do not need to change this, as we are creating smooth curve. The "**Spiral Type**" switch actually defines, which of the spiral's ends has zero curvature (infinite curvature radius):

- **TC** - "*Tangent to Curve*" transition: Start Radius is infinite, End Radius is arbitrary finite value

- **CC** - "*Curve to Curve*" transition (for connecting two arcs of different curvatures): both radii are finite values

- **CT** - "*Curve to Tangent*" transition: Start Radius is finite, End Radius is infinite

When the section is first created, the "**Spiral Type**" is initially set according to the curvature of the previous section - **TC** if the spiral comes after straight line, and **CT** if it comes after an arc.

Now we need a 50 m transition curve for right turn with 150 m radius, so enter the corresponding values in "**Length**" and "**End Radius**" fields. Option for right turn direction is checked by default (Figure 14).
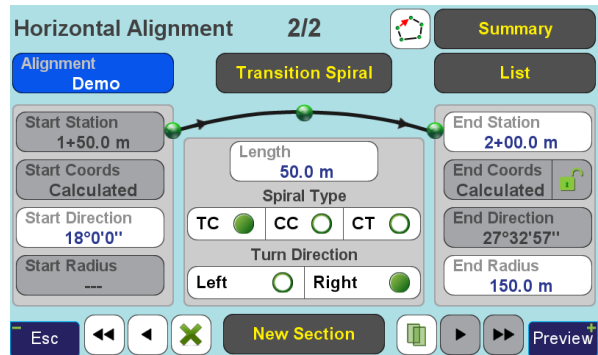
Figure 14

Note that you can use the four navigation buttons at the bottom of the screen (acting the same way on editing screens of all four alignment components) to move between already entered sections:

Stake Out Alignments

◀◀ Go to the first section (starting point)

◀ Go to the previous section

▶ Go to the next section

▶▶ Go to the last entered section

Regardless of the section currently edited, the "**New Section**" button always appends a section to the end of the alignment.

Also, if you need to delete current section or item, tap the "**Delete**" (✖) button.

Tap the "**Duplicate**" (▯) button if you need to insert a new section at current position (not append to the end of the alignment). In this case *an exact copy* of the current section is created (also you may use "**List**" screens to rearrange the sections, as will be shown later).

So, now we need to create an arc. Tap "**New Section**" and click the type button once to change section to "**Circular Arc**" (Figure 15).
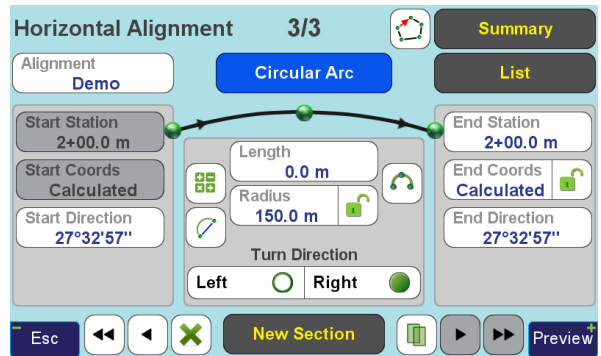
Figure 15

Once again, note that the system initializes arc radius and start direction with correct values, making the joint with transition spiral smooth. We only need to edit the arc length — set it to 150 m.

There are three additional instruments for entering arc sections.

The "**Arc Calculator**" button (⊞⊟) switches to the *CoGo Arc* screen (Figure 16), which can be used to calculate arc length and radius from other arc parameters such as tangent, curvature, middle ordinate, etc. When you enter necessary values, tap "**OK**" button to apply computed radius and arc length to current arc section and return back to editing alignment. Otherwise, tap "**Esc**" to return to editing alignment without modifying current arc section.

Arc

WGS 84 / UTM zone 37N

Field	Value
Radius (R)	150.0 m
Arc Length (L)	150.0 m
A:	57°17'45"
R:	150.0 m
L:	150.0 m
T:	81.945 m
c:	143.828 m
m:	18.363 m
e:	20.924 m
D, chord	38°56'33"

Esc   OK

Figure 16

3-Points Arc

WGS 84 / UTM zone 37N

Point		
P1	94.117m / 33.495m / 0.000m	
P2	149.384m / 83.037m / 0.000m	
P3	174.134m / 153.010m / 0.000m	

A:	57°17'45"	R:	150.0 m	L:	150.0 m
T:	81.945 m	c:	143.828 m	m:	18.363 m
e:	20.924 m	D, chord	38°56'33"		

Esc   OK

Figure 17

The "**Arc by 3 points**" button ( ) switches to the *CoGo 3-Points Arc* screen (Figure 17), which can be used to calculate all arc parameters given any point on arc (**P2**) and arc ending point (**P3**). Starting arc point **P1** is fixed and grayed out, as it is defined by previous alignment section. After entering P2 and P3 and reviewing resulting arc parameters, tap "**OK"** to modify current arc section and return back to editing alignment (in this case, arc end coordinates are set to "**Locked**"). Tap "**Esc**" to return to editing alignment without modifying current section.

The "**Chord**" button ( ) toggles additional fields for entering arc chord **Direction** and **Length** (Now, tap "New Section" and change the new section type to create another transition curve, now joining the arc and a straight:). When chord controls are visible, the exact way of their functioning is determined by "radius lock" button:

- In "unlocked" state, arc parameters (including **Radius**) are defined by **Chord Direction**, **Chord Length** and **Start Direction**

- In "locked" state, arc parameters (including **Start Direction**) are defined by **Chord Direction**, **chord length** and **Radius**
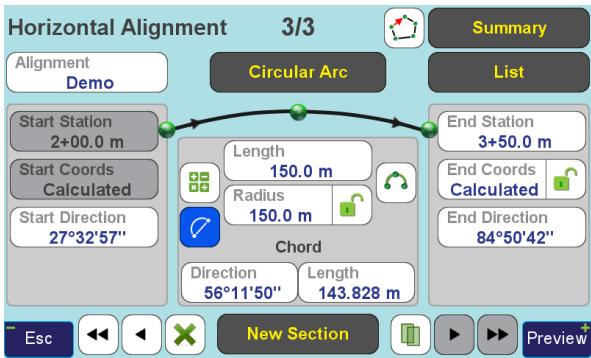
Figure 18

Now, tap "**New Section**" and change the new section type to create another transition curve, now joining the arc and a straight:
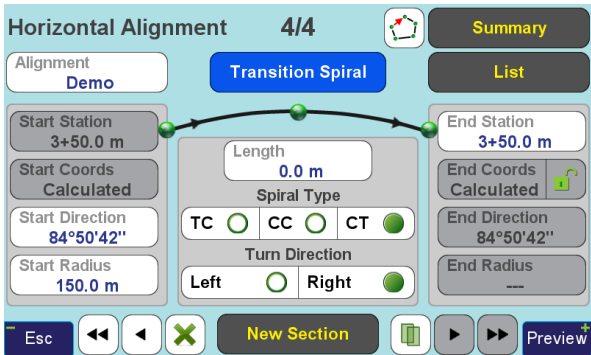
Figure 19

The spiral is already set to "*Curve to Tangent transition*" type, starting with curvature radius of 150 m and ending with zero curvature. We only have to change the

length to 50 m and finally add another straight line 100 m long, supplying our horizontal alignment with the fifth section (not counting the starting point).

Note: the "*Close*" ( ) button can be used to add a straight section towards the starting point if it is necessary to design a closed figure (e.g. fence). This button is displayed only for the last section, and only when distance between starting point and endpoint of the last section (mis-closure) is larger than Min. Stakes Distance (see Staking chapter). Pressing the button brings up a confirmation dialog indicating current mis-closure.

Let us see what we have constructed: tap the "**Preview**" button. You should see something like shown in Small red circles represent design points to be generated. As each newly created alignment inherits stake generation options from previous one (more strictly speaking, each time the generation options are changed, they are saved as default values for future alignments), the spacing between the stakes may be different depending on what had been done on this device before..
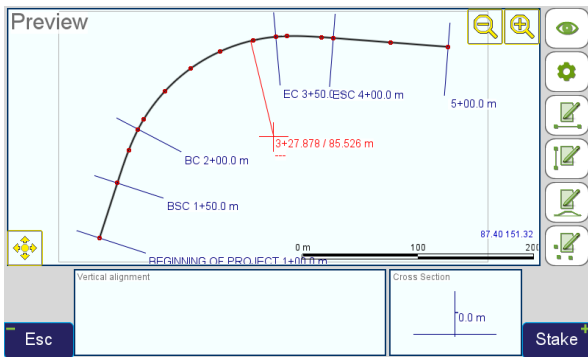
Figure 20

Small red circles represent design points to be generated. As each newly created alignment inherits stake generation options from previous one (more strictly speaking, each time the generation options are changed, they are saved as default values for future alignments), the spacing between the stakes may be different depending on what had been done on this device before.

Note: You can always go to Settings screen (⚙ "*Settings*" button on the Preview screen or "*Settings*" button on the Alignment Summary screen) and use "*Reset to Defaults*" command to revert all settings (except *Station Format*) to factory values.

Bottom panels (*Vertical Alignment* and *Cross-Section*) are still empty, as we have not entered any corresponding data. The main panel now displays the centerline of the alignment separated by blue ticks into sections. Each tick is marked with corresponding station value and joint type:

- BSC = beginning of spiral curve

- BC = beginning of curve

- EC = end of curve

- ESC = end of spiral curve

Red cross in the center of the screen is a cursor. Its coordinates are displayed in the lower right corner of the panel just above the scale bar. Near the cross, two text lines are shown in red: first contains "*station / off-set*", second - computed elevation under the cursor. As we have not entered any vertical information, this line contains "---".

Tap and drag the screen to move the image under the cursor.

Tap and hold the "**Zoom In**" 🔍 button to zoom into the area around the cursor.

Tap and hold the "**Zoom Out**" 🔍 button to zoom out.

Tap either of the two buttons twice quickly to fit the image into the view.

The "**Pan**" button fixes the cursor relative to the scheme and may be used in case you wish to examine thoroughly some cluttered area of a complex alignment without the cursor standing in front at the center.

The red line connecting cursor with the alignment shows the nearest point of the centerline, i.e. the line points at the alignment point with the station val-

Stake Out Alignments

ue of the cursor, and the offset value is the distance along the red line.

Buttons along the right edge of the screen are as follows:

👁   Toggle display of design points and text labels

⚙   Go to the *Settings* screen

✏   Edit the section of the horizontal alignment nearest to cursor, or start entering horizontal alignment if the latter is empty

✏   Edit the section of the vertical alignment nearest to cursor, or start entering vertical alignment if the latter is empty

✏   Edit the cross-section nearest to cursor, or create first cross-section

✏   Edit the offset point nearest to cursor, or create first offset point

Finally, let us specify the coordinates of the starting point of the alignment. Tap "**Esc**" to return to editing screen, then the "**To start**" button (◀◀). Tap "**Coordinates**" field to go to the *Select Point Coordinates* screen (Figure 21). Here you can use various means to input the starting point coordinates (note that elevation coordinate is not used). After editing coordinates, press "**OK**" to return to the starting point screen. Now you can again tap "**Preview**" to go to the *Preview* screen and with the help of coordinates indicated at lower right corner verify that the whole alignment has changed its position without changing shape.
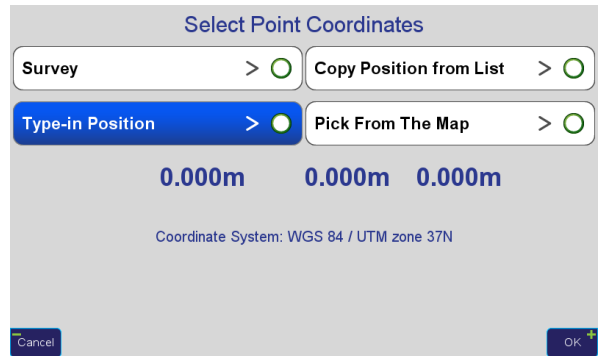
Figure 21

Now, let us pass to creating vertical alignment.

Creating Vertical Alignment

Tap the ✏ button on the *Preview* screen (or go back until you get to the *Summary* screen and tap the "**Vertical**" button) to create Starting Point of the vertical alignment (Figure 22).
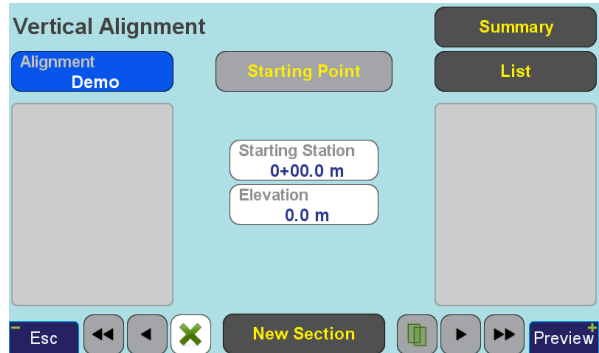
Figure 22

The *Starting Point* of the vertical alignment is characterized by **Starting Station** and **Elevation**.

Note: As soon as we have created a starting point for vertical (or horizontal) alignment, the corresponding component is considered to be not empty, even as it has no linear sections.

Tap the "***Delete***" (✖) button in the Starting Point screen if you need to delete the component completely.

Starting station of vertical alignment does not have to be equal to starting station of horizontal component, but there is not much reason to set it before the start of horizontal alignment, as stake point generation is tied to the horizontal alignment. In our example, vertical starting station is equal to the horizontal one. So, set the **Starting Station** to "1+00.0", and **Elevation** to 150.0. As with horizontal alignment, later changing the starting point coordinate (elevation) will shift the whole vertical profile without deforming it.

Next, we will enter a level line smoothly blending into a slope and back to level.

Like with horizontal alignment, tap the "**New Section**" button to create first section (see Figure 23).

Figure 23

All we can change here actually are horizontal length (via "**Hor. Length**" or "**End Station**" fields) and slope (directly via "**Slope**" or indirectly via "**End Elevation**"). Set the length to 75.0, leave the section level and tap **New Section** to go on. In the new section created, tap "**Straight Line**" button to change type to "**Parabolic Curve**" (Figure 24).

Figure 24

By default, parabolic curve has "**Grade In**" (starting slope) and "**Grade Out**" (ending slope) identical (that is, forming a straight line) and equal to the ending slope of the previous section.

Note: In current implementation all slopes are defined in percent, i.e. as Δ(vertical)/Δ(horizontal)*100%.

We need to create transition curve for 5% target slope. So, enter "50.0" as horizontal length and "5.0" as "**Grade Out**".

Note: You can also enter "**End Elevation**", and "**Grade Out**" will be computed automatically (in our example, set "**End Elevation**" to 151.25 and "**Grade Out**" will be calculated as 5%). As a parabolic curve with fixed starting slope and horizontal length has only one degree of freedom, "**End Elevation**" and "**Grade Out**" fields cannot be edited independently.

Now our screen looks as shown in Figure 25.
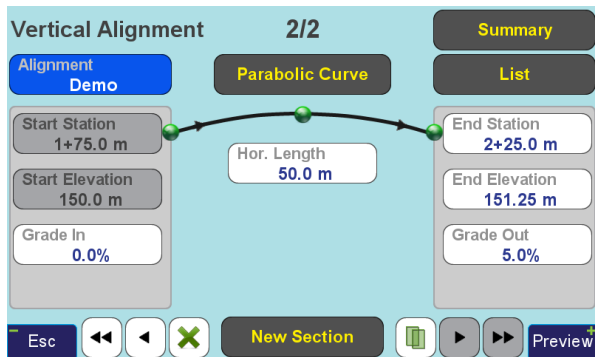
Figure 25

Tap "**New Section**" to create straight line, note that slope is automatically set to our desired 5%, and edit "**Hor. Length**" to 35.0 (Figure 26).
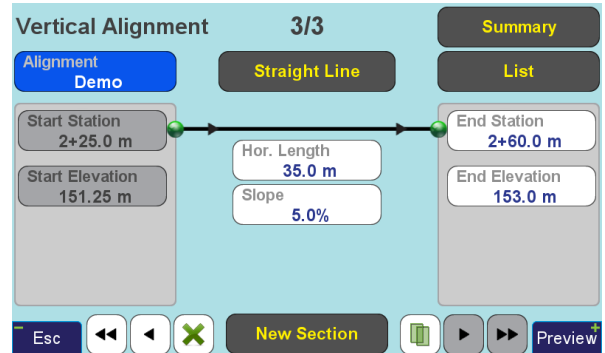
Figure 26

The procedure has become a little bit boring, so let us get familiar with the *List* screen and create another transition parabola via copy. Tap the "**List**" button at the upper right corner of the screen.
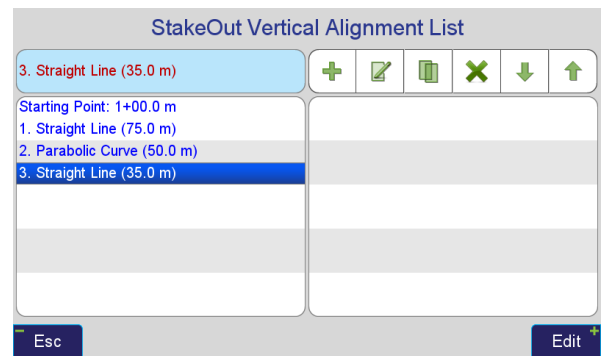
Figure 27

List screens (Figure 27) for all alignment components function in a similar way. The main table lists alignment sections, cross-sections or offset points. Alignment section record contains section type and length; starting point record contains starting station value. Current section (i.e. section which was edited on the most recent visit to corresponding editing screen) is highlighted.

The following buttons constitute the toolbar:

➕   Append new section (identical to the "**New Section**» button of the editing screen)

📝   Edit selected section (go to the editing screen)

📑   Create copy of the selected section

✖   Delete selected section

⬇   Move selected section down the list

⬆   Move selected section up the list

Now, select in the list section "2. Parabolic Curve" and tap the "**Copy**" (📑) button. An identical section is created at selected position (Figure 28).

StakeOut Vertical Alignment List

3. Parabolic Curve (50.0 m)

Starting Point: 1+00.0 m
1. Straight Line (75.0 m)
2. Parabolic Curve (50.0 m)
3. Parabolic Curve (50.0 m)
4. Straight Line (35.0 m)

Esc   Edit
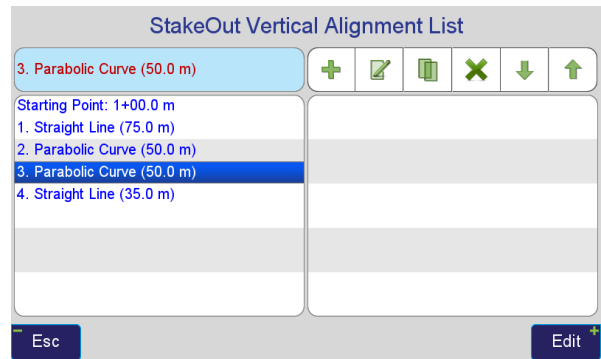
Figure 28

Tap the "**Move Down**" (⬇) button once to position the curve section properly (Figure 29).

StakeOut Vertical Alignment List

4. Parabolic Curve (50.0 m)

Starting Point: 1+00.0 m
1. Straight Line (75.0 m)
2. Parabolic Curve (50.0 m)
3. Straight Line (35.0 m)
4. Parabolic Curve (50.0 m)

Esc   Edit
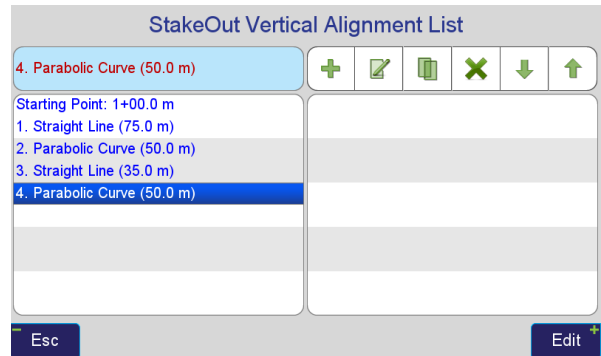
Figure 29

In our case, entering the section directly would have been faster than copying it this way, but this function may be helpful if you need to enter e.g. some horizontal transition spiral with complicated values more

than once.

Tap the "**Edit**" ( ) button to switch to editing the selected parabolic section. As we need to transition the alignment into level line, swap the "**Grade In**" and "**Grade Out**" field values (by the way, note that the copying operation does not preserve smoothness of the joints, so the section is copied unaltered) (Figure 30).
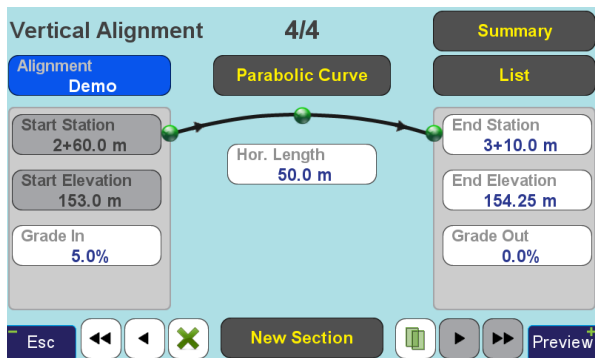
Figure 30

Finally, add last level section 170 m long (Figure 31).
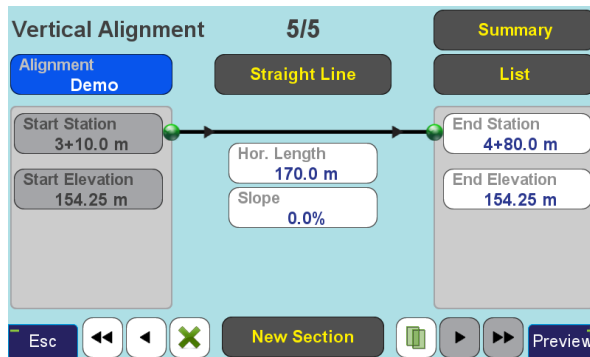
Figure 31

Tap "**Preview**" to go to the *Preview* screen (Figure 32).
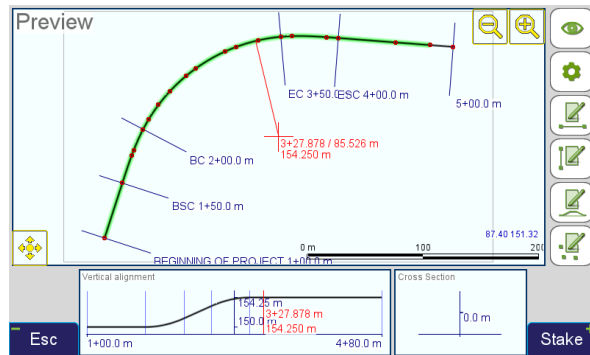
Figure 32

The picture has changed. First of all, the Vertical Alignment panel is no longer empty. It shows the vertical alignment profile (scaled unevenly, so it best fits both horizontally and vertically). The profile is separated by blue lines denoting section joints. Moving cursor in

main (horizontal alignment) panel makes the red cursor in Vertical Alignment panel move synchronously and vice versa. Red text near the cursor in Vertical Alignment panel shows station value and elevation at current position.

In the main panel, cursor now displays elevation values (as we have not defined any cross-sections, the elevation value is the same for all offset values with the same station value). Also, the part of horizontal alignment which has been assigned a vertical profile, is highlighted with green.

Defining Cross-Sections

Now as the centerline has been entered, it is time to define some cross-sections. The layout we are recreating (depicted in the beginning of the document) contains nearly uniform cross-section along the whole alignment except for a narrowing closer to the end. We will need to create 5 cross-sections to implement this, as you will see — without much extra clicks.

All cross-sections for the given alignment have same number of segments, and same codes assigned to the segments — it is possible to change only distance and slope of the segments. So, list of segments is entered once for the first cross-section, and minor editing is done afterwards for the cross-sections to follow.

Switch to cross-section editing screen by pressing the ✎ button on the *Preview* screen (or go back until you get to the *Summary* screen and tap the "**Cross-Sections**" button). You will see the screen shown in Figure 33.
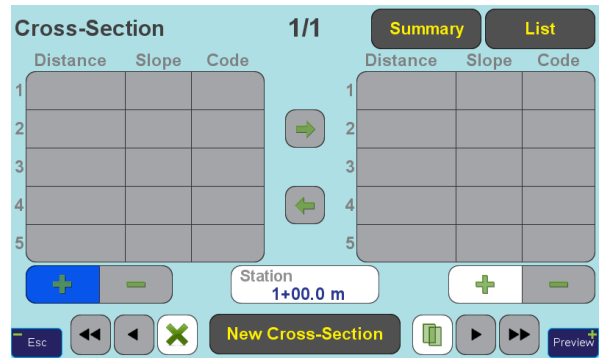
Figure 33

First created cross-section is assigned the station value of the horizontal alignment starting point.

Left and right tables on the screen are used to define respectively left and right (looking in the direction of station value growth along the alignment) cross-section sides. For cross-sections, the "**New Cross-Section**" and "**Copy**" (▯) buttons differ in that the former creates a copy of the last entry, while the latter creates a copy of the entry currently edited.

Note: Regardless of the order in which the cross-sections are entered, they are always sorted by station value.

First we define a cross-section which will last for the most part of the alignment.

Tap left "**Add Segment**" (✚) button to add first segment (Figure 34). Current implementation supports up to 5 segments for each cross-section side.
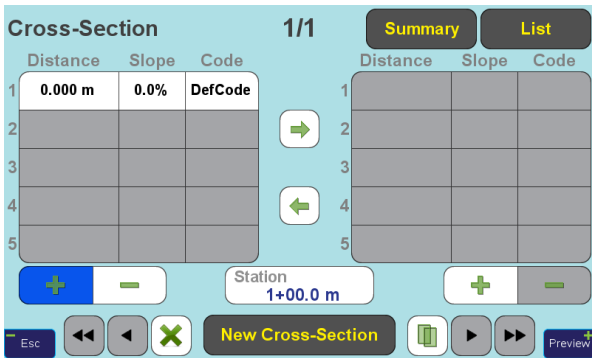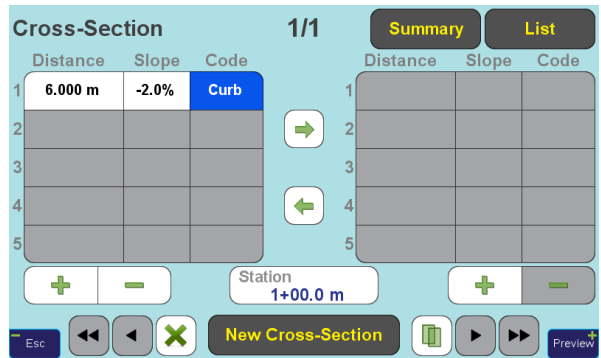
Stake Out Alignments

Figure 34

Figure 35

Codes must have been defined beforehand (pressing the "**Code**" field switches to screen which supports only selection of existing codes. To enter new codes, use *ShapeTags & Codes* commands on *Home* screen).

Also note that once the segments have been entered, the "**Delete Segment**" ( ) button deletes the last segment — there is no way to delete a segment in the middle without deleting segments after it.

The horizontal distance of stakes, corresponding to this segment, from the centerline will be 6 m, slope will be -2%, and code we will arbitrarily call "*Curb*" (for the purpose of this tutorial you may, of course, use any other code including "*DefCode*"). Enter the values by clicking and editing corresponding table fields (Figure 35).

Tap left "**Add Segment**" ( ) button once more to add second segment and set its fields to distance 5 m; slope -60%; code — say, "*Ditch*" (Figure 36).
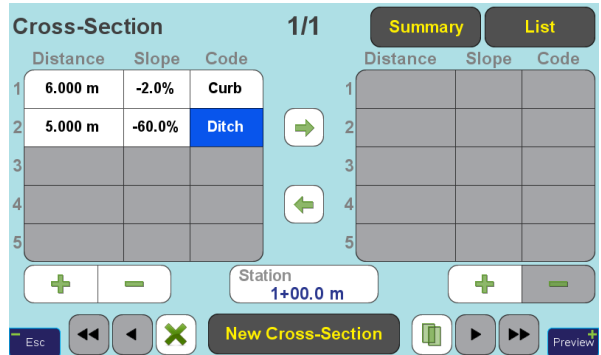
Figure 36

Note: The "***Distance***" field denotes distance from previous segment, not from centerline. So when we enter segments with distances 6 and 5 m, it means that the

second segment is 11 m from the centerline. Distance of 0 is also a valid value.

Time to look at our progress. Tap the "**Preview**" button. Now, besides the new sidelines and design points displayed near centerline in the main panel, the *Cross-Section* panel also shows data (as in *Vertical Alignment* panel, it is scaled unevenly for best fit) (Figure 37). When cursor in main panel is within the cross-section, the *Cross-Section* panel also has cursor with coordinates.

Note two important things: 1. As we now have cross-sections defined, elevation outside the sidelines is not calculated (cursor in main panel displays the "---" in place of elevation). 2. Elevation displayed next to cursor in main panel is a sum of elevation along centerline, displayed next to cursor in the *Vertical Alignment* panel, and relative elevation across centerline, displayed next to cursor in the *Cross-Section* panel.

Figure 37

Tap "**Esc**" to return to editing the cross-sections.
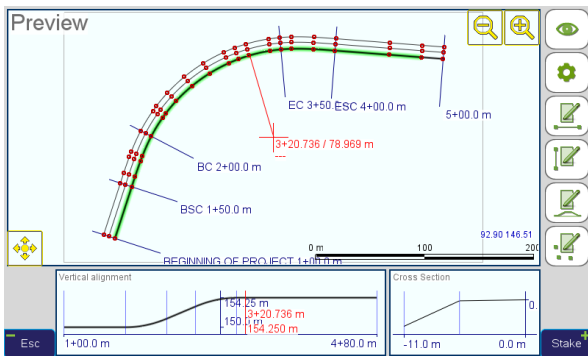
We will define right side a bit later, and now set up the narrowing. It is denoted by cross-sections equal to initial one at stations 4+10 and 4+80, and cross-sections with degenerate outer segment at stations 4+30 and 4+60.

So, tap "**New Cross-Section**" (screen switches to editing the created entry). Set "**Station**" to 4+10. Tap "**New Cross-Section**" once more. Set "**Station**" to 4+80.

To create two inner cross-sections, tap "**New Cross-Section**" once again. Set "**Station**" to 4+30 (position of the entry in the list changes to "*3/4*" as the entries are sorted by station value, as it was mentioned before). Set "**Distance**" field for the second segment to 0. Tap the "**Copy**" (⬛) button to create copy of the current (not last) entry. Change "**Station**" to 4+60.

Tap "**Preview**" and see that the left side of the alignment is complete (Figure 38).
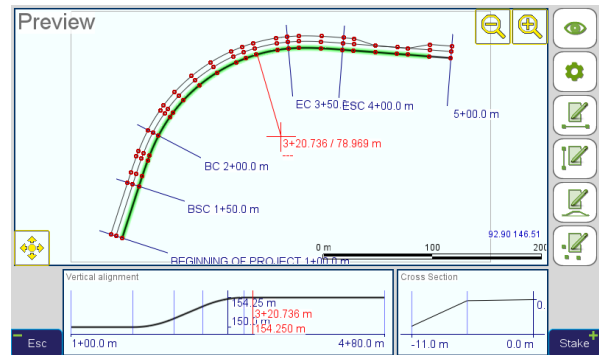
Figure 38

Tap "**Esc**" to return to editing screen again.

There is one last step left — tap the "**Copy Left to Right**" () button to copy the whole left side cross-section definition to the right side (Figure 39).
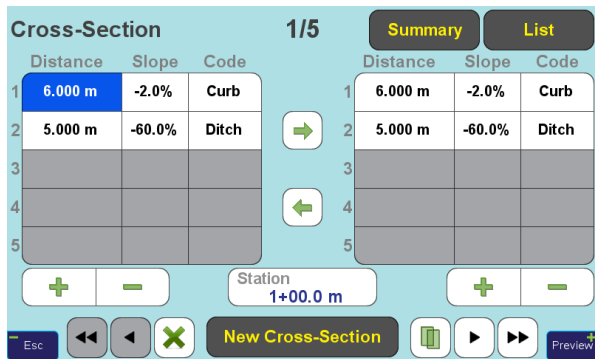

Figure 39

Tap "**Preview**" to see that cross-sections definition is complete (Figure 40).
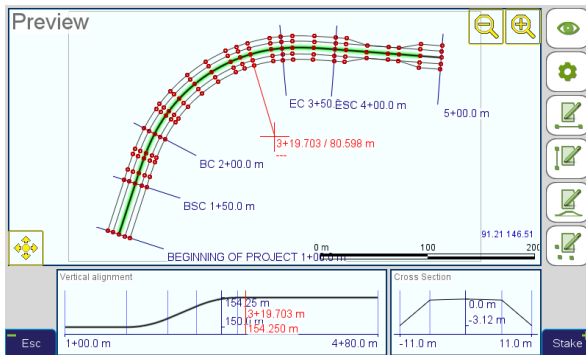

Figure 40

Entering Offset Points

If it is necessary to stake some separate points (e.g. lamp posts positions) with known station/offset values relative to the alignment, Offset Points functionality can be used for that. To enter offset points, use the button on the *Preview* screen, or the "**Offset Points**" button on the *Alignment Summary* screen.

Entering offset points is straightforward (Figure 41).
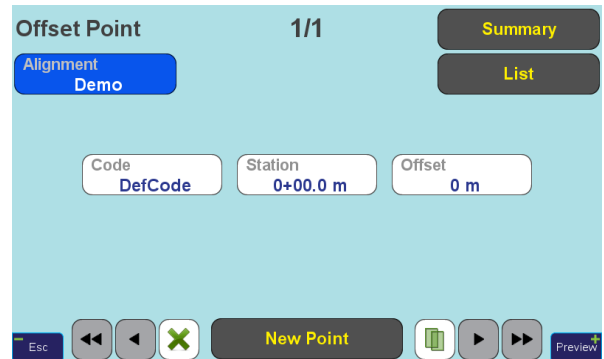
Figure 41

Just fill the "**Code**", "**Station**" and "**Offset**" fields, pressing "**New Point**" or "**Copy**" () to create each point. Our two points will have equal code "*Post*", station value of 1+15, and offset values of +7.5 and -7.5 m respectively, so it is better to use "**Copy**" button to create the second point and change only offset value (Figure 42).
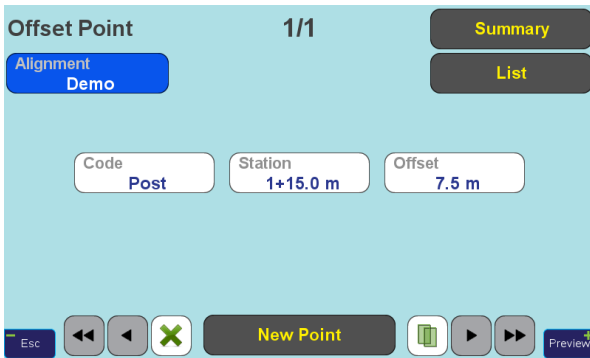
Figure 42

As usual, tap "**Preview**" to see the final layout of our alignment (Figure 43).
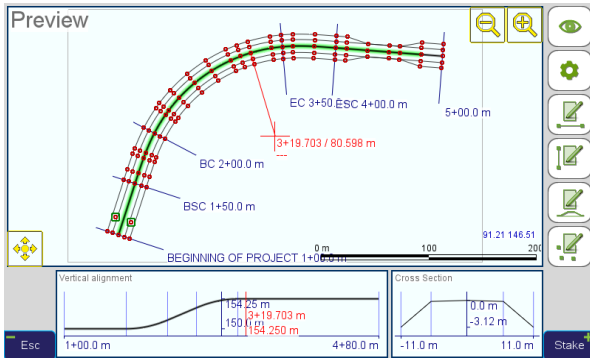
Figure 43

Modifying the Alignment

Finally, let us do small editing test. Return to the *Alignment Summary* screen and tap the "**Alignment**" button, which is equivalent to conventional "save as"

command. The system suggests a new name for the alignment (Figure 44).

Figure 44

Tap "**Done**" to agree with the suggested name. Return to the *Summary* screen, already with the new alignment (which is the copy of the one we created). Our "*Demo*" alignment stays intact, and we can return to it any time by performing the "**Open Alignment**" command from the *Stake-Out/Prepare* screen.

Tap "**Horizontal**", pass through all sections and for each arc or spiral section, change "**Turn Direction**" from **Right** to **Left**. Return to the section 1/5 (Straight Line), edit the "**Direction**" field so that it says "118°" instead of "18°" we have set initially.

Tap "**Preview**" and note that alignment shape have changed as we expected, keeping everything consistent and smooth (Figure 45).
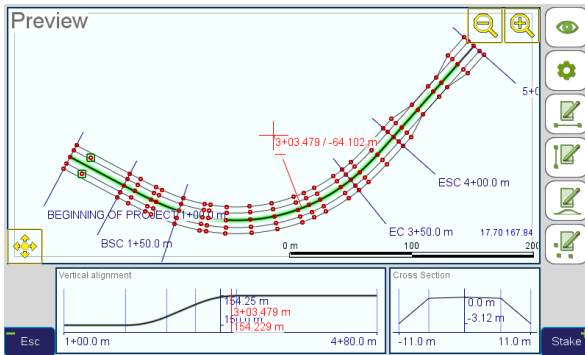
Figure 45

Figure 46

Staking

For staking, the alignment is converted into a sequence of design points, which are then staked in the same manner as separate single design points (except for the "**stake here**" mode which is described later).

Stake Settings

Before starting the actual staking process, it is necessary to set or review the stake generation settings. The *Settings* screen (Figure 46) is called either by the "**Settings**" button in *Alignment Summary* screen or by the "**Settings**" (⚙) button in *Preview* screen.
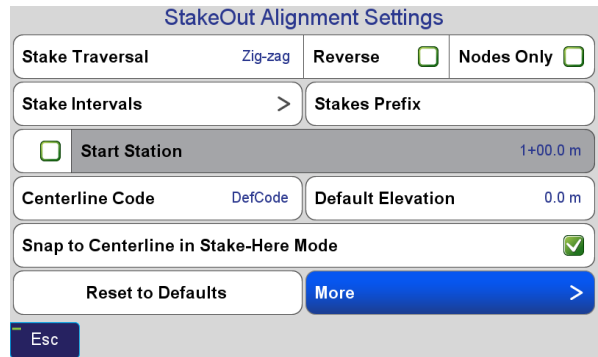
The "**More**" button leads to another settings screen (Figure 47).
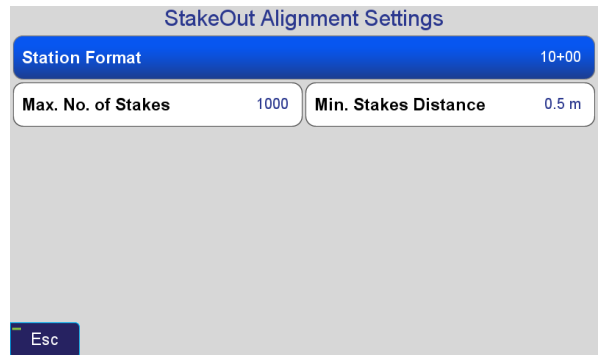
Figure 47

Let us review settings on both these screens.

"**Station Format**" and "**Snap to Centerline in Stake-Here Mode**" are global settings, which influence all alignments. Changing all other settings affects cur-

rently active alignment only, and defaults for alignments to be created in future, but not other already created alignments.

Settings on these screens have the following meaning:

- **Stake Traversal** — defines which alignment components become source of stakes, and order in which these stakes are traversed. Selecting this setting opens the screen as shown in Figure 48.

Figure 48

The following options are available for Stake Traversal:

- o **Zig-zag** — all alignment components are utilized (centerline, cross-section sidelines and offset points) — sample shown in Figure 49.
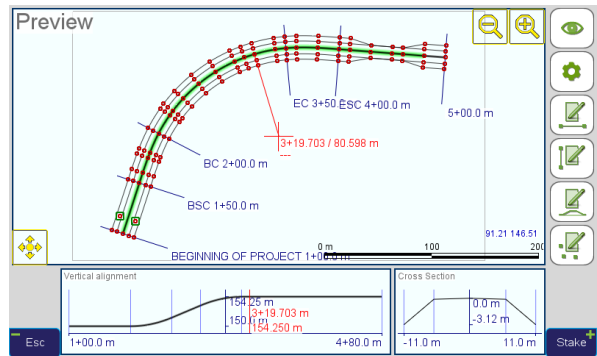
Figure 49

The stakes are passed in the zig-zag manner in station value ascending order, the corresponding trajectory on map is shown in Lane by Lane — same as "Zig-zag", but stakes are sorted by offset and passed in a sort of spiral: first, the centerline is passed in station ascending order, then first left sideline in station descending order, then first right sideline in station ascending order, and so on. Corresponding trajectory on map looks like shown in Centerline Only — only centerline is staked, cross sections and offset points are ignored. The centerline can be offset by the "Offset" value, as shown (for example offset value of 20 m) in Offset Points Only — only offset points are staked, other alignment components are ignored....
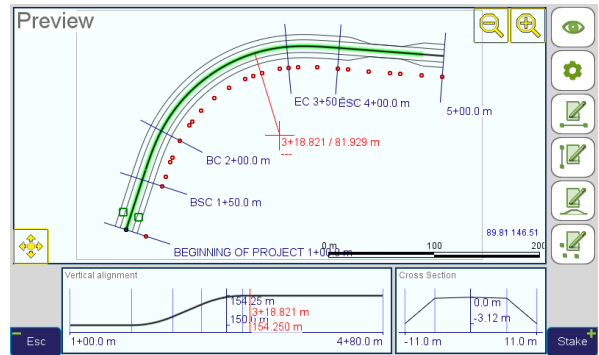
Stake Out Alignments

Figure 50

Figure 51

o **Lane by Lane** — same as "**Zig-zag**", but stakes are sorted by offset and passed in a sort of spiral: first, the centerline is passed in station ascending order, then first left sideline in station descending order, then first right sideline in station ascending order, and so on. Corresponding trajectory on map looks like shown in Centerline Only — only centerline is staked, cross sections and offset points are ignored. The centerline can be offset by the "Offset" value, as shown (for example offset value of 20 m) in Offset Points Only — only offset points are staked, other alignment components are ignored...

o **Centerline Only** — only centerline is staked, cross sections and offset points are ignored. The centerline can be offset by the "**Offset**" value, as shown (for example offset value of 20 m) in Offset Points Only — only offset points are staked, other alignment components are ignored..

Figure 52

o **Offset Points Only** — only offset points are staked, other alignment components are ignored.

- **Reverse** — the stakes generated according to all other options are traversed in reverse order.

- **Nodes Only** — the Stake Intervals setting is ignored, stakes are put only at stations where some of the alignment components change (at joints between horizontal and vertical alignment sections, at defined cross-sections) and at offset points, like illustrated in Stake Intervals. This button switches to screen which controls generation of intermediate stakes (this button is disabled if the "Nodes Only" setting is checked, as in this case no intermediate stakes are generated) as shown in Line Stake Interval — interval between generated points on straight horizontal sections. Note that point stations are aligned at the interval value multiples, for example if section starts at 0+95, ends at 2+05 and stake interval is 50 m, the stakes for that section are generated at stations 0+95, 1+00, 1+50, 2+00 and 2+05.:.
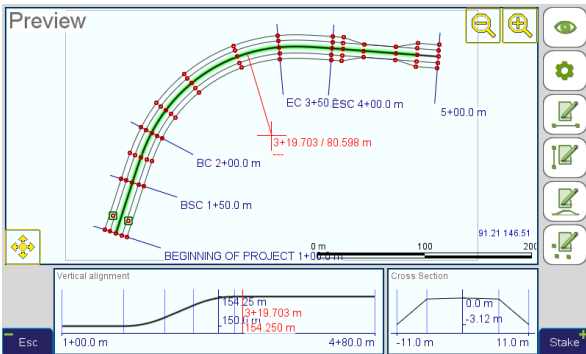
Figure 53

- **Stake Intervals**. This button switches to screen which controls generation of intermediate stakes (this button is disabled if the "**Nodes Only**" setting is checked, as in this case no intermediate stakes are generated) as shown in Line Stake Interval — interval between generated points on straight horizontal sections. Note that point stations are aligned at the interval value multiples, for example if section starts at 0+95, ends at 2+05 and stake interval is 50 m, the stakes for that section are generated at stations 0+95, 1+00, 1+50, 2+00 and 2+05.:

Figure 54

o **Line Stake Interval** — interval between generated points on straight horizontal sections. Note that point stations are aligned at the interval value multiples, for example if section starts at 0+95, ends at 2+05 and stake interval is 50 m, the stakes for that section are generated at stations 0+95, 1+00, 1+50, 2+00 and 2+05.

o **Curve Stake Interval** — interval be-

Stake Out Alignments

tween generated points on circular and spiral horizontal sections. The generation principle is the same as noted for **Line Stake Interval**.

o **Max Line Offset** — if this option is enabled (checked), its value controls generation of additional stakes so that on curve horizontal sections, deviation of polyline passing through stakes from initial curve is within this limit. Algorithm: each generated pair of neighbor design points is checked for distance from the ideal curve, and additional stake is inserted between them if straight line connecting them is more than Max Line Offset from the curve; repeated until all connecting lines are close enough to the curve. Thus, the less the radius of curvature, the more dense are generated stakes.

As an example, compare two illustrations below: in both cases, **Line** and **Curve Stake Intervals** are set to 10000 m.

The first one with **Max Line Offset** disabled is shown in The second — with Max Line Offset set to 0.05 m is shown in Max Line V. Offset — the same as Max Line Offset, but for parabolic curves in vertical alignment...
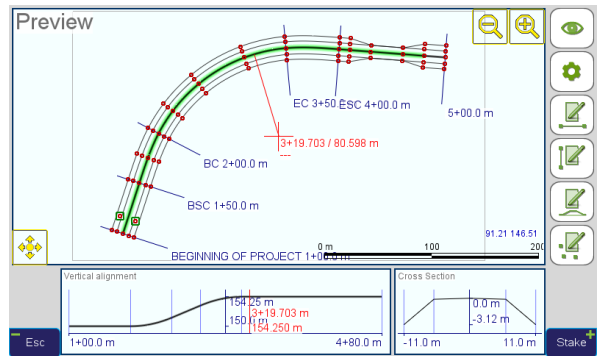
Figure 55

The second — with **Max Line Offset** set to 0.05 m is shown in Max Line V. Offset — the same as Max Line Offset, but for parabolic curves in vertical alignment..
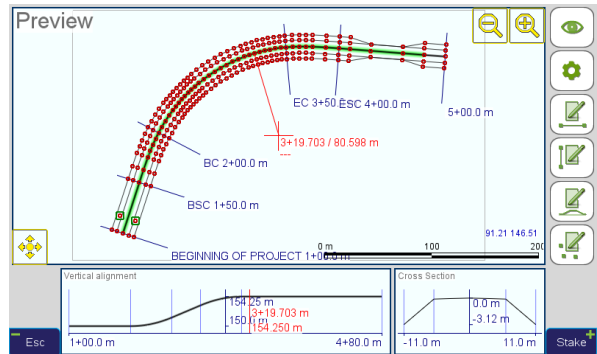
Figure 56

o **Max Line V. Offset** — the same as **Max Line Offset**, but for parabolic curves in

vertical alignment.

- **Stakes Prefix** - prefix string added to design points saved to map, so that they can be easily distinguished from other map objects.

- **Start Station** — if this setting is enabled (checked), its numeric value defines station value to start generating stakes from. Depending on the "**Reverse**" setting:

  o If "**Reverse**" is unchecked, it is minimum allowed station value

  o If "**Reverse**" is checked, it is maximum allowed station value

  This setting may be used to continue stake process after part of it has been completed before, or if some alignment part is not reachable.

  Below are examples for *Start Station* set to 1+50:

  With "**Reverse**" unchecked — Figure 57.
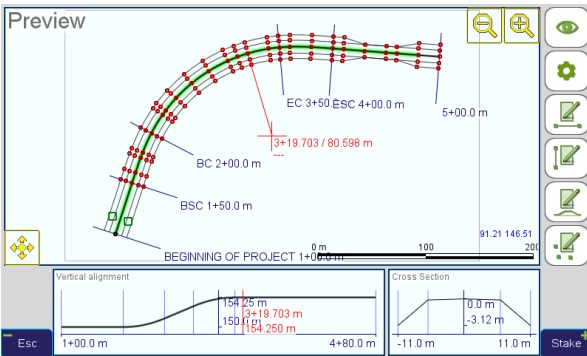
Figure 57

With "Reverse" checked — Figure 58.
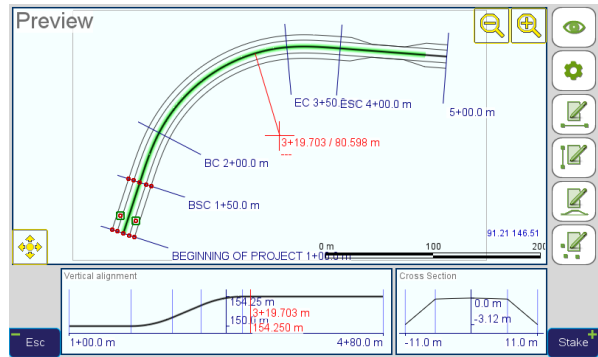
Figure 58

- **Centerline Code** — code for design points generated on the alignment centerline.

  Note: This code does not have to be different from cross-section or offset points codes. All stakes may share the same code, and all stakes may share the same code "DefCode".

- **Default Elevation** - elevation used for design points generated for pure 2D part of the alignment (i.e. outside the range of the vertical alignment).

- **Snap to Centerline in Stake-Here Mode** — in "**stake here**" mode (described below), put target coordinates of all created design points to the centerline (i.e. with offset equal to zero). This option should be turned on if you need to stake a "zero-width" line object, and turned off if you actually stake a surface defined by the alignment, and points to stake not necessarily belong to the

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alignment centerline.

- **Station Format** — global setting of visual representation of station values. Does not influence any calculations and affects display only. Available options:

  o "**1000**" — display station as general floating point value, e.g. "4200.0"

  o "**10+00**" — display station as floating point value with last two digits to the left of decimal point separated by a plus, e.g. "42+00.0"

  o "**1+000**" — display station as floating point value with last three digits to the left of decimal point separated by a plus, e.g. "4+200.0"

- **Max. No. of Stakes** — accidental input of too long section or too small stake interval may lead to generation of so large number of design points that the system starts responding slow, or to flooding the map with large quantity of false points. On the other hand, hard limit on the number of stakes may be undesirable in some situations. So, this setting defines the maximum number of generated design points which may exist at a time for active alignment. Note that this parameter does not limit the total number of objects on a map.

- **Min. Stakes Distance** — more or less complex alignment configuration may lead to generation of stakes very close to each other (for example, stake point at section joint at 0+99.7 and design points produced by interval staking at 1+00.0). There is little or no sense in leaving such stakes as separate points, so out of stakes which are closer to each other than this threshold, only one is left (section joint has precedence over interval stake).

- **Reset to Defaults** — this button resets settings for current alignment to factory defaults.

Stake Modes

There are three general stake-out modes, which are switched by the "**Mode**" button in the *Stake-Out/Prepare* screen:

Stake Points.

Alignments are not used in this mode.

Stake Out Alignments
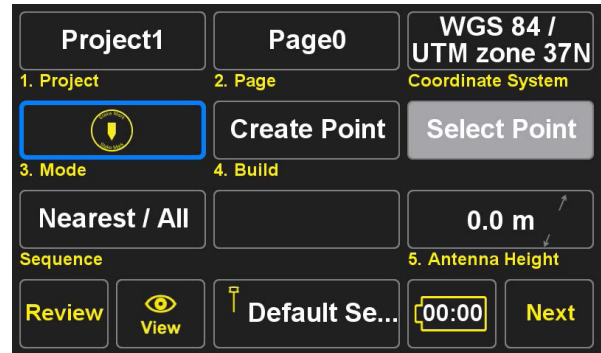
Tap **Create Point** to create new design point by entering its coordinates manually, copying from another point in the list, surveying or pointing at needed location on the map

Add Point

Name	Stake1

Code	Description

Copy Position from List > ○	Type-in Position > ○

Take Current Position from Map	●

-6.180m   19.021m   0.000m

Add Point	Add and Stake

Esc

Tap **Select Point** to select an existing point from the points list to stake.

Tap **Sequence** to set up sequence in which existing points are staked and select subset of points to be staked

Stake Points Mode

Nearest Point ●	Optimized Path Length ○	Alphabetic ○

Use All Points On Page ●	Select Points to Stake > ○

Skip Already Staked Points	☑

Reset Sequence

Esc   Stake

Stake Alignment Points.
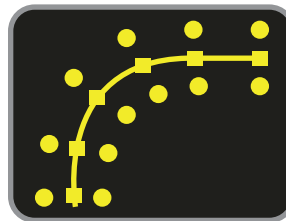
Design points are created from current alignment as defined by the Settings screen called either by the "**Settings**" button in *Alignment Summary* screen or by the "**Settings**" ( ) button in *Preview* screen.
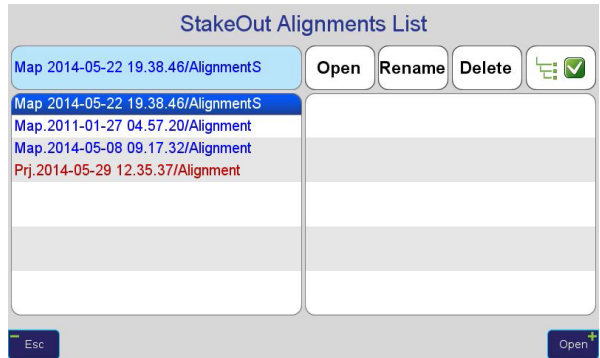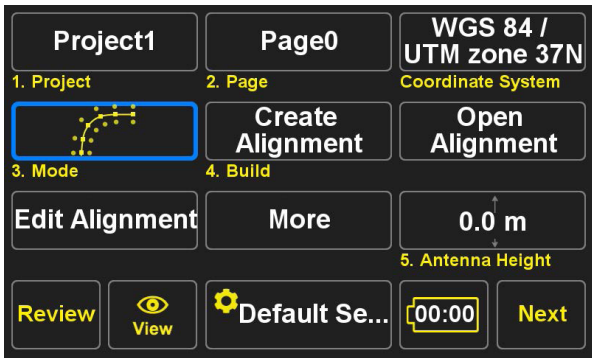
• **Create Alignment** creates new alignment, as described in this tutorial.

• **Open Alignment** switches to the list of all existing alignments to open, rename or delete them


As alignments are stored with projects, use the "**Show all**" ( ) button to display alignments available in all projects

• **Edit Alignment** edits current alignment.

• **More** brings up additional alignment options, which include

Stake Line — quick set-up alignment to stake straight line connecting 2 points. Define end points and tap Create Alignment to create a new alignment containing horizontal and vertical components and switch back to alignment editing.
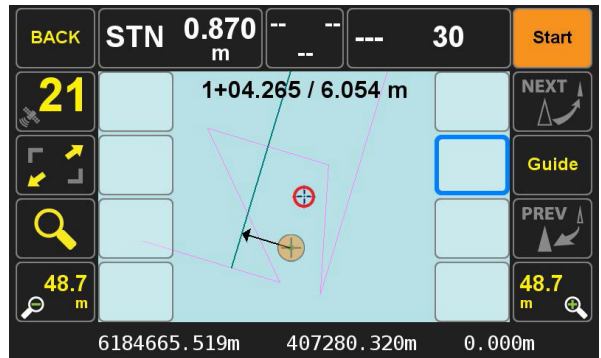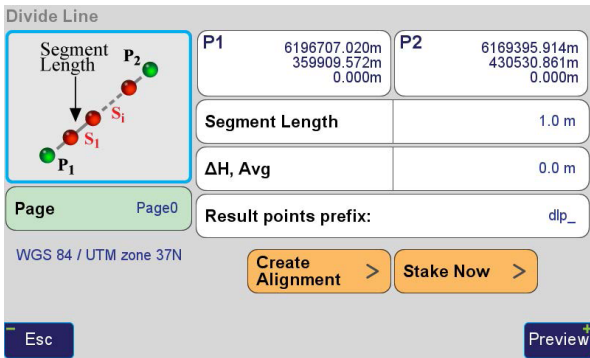
Stake Polyline — select existing polyline object to create horizontal and vertical sections from each of the sections constituting it.

Stake Here.
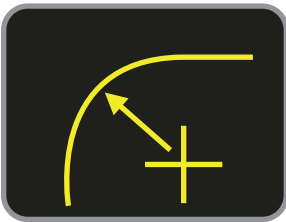
This mode also uses current alignment, but a stake point is created each time a survey point is collected. Station / offset of current position relative to the alignment is displayed on map, and guide line is shown on the screen pointing at the nearest alignment centerline point

Depending on the option **Snap to Centerline in Stake-Here Mode,** which can be changed in the Settings screen called either by the "**Settings**" button in Alignment Summary screen or by the "**Settings**" (

) button in *Preview* screen, each time the surveyed point is accepted, a new point is created with target coordinates at the alignment centerline if **Snap to Centerline** is on, or at the current position otherwise. In the former case, the cut sheet for the point will contain residual vector both in horizontal and vertical directions between measured point and centerline. In the latter case, the horizontal target and actual coordinates are equal, and cut sheet contains vertical discrepancy between designed and actual surface.

Tags & Codes

Using ShapeTags and Codes

ShapeTags are used in J-Field to control connections between collected points. Points collected with the same ShapeTag name are connected together by a line or curve (as the user has selected). Points collected with the same ShapeTag name continue to be connected until the user ends the line. Polylines can be ended open or closed back to the first point. Once a ShapeTag is ended, it can be reused for another Polyline collected later.

The benefit of using ShapeTags is especially evident in the J-Field Auto Sequence. By building a list of ShapeTags to be collected, J-Field can automatically switch from one polyline to the next according to the user-defined list. This is particularly beneficial to cross-section data collection. Consider a cross-section of a road that has a ditch on either side. The cross-section sequence would be Left Natural Ground (LNG), Left Top Bank (LTB), Left Ditch Flow Line (LFL), Left Edge of Pavement (LEP), Centerline (CL), Right Edge of Pavement (REP), Right Ditch Flow Line (RFL), Right Top Bank (RTB),Right Natural Ground (RNG). The Auto Sequence would increment from one line to the next based on the ShapeTags (LNG, LTB, LFL...RTB, RNG). Auto Sequence also allows for reversing the sequence once complete (RNG, RTB, RFL...LTB, LNG).

Codes are used in a unique way within J-Field. Codes are designed by the user and function similarly to layers in AutoCAD. Codes also carry default symbol types and default attributes. The Code "Boundary" might contain a default circle symbol, and the attributes "Type", "Size", "ID Cap". Each point collected with the Code "Boundary" will use the circle symbol by default, and prompt for the attributes Type, Size and ID Cap. Upon Export to dxf (drawing exchange file) from J-Field, Codes can be used to define the layers of the exported polylines. When creating a ShapeTag, you must create its Code first. A Code may belong to several ShapeTags. Codes provide a very powerful data structure. When collecting standalone points, you can also use ShapeTag, Code and other attributes to make your data collection easy in the field and provide versatile documentation.

Using ShapeTags and Codes

Point ──┬──▶ [**Point Name**]　　*May auto increment*

　　　　├──▶ [**Point Description**]

Tag ──┬──▶ [**Tag Name**]　　*May auto sequence*

　　　　├──▶ [**Tag Description**]

　　　　└──▶ [**Point Name Tamplate**]　　*For point name auto increment*

Code ──┬──▶ [**Code Name**]

　　　　├──▶ [**Code Description**]

　　　　├──▶ [**Symbol**]

　　　　├──▶ [**ID**]

　　　　├──▶ [**Category**]

　　　　├──▶ [**Variable Attribute 1**]

　　　　├──▶ [**Variable Attribute 2**]

　　　　├──▶ [**Variable Attribute 3**]

　　　　├──▶ [**Variable Attribute 4**]

　　　　└──▶ [**Variable Attribute 5**]
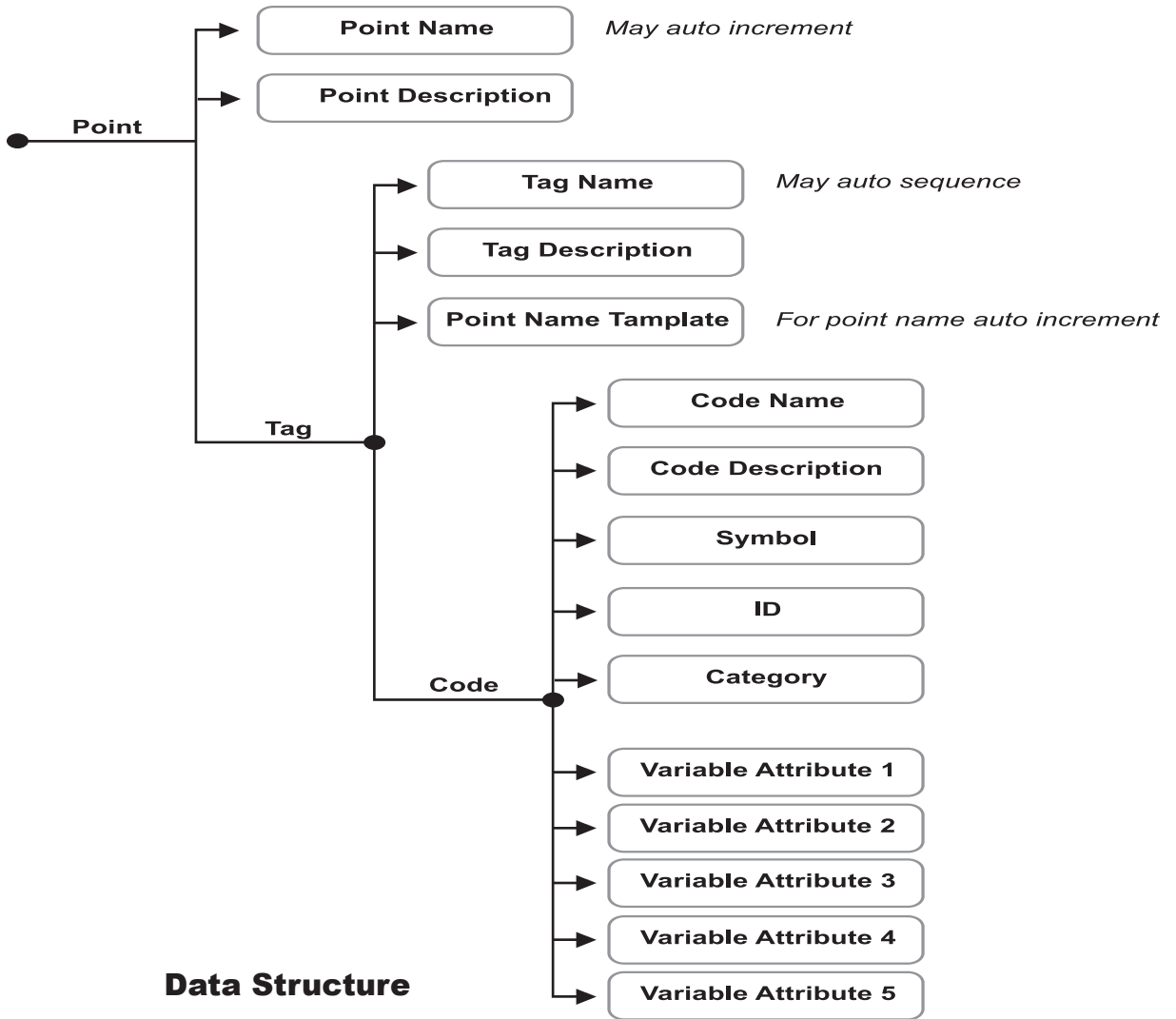
Data Structure

Defining ShapeTags & Codes

Tags are defined by selecting ShapeTags & Codes from the Home screen and then pressing the Manage ShapeTags button to open the Select ShapeTags screen.

Select ShapeTags Screen

The Select ShapeTags screen lets you Create, Edit, and Delete ShapeTags. To create a ShapeTag press Create and this screen is opened:

Here we are creating a "TOP1" ShapeTag. It has "E-TOP" as the Code associated with it. This will be used as the Code when a Point is collected with this ShapeTag. The ShapeTag has a ShapeTag Description of "Top of Ditch".

The Naming Template box can be used for controlling the Point Name of Points collected with this ShapeTag. If we were to enter "TOP" for the Naming Template the first point would have a Point Name of "TOP1", the second Point would be "TOP2" and so on.

Press Create to create this ShapeTag:

Favorite ShapeTags & Codes

Favorite ShapeTags & Codes are used in to recall frequently used ShapeTags and Codes. The reservoir of ShapeTags and Codes are stored as global values, favorite ShapeTags and Codes are saved with Setup profiles. If you recall another Setup profile, you will recall the Favorite ShapeTags and Codes associated with it.

Favorite ShapeTags Screen

Your Favorite ShapeTags can be modified by selecting Manage ShapeTags from the ShapeTags & Codes screen found in the Setup menu. More ShapeTags may also be added to your Favorite ShapeTags in this screen by clicking empty boxes and then selecting which ShapeTag you wish to add and pressing Select. Clicking an empty box takes you to the Select ShapeTags screen. Use Clear All to remove all the ShapeTags from the Favorite ShapeTags screen.

Codes can be added to your Favorites by selecting Favorites Codes from the ShapeTags & Codes screen found in the Setup menu.

Using ShapeTags

In this example it is demonstrated how to use to ShapeTags to create linework for a road and ditch.
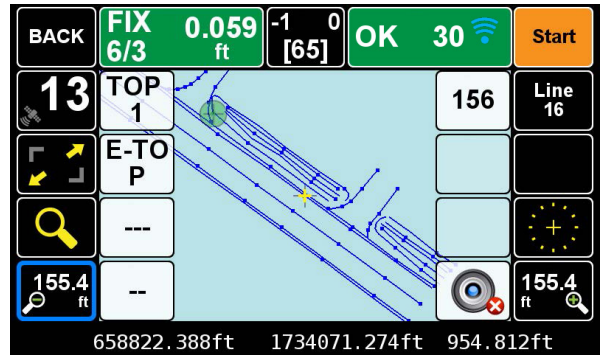
Linework of a Road and Ditch Created Using ShapeTags

To begin using ShapeTags to generate linework open the ShapeTags Switcher screen by clicking the ShapeTag box in the Collect Prepare screen.

Collect Prepare Screen

Tags Switcher Screen

The Tags Switcher screen is used to select the ShapeTag that will be associated with the next point. When opened it will display your Favorite ShapeTags.

In this example we will enable Auto Sequence Mode by checking it's box found in the ShapeTags Switcher screen.

Auto Sequence Mode with automatically cycle the ShapeTags in the order shown in the ShapeTags Switcher Auto Sequence screen. This is useful for creating cross sections at intervals as you will see in this example.
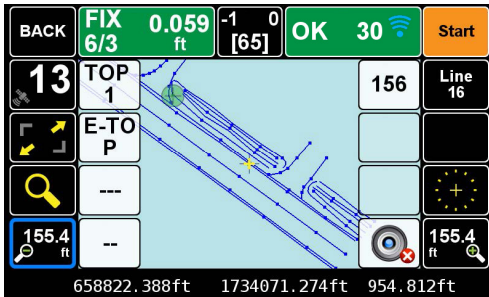
ShapeTags Switcher Auto Sequence Screen

Next click Configure and you will be taken to the Auto Sequence Setup screen. This screen can also be accessed by selecting Auto Sequence from the ShapeTags & Codes screen found in the Setup menu.

Auto Sequence Setup Screen

Click on the first empty box and click Insert to add a ShapeTag.

Using ShapeTags and Codes
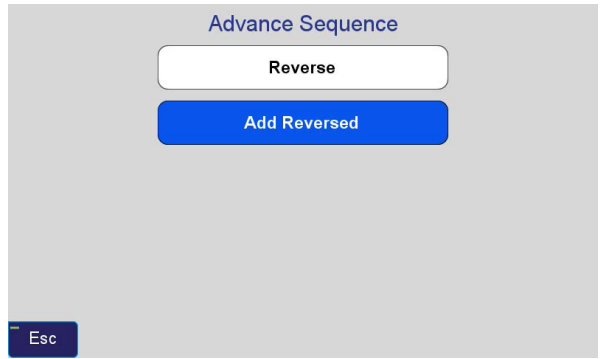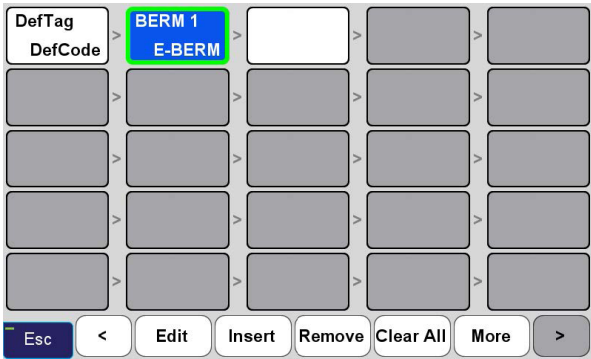
We continue to add more Tags to this sequence:
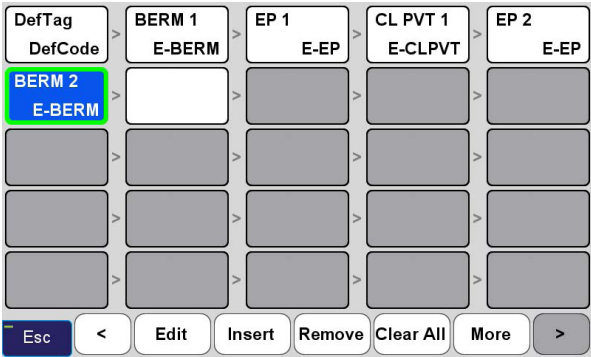
We have now added the reverse sequence of tags:
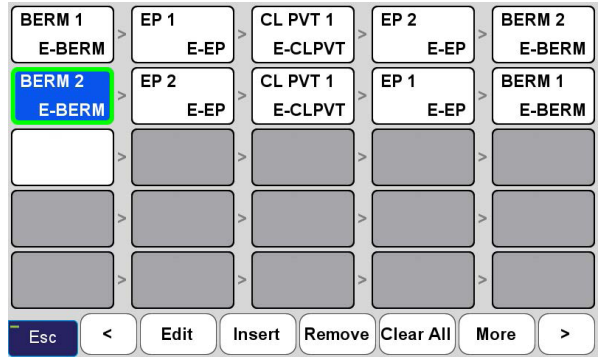
We now have tags for the two sides of the berm, the edge of pavements and the centerline. Now we want to reverse this sequence so we can continue collecting points as we walk across the road, back to the first side.   We do this by clicking More and then selecting Add Reversed. Before doing this we need to click on the first box with the "DefTag" and click Remove to eliminate it.

Press Esc to be taken back to the completed Tags Switcher Auto Sequence screen:

Using ShapeTags and Codes
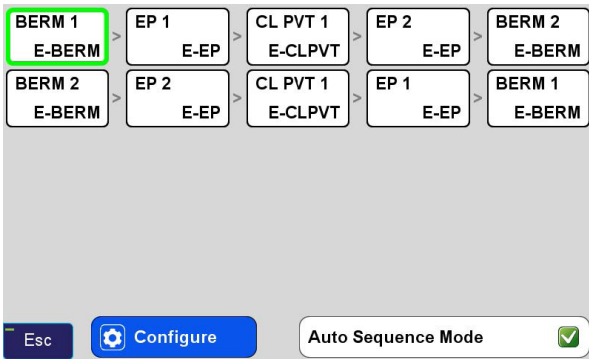
Press Esc again to be taken to the Collect Prepare screen.

Click Point to change collect mode from collecting Points to collecting Lines:

Now the Tag is set to the first Tag in our Auto Sequence series. The "A" in the bottom right corner of the Tag window indicates that we have Auto Sequence Mode enabled.
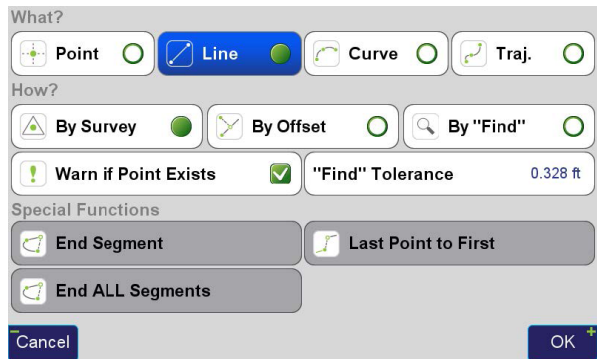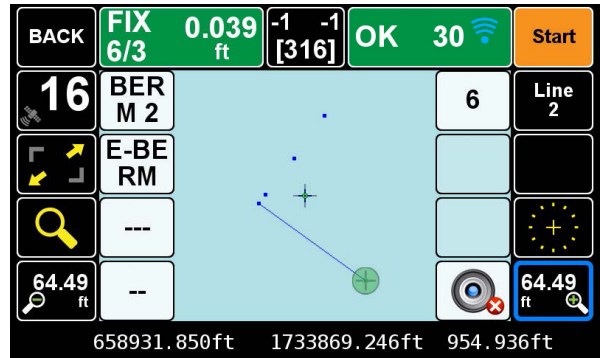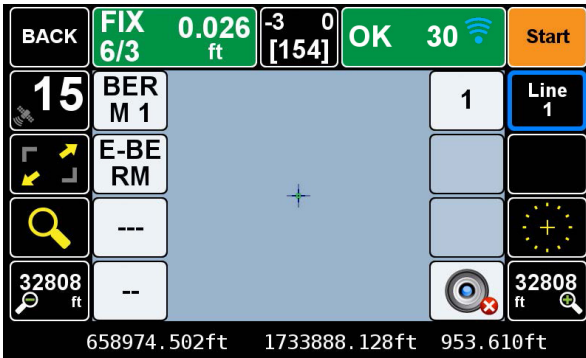
We begin collecting Points for the lines:

We want to now click Next to be taken to the Collect Action screen so we can begin building linework:
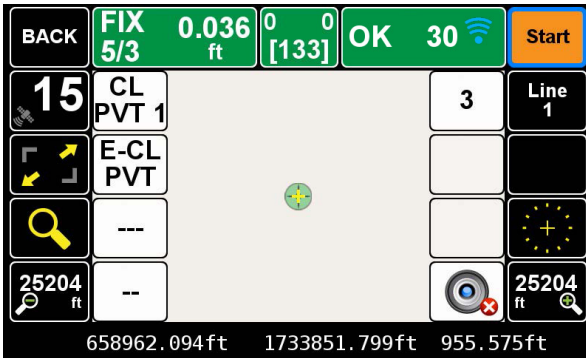
The number of Points in current Line being collected is displayed below "Line". Here you can see we are ready to collect point "2" in this line.
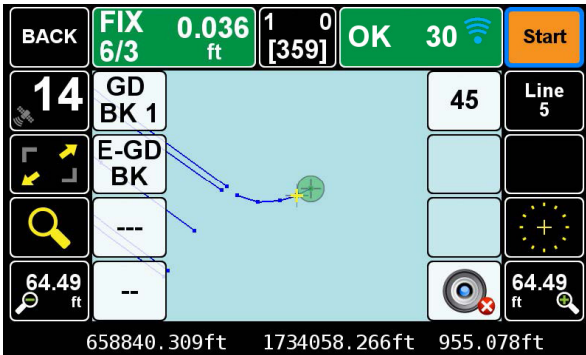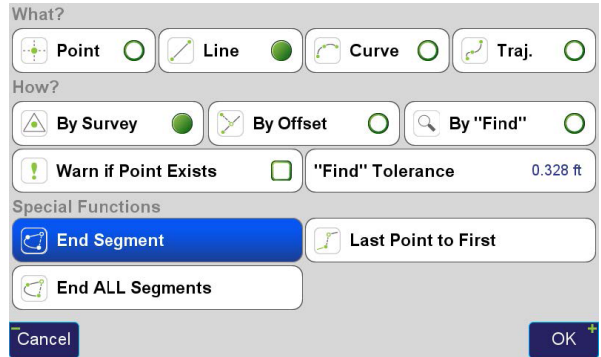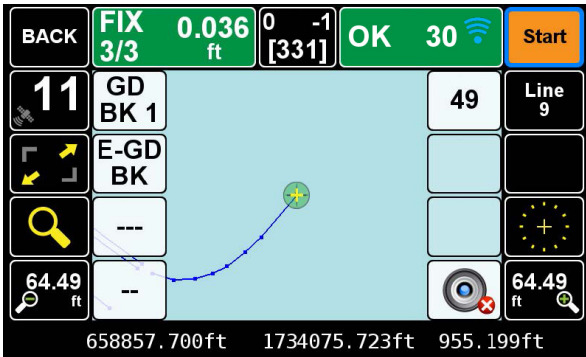
We continue collecting Points from sections of the road and our lines are automatically drawn:
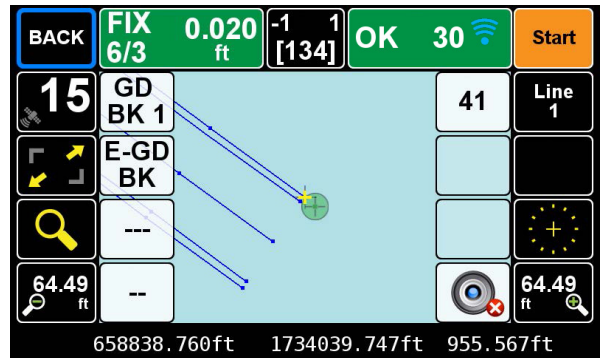
The Tags automatically sequence. The first Point has a Tag of "BERM 1" and the third has a Tag of "CL PVT 1".
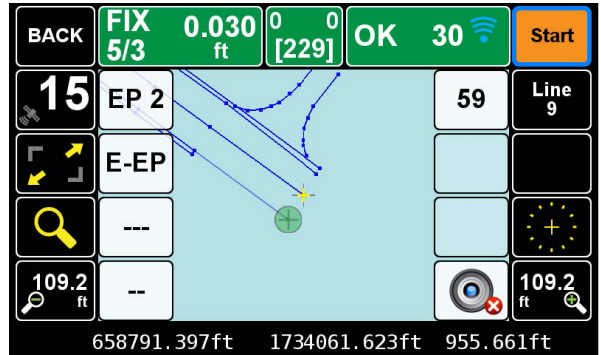
When we collect Point "6" a line is drawn between Points "5" and "6" since these both having a tag of "BERM 2":

We come to a driveway and turn off Auto Sequence Mode and set the Tag to "GD BK1" to collect the linework for the driveway:

Using ShapeTags and Codes

Here the Tags do not sequence and consecutive Points are all connected with a line since they all are collected with the same Tag.

To end the current line we press Line and then press End Segment in the following screen:

We collect another line for the other side of the driveway. Once it is completed and ended we turn Auto Sequence Mode back on and continue collecting road sections:

Our Lines continue to be drawn from where we left off before starting the driveway lines since we never ended these segments. Once we complete all the road sections we click Line and then End All Segments to end all the lines:

Using ShapeTags and Codes
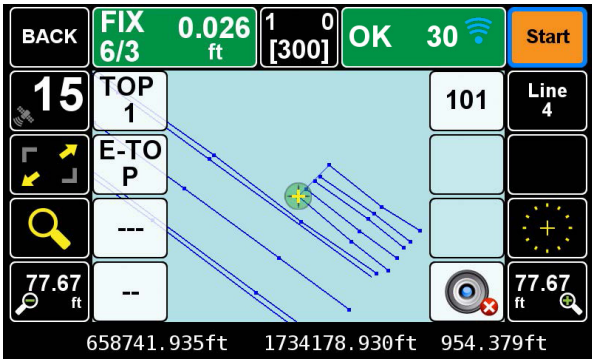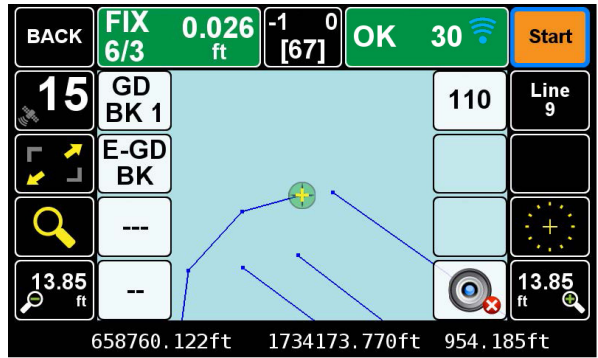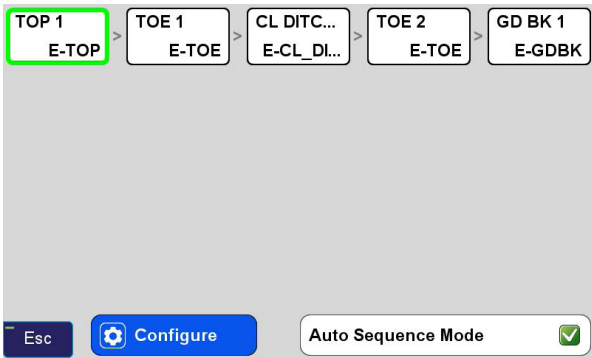
We continue collecting linework in a similar fashion to complete this Project:
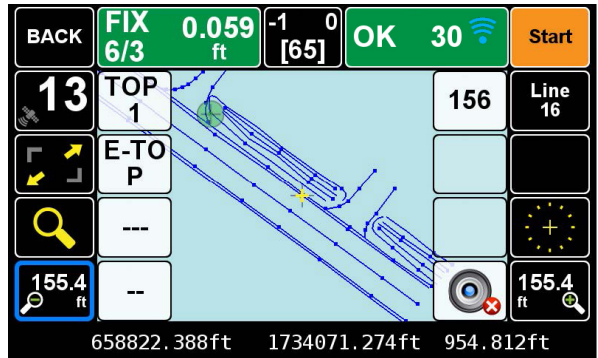
In this screen Last Point to First can be used connect the first and last points in the segment.

We now are ready to add linework for the ditch along the road. We setup a new Auto Sequence and proceed with collecting the linework for the ditch:

To define the ground around the bank we turn off Auto Sequence Mode and continue the linework with the "GD BK1" tag:

Of ShapeTags and Codes

In this example of Codes I have several that have imported from CAD as well as a few that I've created in J-Field directly:

This is perhaps the most efficient way to develop your own codes.

Begin by importing a dwg file with your personal layers (particularly those layers you use for collected data). Once imported, you can edit the individually created codes.

Take care to check "Use Layer as Code" and "Create Missing Codes". This will create Codes from every layer used in the imported drawing.

Once imported you can select a Code and edit its attributes.

Here, you can see I've edited a Code named "Control". I created a category for it called "Collection" as this is a code I anticipate using while collecting points (rather than calculation). So I can use this for filtering the large number of codes visible by selecting this "Collection" category from the Select Code list (see button at top right first slide above). I can explain what this code is in the Code Description and (in the future) assign a default symbol to this Code. The attributes I've created are Monument Type, Condition, Set By, Source. Of course these are my own, and you may find yourself wanting something else, but as can be seen this allows me to quickly specify the type of monument this control point is, the condition I found it in, who placed it, and what its source is (i.e., OPUS, HARN, etc.).

Attributes Values

60d NAIL		Select	New	Delete

< E M P T Y >
1/2" IRON ROD
12" GALV SPIKE
60d NAIL

Esc

This is my current list for "Type". This list grows as I add more attributes in the editor as well as in the field while I'm collecting data based on my entry. Notice that I can very quickly select 1/2" IRON ROD for my monument type much faster than typing in this text. This is the case for all attributes. Type it once and it is available very quickly any time in the future.

Looking at another:

Edit Code

Code	BOUNDARY	Symbol	
ID	1	Category	COLLECTION

Code Description

FOUND/SET	FOUND
SIZE	1/2"
TYPE	IRON ROD
ID	NONE
CONDITION	GOOD

Back | Update

Here I've created one for Boundary. You can see that this has the attributes pre-populated with my most commonly

encountered boundary monument, a 1/2 inch rebar found in good condition. For my first attribute for "Found/Set" I have a list already created that includes "Found" and "Set". For Size, I have a list that contains 3/8", 1/2", 5/8", 3/4". As I add to these attributes the list grows. I can also delete attribute values that are no longer needed. For the Boundary code, I've preselected these values rather than <EMPTY> as shown on the Control code.

When exporting your data, you can select the output to something like:

Export to file: USB Device\Prj.2014-10-02 20.1...

Presets

Export Range	Project	Output points: 0

Coordinate System: NAD83(2011) / California zone 3 / NAVD 88

Page | Page0

Attribute 5

Name	Attribute 1 +	Sep. 1	,
N Surveyed	Attribute 2 +		
E Surveyed	Attribute 3 +	Sep. 2	,
H Surveyed	Attribute 4 +		
Description	Attribute 5	Decimals	3
Code Name +		Header Line ✅

More Settings >

Back | Next

This exports the name of the point, the N,E,H of the surveyed (not design) point, the Description of the point, the Code Name, the Attribute 1, 2, 3, 4 and 5. The plus signifies that these elements will use Sep. 2 (separator 2) which I generally have set to space. So a collected boundary point may look like this:

1,6835851.497,3100685.44,395.789,BP, BOUNDARY FOUND 1/2" IRON ROD NONE GOOD

Where 1 is the point name,

6835851.497 is the Northing
3100685.44 is the Easting
395.789 is the Elevation
BP is the description
BOUNDARY is the Code name
FOUND is attribute 1
1/2" is attribute 2
IRON ROD is attribute 3
NONE is attribute 4
GOOD is attribute 5

With the use of Codes easily accommodating generic entry of point information, the description can be used more like a text note rather than containing action coding and point information.

A quick note regarding Tags. Tags can be thought of as the name of connected geometry (polylines composed of lines and arcs) making action coding, required by many other collectors, unnecessary to linework collection in J-Field. Codes, then, can be used specifically for point/line data. This data can be entered very quickly because of the libraries that are constantly growing and updating.

One of the great aspects of tags and codes in J-Field is that you can grow into them. Use descriptions for a while, then add Codes when it is convenient. Just add a white box for Codes and one for attributes. No need to radically change your experience.

Using ShapeTags and Codes
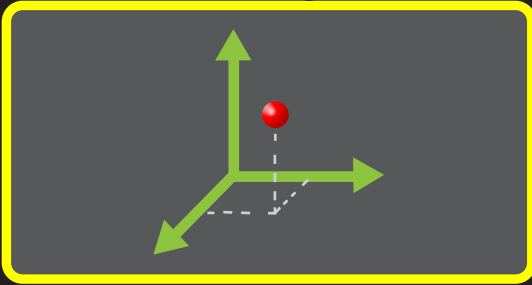
**Coord. Sys**

Coordinate System Basics

The simplest, most representative mathematical model of the shape of the Earth, thus far conceived, is that of an ellipsoid – similar to a sphere but slightly longer at the equatorial axis than it is at the polar axis, the ellipsoid is an ellipse, rotated about the minor polar axis. While not perfectly representative of the Earth's undulating surface: mountainous, oceanic, craggy, hilly, etc., the ellipsoid reasonably approximates with a simple mathematical model the shape of the Earth.
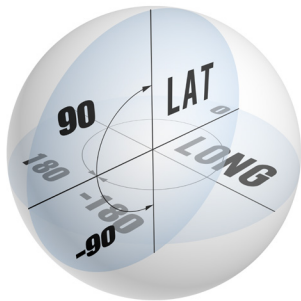
Ellipsoid coordinates are generally expressed as latitude and longitude and ellipsoid height. This type of coordinate does not lend itself to easy visualization on the ground nor simple mathematical manipulation for inversing between geodetic coordinates. Another geodetic coordinate system that allows for simpler mathematics is Earth Centered, Earth Fixed (ECEF). This Cartesian coordinate system has thee axes (XYZ) extending from the origin which is located at the Center of Mass of the Earth. The X axis is along the equatorial plane, extending in a positive direction from the origin, through 0° longitude. The Y axis is along the equatorial plane, extending in a positive direction from the origin, perpendicularly from the X axis, through 90° East longitude. The Z axis extends in a positive direction from the origin, through the North pole. For surveyors, challenges with this system arise in that while the mathematics in determining distances between points is a simple exercise of the 3D Cartesian geometry (Pythagorean Theorem), the result has little relevance to measurements along the surface of the Earth where surveyors generally work, as the results of inverses between two points on the surface will be chords, and resulting directions will have minimal apparent relationship to North. Because of the limitations of each of these systems for cadastral surveying, projections,

such as the State Plane Coordinate System, have been developed which project geodetic points on the Earth (latitude and longitude) to a flat plane which allows for simple planar geometry and trigonometry to be applied to most calculations.
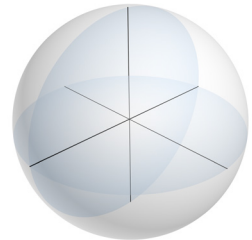
Most surveying software available today uses a point database composed of a Cartesian 2D grid, Northings and Eastings, with an optional third Height dimension allowing for programs utilizing the same planar mathematics. The difficulty in this approach, particularly with GNSS surveying, is that the world we survey over, across, and under is anything but flat, and projections, while useful tools for

visualization include distortions (namely mapping angles, 2nd term corrections, scale factors and elevation factors).

J-Field balances the need for flat Earth calculations, for the user and accurate Geodetic point storage by storing points internally as Latitude, Longitude and Ellipsoid Height, (LLH) and transforming coordinates on-the-fly to any projection desired. To the user, with a State Plane Coordinate System set for the project, this transformation is entirely transparent. The user sees State Plane Coordinates, can export State Plane Coordinates and can import State Plane Coordinates, while never actually seeing the internal database coordinates that are LLH. This scheme simultaneously provides a comfortable user interface and geodetic purity in the software, unprecedented in previous field software.

In the early days of precise geodetic positioning several reference frames were developed - in North America the most common being the World Geodetic System of 1984 (WGS84) and the North American Datum of 1983 (NAD83). Initially these systems were thought to be nearly identical, but with the refinement of measurements over time, it has been determined that the difference in the position of the center of mass of the Earth (or origin) for NAD83 and for WGS84 is separated by approximately 2 meters with slight axes rotations and scale difference. WGS84 is the coordinate system of the Global Positioning System which is maintained by the US Department of Defense, and the realization (the actual physical points with coordinate values) is classified, however the International Earth Rotation and Reference System Service (IERS) has, by observation, developed the International Terrestrial Reference Frame (ITRF) which is understood to be equivalent to WGS84. Based on further long term observations it has become possible to develop precise transformation between WGS84 (or more specifically ITRF2008) and the North American Datum of 1983 (NAD83).
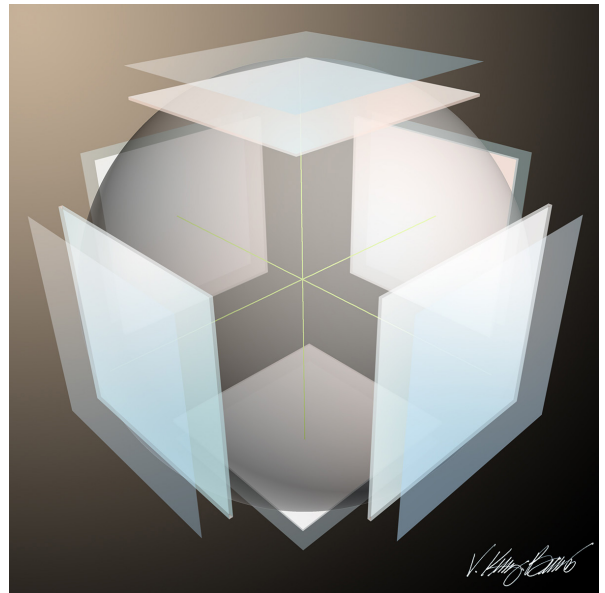
From direct comparisons of ITRF08 and NAD83, geodesists have developed and continue to refine a 14 parameter transformation that computes the difference between the systems in X,Y,Z, rotation of X, rotation of Y, rotation of Z, and scale. These are seven of the 14 parameters.

WGS84 also differs from NAD83 in that the US National Geodetic Survey goes to great lengths to keep the NAD83 reference frame relative to the North American Tectonic Plate. This allows NAD83 coordinates to change very little over time, based only on improved positioning accuracy and regional and local ground movements. This requires velocities of points across North America to be meticulously generated to relate this seemingly static reference frame (which is actually moving at a rate of a couple of centimeters per year) to the center of mass of the Earth.

Coordinate Systems

With all of these movements in coordinates, how is a surveyor expected to maintain a coordinate database that can be used for years? Javad's knowledgeable team of geodesists and software engineers has created a rigorous and accurate means to accomplish this. Because NAD83 is constantly maintained by NGS relative to IGS08 (which is substantially the same as ITRF2008) through observed velocities of the Continuously Operating Reference Station Network (CORS), it is possible to relate the internal coordinate database to a specific epoch (date and time) within ITRF2008. For J-Field the internal reference frame and epoch is ITRF2008, at the epoch (or date/time) defined by the user at the creation of a particular Coordinate System. As Coordinate Systems are refined creating new adjustments, this scheme will allow any collected points to be easily transformed across epochs and reference frames to other highly precise reference frames both now and in the future. For the surveyor, all of this is transparent and he may well never view his coordinates related to ITRF2008 in J-Field, preferring to only consider his coordinates in his favorite geodetic coordinate system, but he will do well to understand that internally within the database all coordinates in all projects are related to the same reference frame with the appropriate epoch.

Therefore if a surveyor enters the NAD83(2011) coordinates of a point from an NGS Online Positioning User Service (OPUS) solution into J-Field, with the proper coordinate system set, the coordinates are transformed from NAD83>ITRF08 using a 14 parameter transformation and then stored. At any time these coordinates are viewed, exported or used for COGO calculations, they are retrieved from the database as ITRF08 and transformed from ITRF08>NAD83 before being used or displayed.

Beyond the benefits of storing all project coordinates in a common reference frame, users can also make use of the ITRF08>NAD83 transformations for entering coordinates from positioning services that do not support NAD83, such as the Australian Positioning Service (AUSPOS). Because this service only publishes ITRF08 coordinates, it is necessary to make the transformation from ITRF08>NAD83 if the user wishes to be related to NAD83. *J-Field* can accomplish this with ease.

Coordinate Systems

Building A Coordinate System In J-Field

In J-Field, a Coordinate System is composed of:

- A Related Geodetic System (or reference frame) such as WGS84(ITRF2008), PZ-90 or NAD83(2011)
- A predefined Projection, such as UTM or State Plane or any other custom Projection including Transverse Mercator, Lambert Conformal Conic 2SP/1SP, Cassini-Soldner, Transverse Mercator, Oblique Mercator (Hotine Variant A and B), Oblique Mercator (2 Points), Oblique Stereographic, Mercator, Polar Stereographic (Variant A and B). LLH and ECEF can be used without a projection if desired.
- A Height System (Ellipsoid or Orthometric)
- A Geoid if the Height System is Orthometric - Geoid models approximate sea level, as affected by variations in gravity, which is necessary for precise GNSS positioning to make meaningful heights consistent with the results of a level run
- An Epoch, a point in time to which the composed coordinates will be related
- A Transformation, 14 parameter transformation used to convert the user's coordinate system to WGS84(ITRF2008) or a time-related transformation such as HTDP in U.S. and the National Epoch Transformation (NET) v6.0 for Canada,
- An option to rename, and (if a projection is used) add a scale factor and rotation to the coordinate system

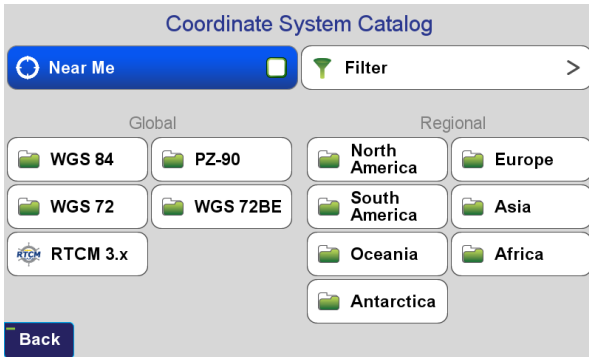To create a coordinate system in J-Field, press *Coord. Sys.* from the *Home* screen.
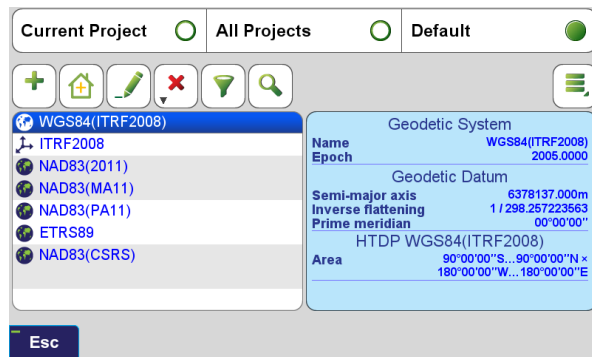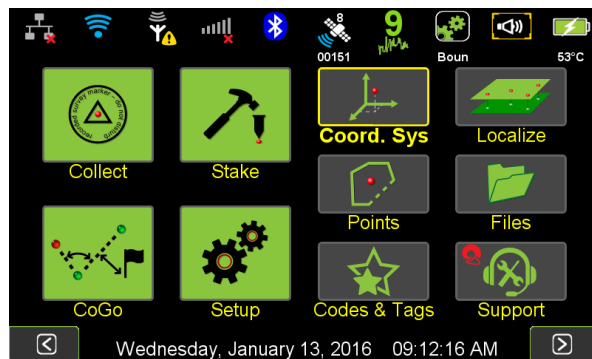
The radio buttons at the top of the screen toggle a filter to show coordinate systems in Current Project, All Projects or the Default coordinate systems.
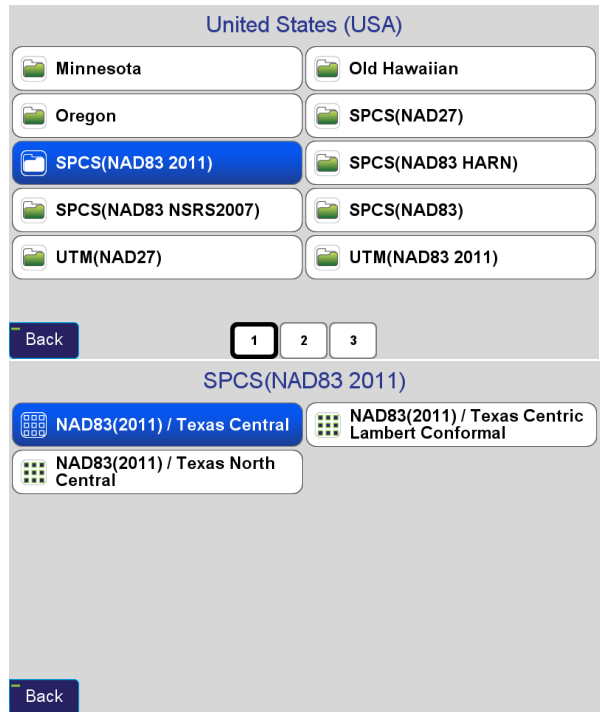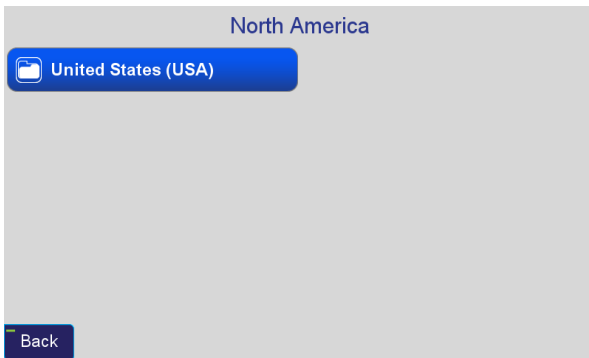
If the system you want does not appear on the screen, press the (*Add*) button which bring the user to the Coordinate System Catalog. In J-Field there are thousands of coordinate systems found in the catalog. In order to limit the selections, the user can press the *Filter* button to

limit the options to a geographic area, as well as select only certain types of stored systems (such as only Grid).

Coordinate System Catalog

- ◎ Near Me ☐
- ▼ Filter >

Global

- 📁 WGS 84
- 📁 PZ-90
- 📁 WGS 72
- 📁 WGS 72BE
- ⊕ RTCM 3.x

Regional

- 📁 North America
- 📁 Europe
- 📁 South America
- 📁 Asia
- 📁 Oceania
- 📁 Africa
- 📁 Antarctica

Back

Checking the *Near Me* filter will limit the option selections to an area in the proximity of the receiver's position. Once the filters have been set, select the applicable regional option.

North America

- 📁 United States (USA)

Back

United States (USA)

- 📁 Minnesota
- 📁 Old Hawaiian
- 📁 Oregon
- 📁 SPCS(NAD27)
- 📁 SPCS(NAD83 2011)
- 📁 SPCS(NAD83 HARN)
- 📁 SPCS(NAD83 NSRS2007)
- 📁 SPCS(NAD83)
- 📁 UTM(NAD27)
- 📁 UTM(NAD83 2011)

Back | 1 | 2 | 3 |

SPCS(NAD83 2011)

- ▦ NAD83(2011) / Texas Central
- ▦ NAD83(2011) / Texas Centric Lambert Conformal
- ▦ NAD83(2011) / Texas North Central

Back

For this example, North America>United States (USA)>SPCS(NAD83 2011)>NAD83(2011)/Texas Central Zone has been selected.

Once the Coordinate System is set, the user is guided to an setup page for Height System, Geoid, Input Epoch, Transformation, and Adjust Grid-to-Ground & Rename.

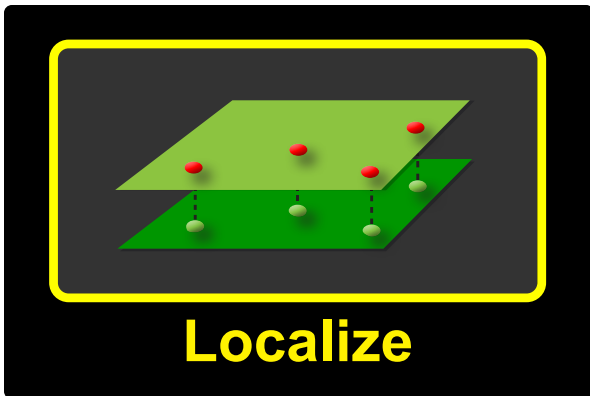*Coordinate Systems*

NAD83(2011) / Texas Central | NAVD 88

Name: **NAD83(2011) / Texas Central** Related geodetic system: **NAD83(2011)**
Projection: **SPCS83 Texas Central zone** (0,)
Area: 29°46'48''N...32°15'36''N × 106°37'48''W...093°30'36''W

| ⇕ | Height System: NAVD 88 | > |

| g̃ | Geoid: GEOID12B CONUS South 42N | > |

| ⊕ | Input Epoch: | 2010.0 |

| ⚹ | Transformation: HTDP WGS84(ITRF2008) to NAD83(2011) / NAVD 88 / SPCS83 Texas Central zone | > |

| 🏛 | Adjust Grid-to-Ground & Rename | > |

| ‒ Esc | | Done ＋ |

For all surveying in the US, it is strongly recommended that NAD83(2011) with Epoch 2010 be selected for all survey work as this is the current supported realization supported by NGS. Gooid model "GEOID12B CONUS South 42N" should be used when south of latitude 42N and "GEOID12B CONUS North 40N" is used when north of latitude 40N in the US (note that they overlap by 2 degrees). HTDP transformations should be used for compatibility with DPOS.

If desired, the name of the coordinate system can be changed to something more abbreviated by selecting *Adjust Grid-to-Ground and Rename*. Here it is possible to type in a new name for the newly created coordinate system.

This button can also be used to create a modified State Plane system that applies a scale factor from selected origin coordinates. This is useful for creating a system that mimics State Plane while also allowing for Grid inverses that are very near to actual horizontal ground distances. See the *Quick Start Guide to the TRIUMPH-LS* for full instructions on how to do this.

Localize

Localization

The purpose of a localization is to reference and relate a local coordinate system (e.g., a N 5000, E 5000 system from a total station survey) to known geodetic coordinates or to a known grid coordinate system (e.g., State Plane Coordinates). Once the localization is configured, the local system can be used as a coordinate system in J-Field.

In a localization, local coordinates are paired with RTK surveyed points. These localization reference points are used to determine the best-fit relationship between the local system and the geodetic surveyed points. These points should be carefully selected. Choose precisely known points in the local system that can be surveyed accurately with RTK (they have open views of the sky and are away from trees, buildings and structures). Point geometry is also critical as observations to these points will determine scale and rotation of the resulting coordinate system. As in total station surveying, ties to longer baselines with good network distribution will give better results. Scrutinize monuments to be surveyed to insure they appear stable

and unchanged since being established. Localizations are a powerful tool, but must be handled with great attention to detail for best results. Few other operations other than localizations in GNSS surveying offer more potential for gross errors.

To begin creating a localization, points from the local system must first be imported into J-Field. Importing points is fully detailed in the *Quick Start Guide to the TRIUMPH-LS*. It is critical that points are imported into a new Local coordinate system if they are to be used to setup a new localization.
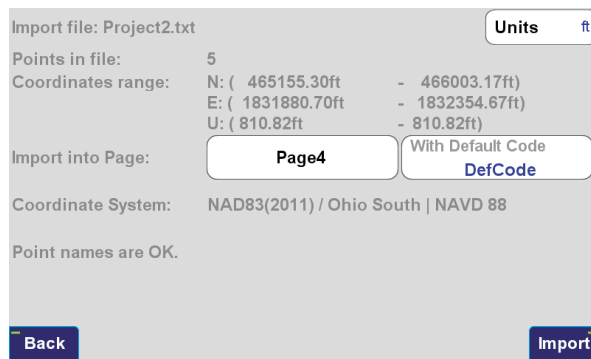
Import Text Files screen, notice that a Local system is not currently chosen.

To change the coordinate system to a local system follow these steps. Tap the *Page* button:

Pages

Deeds	⭕	Edit	☑	Page5	⭕	Edit	☑
Page1	⭕	Edit	☑	Page6	⭕	Edit	☑
Page2	⭕	Edit	☑	Page7	⭕	Edit	☑
Page3	⭕	Edit	☑	Page8	⭕	Edit	☑
Page4	🟢	Edit	☑	Page9	⭕	Edit	☑

Page4: NAD83(2011) / Ohio South | NAVD 88

Cancel   OK

Tap the **Edit** button of the currently selected Page. If you desire to import the points to a different page, the current page can be changed with the radio buttons on the left.

Edit Page

Page Name	Page4
Page coordinate system	NAD83(2011) / Ohio South	NAVD 88
Color	Blue

Cancel   Delete objects   OK

Tap the **Page coordinate system** button.

Current Project 🟢	All Projects ⭕	Default ⭕

NAD83(2011) / Ohio South | NAV...

Grid System
Name | NAD83(2011) / Ohio South | NAVD 88
Epoch | 2010.0000

Geodetic Datum
Semi-major axis | 6378137.000m
Inverse flattening | 1 / 298.257222101
Prime meridian | 00°00'00"

HTDP WGS84(ITRF2008) to NAD83(2011) / NAVD 88 / SPCS83 Ohio South zone

Esc   Select

Tap the ⌂ (*Add Local*) button to create a new local coordinate system.

Local System

Local System Name:

⌂ Project2 - 1

Underlying Coordinate System:

🌐 WGS84(ITRF2008)

Esc   OK

Edit the name of the new Local System if desired. If the coordinates being imported are approximate state plane coordinates, change the Underlying Coordinate System to that state plane coordinate system so that these points can be staked and viewed on the map before a localization is setup. This is useful to provide guidance to their

approximate locations.

Local System

Local System Name:

🏠 Project2 - 1

Underlying Coordinate System:

▦ NAD83(2011) / Ohio South | NAVD 88

Esc   OK

Press *OK* once the name and Underlying Coordinate System have been configured as you desire.

Current Project ●	All Projects ○	Default ○

➕ 🏠 ✏️ ❌ ▽ 🔍   ☰

▦ NAD83(2011) / Ohio South | NAV...
🏠 Project2 - 1

Local System	
Name	Project2 - 1
Epoch	2010.0000
Geodetic Datum	
Semi-major axis	6378137.000m
Inverse flattening	1 / 298.257222101
Prime meridian	00°00'00''
WGS 84 to Project2 - 1	
Area	Entire World
Geoid	
Geoid model file	g2012au_south.bin

Esc   Select

The numeric value inside the Local System icon indicates the number of paired points used in the localization of the coordinate system. It will indicate "0" until a localization has been setup and saved.

Highlight the newly created local system and press **Select**. The import screen should now show that the points will be imported into this local system.

Import file: Project2.txt   Units   ft

Points in file:	5
Coordinates range:	N: (465155.30ft – 466003.17ft)
	E: (1831880.70ft – 1832354.67ft)
	U: (810.82ft – 810.82ft)

Import into Page: Page4   With Default Code
                                          DefCode

Coordinate System: Project2 - 1

Point names are OK.

Back   Import

To begin configuring the localization tap the *Localize* button found on the *Home* screen.

Design	Project2 - 1	Surveyed

🏠 Project2 - 1   ▦ NAD83(2011) / Ohio South | NAVD 88

➕ ✏️ ❌   ΔN   ΔE   ΔU   ➕ ✏️ ❌

🅰 Customize   🔗 Link   ⠿ Auto

Back   Save

The underlying surveyed coordinate system is shown on the right while the local system is on the left. These can be changed by tapping their boxes. To add a Surveyed

point tap on the (*Add*) on the right side of the screen. An option to *Add Single Point* or *Add Multiple Points* will be presented.
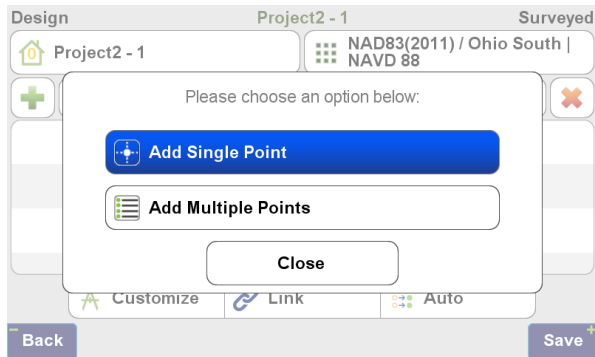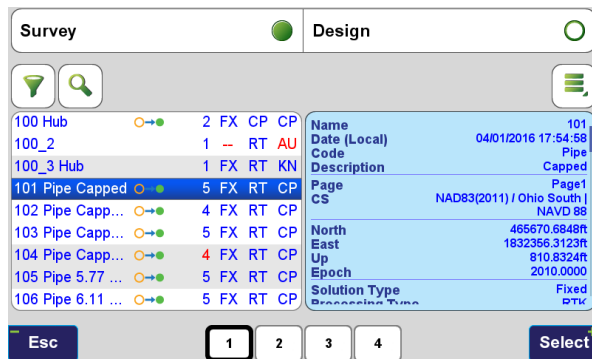

In this example the **Add Single Point** option was selected. Here the from **List** option is chosen to pick the point from the points list.
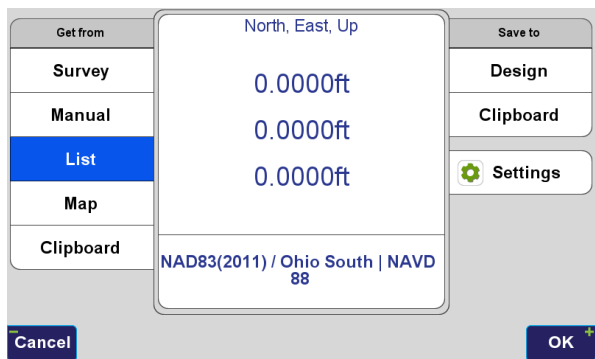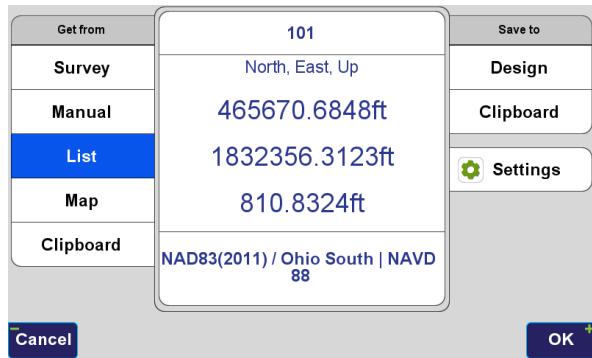

The desired point is then selected from the list. Note that

the Survey option must be selected at the top of the screen to select a survey point.

After the point has been selected the coordinates will be displayed for review in the point selection screen. This screen can be bypassed by disabling the *Confirm Selection* option found in the *Settings* of this screen.

Press **OK** to confirm the selected point. The selected point will now be displayed on the Survey side of the localization

screen.
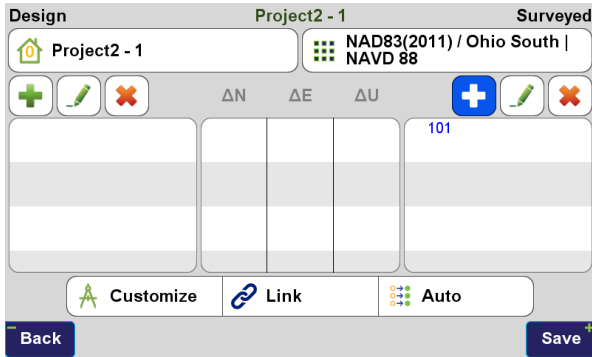
Add points to the Design side (left) by tapping the left *Add* button.
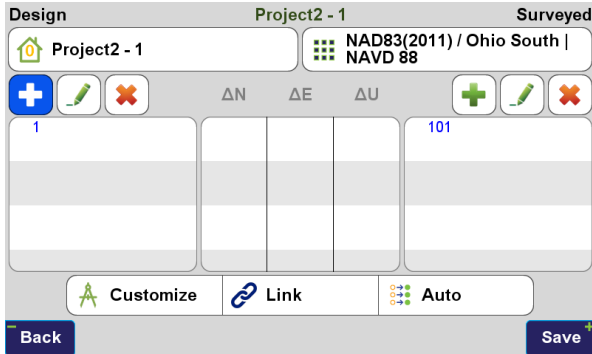
After a pair of points have been added, an association between them can be created by selecting both the Design and Surveyed point and tapping the Link button. To select them, tap each point name so that a green arrow appears beside each point.
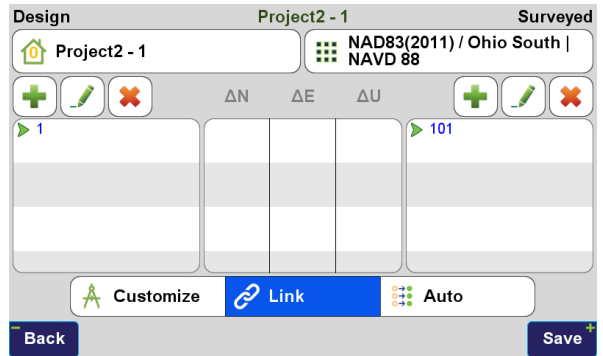
Next tap the **Link** button and four options will be presented to select if you want to create a *Horizontal & Vertical*, *Horizontal*, *Vertical* or *Check* association between the points. If *Check* is chosen these points will display residuals and will not be used to compute the localization.
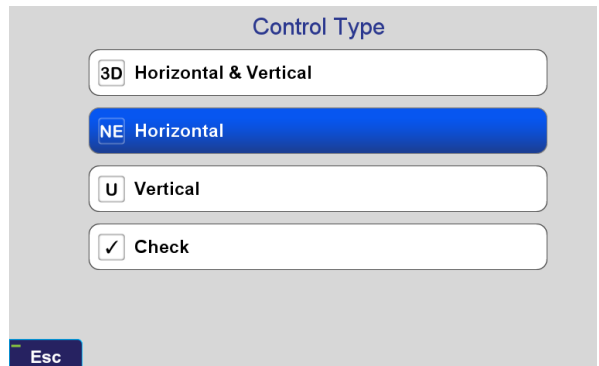
In this example *Horizontal* is selected since the design point was not imported with a real height.
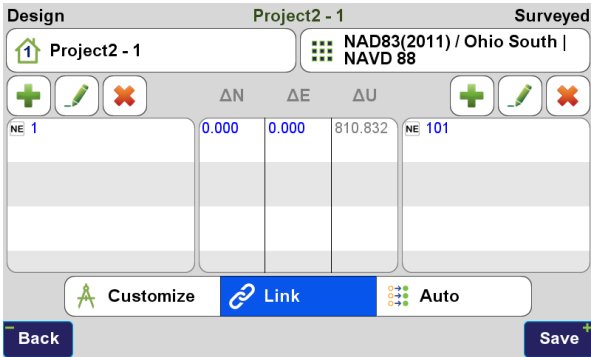
The localization parameters can be viewed by tapping the **Customize** button. At this point a single point localization exist. The surveyed coordinates are translated to the design point but no rotation is included in the localization parameters. When a single point is used the *Grid-to-Ground Factor* is automatically calculated applied. GNSS distances measured in this local coordinate system should match ground distances measured with a total station.
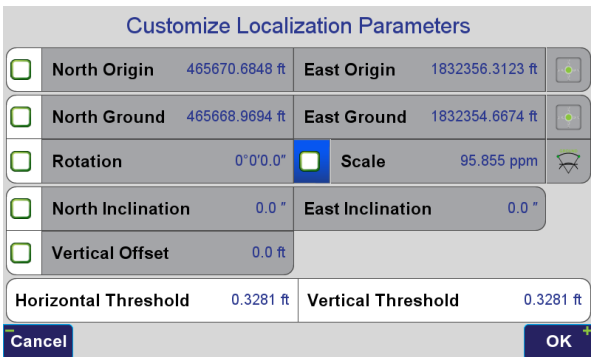
Multiple points can be added to the localization by using the **Add Multiple Points** option after clicking one of the *Add* buttons.
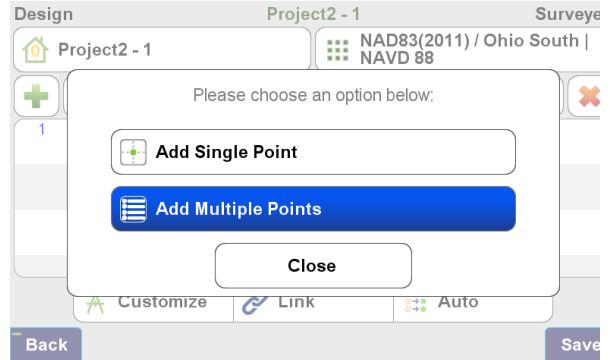
Select the points to add by checking them from the list. It is easiest to use the hardware arrow and check buttons to select points in this screen. The chosen points displayed on the right side will be added after tapping *Select*.
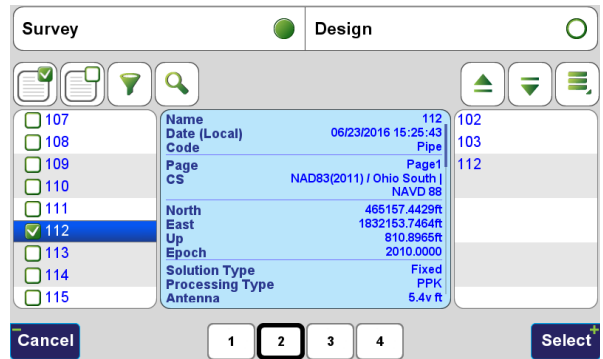
More *Design* and *Surveyed* points are both added.

Auto is used to automatically link pairs of points. Note that point pairs do not have to be matched in the same row. J-Field can automatically determine the pairs.

Click the *Customize* button to view the localization parameters. Notice that the *Scale* factor is based upon a best-fit solution of the localization points. While this is the case, grid distances between points that are displayed throughout J-Field in the CoGo functions and on the map screens may not match total station distances. This is

dependent upon how much the best fit scale factors differs from the *Grid-to Ground Factor*.

To force the *Scale* factor to the actual *Grid-to-Ground Factor*, check the box beside *Scale* and then tap the (*Grid-To -Ground*) button. This will calculate an averaged *Grid-to-Ground Factor* from the Surveyed points used in the localization.

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After tapping OK the residuals with the new scale factor will be displayed.

Notice that many of the residuals are high in this example. This is the result of inaccurate measurements of either the surveyed or design points. In this case, the cause is suspected to poor measurements of the design coordinates which were created from platting the original survey. Localizations with high residuals should not be used to determine design coordinates for the reestablishment of missing monuments. For example, if monumentation is missing at design point 5, it would not be appropriate to set a pin at the coordinates for design point 5, rather traditional methods to determine the coordinates of the missing monument should be used (e.g. doing a distance-distance intersection from 2 adjacent corners). Localizations with high residuals can still be very useful in determining the location where to search for monuments.

If a pair of points is suspected to be the cause of the high residuals, the association between the pair of points can be changed to a *Check* type of control. Select the points you desire to change and tap the *Control Type* button (middle button on the bottom row) and select *Check*.

Design point 12 with surveyed point 112 were changed to Check points in the above example. There residuals are displayed in gray. Notice that removing it from a horizontal control type did not improve the residuals in this example.

To save and apply the localization press **Save** once you are satisfied with how it is setup.

The localization parameters will be displayed for review. J-Field allows the localization to be modified and refined after it has been saved. At times, monuments can be difficult to find even after the localization has been setup. Often it can be beneficial to add two additional points into the locational (which minimally defines the translation and rotation) which are located closer to the monument that can't be located. The localization can then be modified to use only these points as *Horizontal* control (the others are changed to *Check* type control points). This process should improved the calculated coordinates for the missing monument and aid in the location of it.

A Note About Inclination Values

If multiple associations with vertical control types are used in the localization, a best fit inclination will be calculated. If the geoid model for the given location is accurate and surveyed and design heights are accurate, the inclination should be very close to 0. In cases where it is not 0, it is best to force it to 0 or to only use a single *Vertical* control association.

It can be forced to 0 by checking the *Inclination* box found in the *Customize Localization Parameters* screen and changing the vales to 0.

Customize Localization Parameters		
North Origin 465735.9151 ft	East Origin 1832270.1955 ft	
North Ground 465734.1558 ft	East Ground 1832268.4306 ft	
Rotation -0°2'54.757586"	Scale 96.206 ppm	
North Inclination 0.0 "	East Inclination 0.0 "	
Vertical Offset 0.0 ft		
Horizontal Threshold 0.3281 ft	Vertical Threshold 0.3281 ft	
Cancel		OK

Coordinate System Selection Influences in CoGo

The selected coordinate system of a Page has important implications for CoGo in J-Field. The Javad design team, composed of knowledgeable geodesists and gifted engineers, has included many tools for surveyors to address so-called "Grid vs. Ground" issues. In *CoGo Inverse*, for instance, a surveyor can view the results of the inverse between points in several different ways.

Direction

Directions can be viewed as one of four types by simply toggling the direction button.
- *Geo*
- *Grid*
- *Mag Geo*
- *Mag Grid*

Geo
Geo direction type refers to Geodetic bearings, this computes the direction from the beginning point (P1) turned from polar North to the ending point (P2), independent of gravity (normal to the ellipsoid). The geodetic bearing actually changes along this line (unless the line is longitudinal) because of the convergence of meridians (recall that all longitudinal lines converge at the poles). Because of this convergence, other than points on the same longitude, the forward bearing (P1>P2) will differ from the reverse bearing (P2>P1) by 180° and the convergence angle. The magnitude of the convergence angle will increase as points are further apart East and West and the rate of this change in magnitude will increase as the latitude increases. Note that the Geo direction type can always be viewed regardless of the current coordinate system.

Grid
If the current Page Coordinate System is a projection, such as State Plane, the direction can be viewed in Grid, which is figured from North at the central meridian of the projection by treating all meridians as parallel. With Grid, the direction between two points is the same along the entire line between those points, so that the forward Grid bearing (P1>P2) is precisely 180° from the reverse Grid bearing (P2>P1). If a geodetic system (latitude and longitude) or geocentric Cartesian system (ECEF/XYZ) is current, the Grid direction type will report the same direction as the Geo direction type.

Mag Geo and Mag Grid
Mag Geo and Mag Grid both apply the magnetic declination at P1 to the Geo and Grid direction types using the time-dependent World Magnetic Model (WMM) 2010-2015. J-Field will continually and automatically be updated to that model in accordance with all official NGA releases.

Distances
Distances can also be viewed in one of four types by toggling the distance button.

- *Geo*
- *Grid*
- *Ground*
- *Slant*

Geo distance
Geo distance type is the distance between two points as measured along the ellipsoid.

Grid distance
Grid distance is the 2D (North and East) Cartesian inverse of two grid coordinates. Depending on the projection design

and the location of the inverse points (P1 and P2) within the projection, the Grid distance can vary significantly from the Geo (ellipsoid) distance. If the current coordinate system is a local (created through *Localize*) or a modified state plane coordinate system (created through *Adjust Grid to Ground & Rename*) the grid distance reported is from the local or modified grid coordinate system rather than the underlying grid system. The grid and ground distances should be nearly identical if a grid-to-ground scale factor was used when creating the local or modified coordinate system.

Ground distance

The Ground distance type, generally the most important type to surveyors, is the distance between two points as measured along the design surface, such that the elevated reference surface can be thought of as passing through the average ellipsoid height of P1 and P2. Note that this distance type is related to the ellipsoid height of P1 and P2. If other points of interest vary significantly in ellipsoid height from the height of these two points, the scale of the ground distances between those points will also vary as a result. Geometric closures using these distances may suffer as a result, as an inverse at an average ellipsoid height of 1000 meters will not correlate well to an inverse at an average ellipsoid height of 500 meters by a factor of approximately 1ppm per 6.4 meters (21 feet) of change in ellipsoid height. In this example, an ellipsoid height difference of 500 meters affects the distance by 78ppm.

Slant distances Mark to Mark
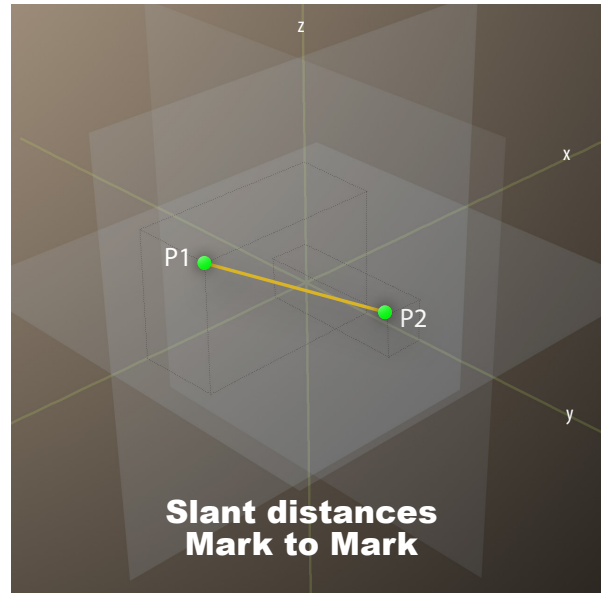
Slant Distances

Slant distance type is the direct geocentric Cartesian (ECEF/XYZ) inverse of the coordinates of P1 and P2, sometimes referred to as Mark-Mark. Slant distance between two points is not affected by the current coordinate system.

Examples

Grid Direction related to Texas North Central Zone.

Grid Direction related to Texas North Central Zone, Ground Distance calculated using the average ellipsoid height of P1 and P2.

Geodetic Direction
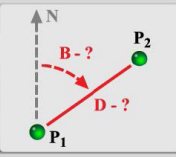
Slant Distance – Mark to Mark direct chord distance
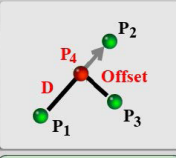
Geodetic Distance (measured along ellipsoid)

Offsets, Projecting to a Line 1

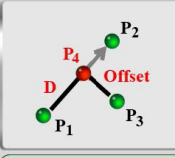This application in CoGo>Offsets calculates the distance a point (P3) is from a line formed by two other points (P1 and P2). Once solved the user can then store a point (P4) on the line between P1 and P2 at the perpendicular intersection of P3>P1-P2. In a geodetic sense, this line could be a geodesic line or a grid line if a projection is current (such as State Plane, UTM, etc.). J-Field determines which definition to use based on the current Coordinate System.

If a geodetic system (latitude and longitude) is current or a geocentric Cartesian system (ECEF/XYZ) is current, J-Field uses the geodesic definition of the line P1-P2. If a map projection; e.g., State Plane, UTM, etc. is used, then J-Field uses the grid definition of the line. Over short P1-P2 line distances, the difference between these two definitions is minimal; over longer offset distances the difference becomes more noticeable. J-Field affords the user the flexibility to choose which definition to use simply by the selection of the current coordinate system, such that the results will be consistent with the coordinate system definition.

Note that this intersection is based on the Grid definition of the direction of the line from P1 (S104) and P2 (BP1). This is because a State Plane system was current. Had this system been geodetic, such as NAD83(2011), the solution would have been based on the geodesic definition of the direction from P1 to P2. The distances reported can still be toggled to reflect the different distance types down line and the offset from the line regardless of the current coordinate system.

Surfaces

Ground surface

Ground distance at average height

Local design surface at average height

P2

P1

P1

P2

Geo distance

Grid distance distortion greater than geodesic distance

ELLIPSOID

SURFACE

P1

P2

P1

P2

Secant projection surface typical of State Plane and UTM

Grid distance distortion less than geodesic distance

Geo distance

Zone limits for practical usage of projection surface balancing both positive and negative distortions

Basic
- Direct
- Inverse
- Transverse
- Triangle
- Shift
- Move
- Rotate

Offset
- Offset
- To Line 1
- To Line 2
- Bearing-Bearing

Intersections
- Distance-Distance
- Bearing-Bearing
- Bearing-Distance
- Angle-Angle
- Angle-Distance
- Angle-Distance
- Diagonals

Area/Perimeters
- Area/Perimeter
- Polyline Length
- Hinge
- Parallel

Stakes
- Divide Line
- Stake Line
- Stake Curve
- Arc
- 3-Points Arc

Tools
- Factors
- Accuracy
- Average
- Relative Accuracy

Using CoGo

The Coordinate Geometry (CoGo) menu contains functions used to calculate coordinates, areas and scale factors. New points can then be created from the resultant calculations. The following Cogo functions are included in the 6 menus listed below:

In all CoGo functions labels shown in black are inputs and labels shown in red are the resultant calculations. Known points are green and red points are new points created from the calculation.

CoGo Basic
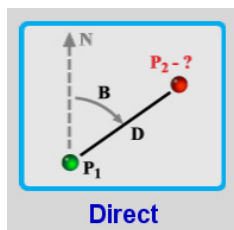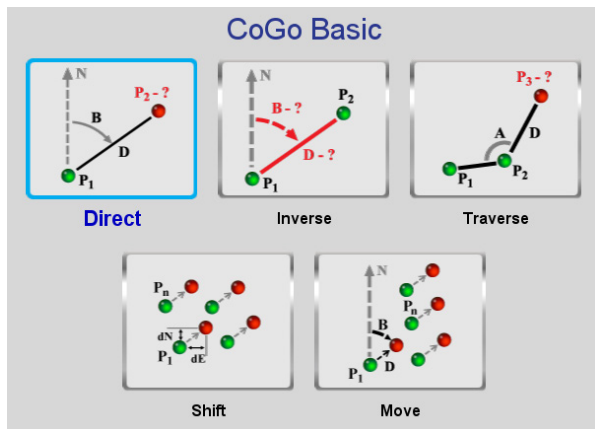
CoGo Basic

Direct

Direct calculates the coordinate of a new point (**P₂**) given the coordinate of a known point (**P₁**), bearing (**B**) and distance (**D**) from **P₁**.

The input screen looks like this:

Clicking on any of the input boxes will display the entry screens for these values.

Notice the vertical line in the white box shown between **ΔH** and the input "0.0 ft"

Clicking on the left side of this white box with **ΔH** will toggle it to the other options of **H**, **Slope** and **H, Abs.**

Clicking on the right side of this box will allow for the entry of the value. This functionally is similar in all CoGo menus when you see a white box separated with a vertical line in the middle.

The resultant point is shown in the orange box. Clicking on this box will allow you to edit the Name, Description and Code of this point.

Once all the inputs have been entered click **Preview** to view a map of calculation:

```
BACK        CoGo        Create
                        N
                              100
                    ⊕
                                4
168.6                      168.6
ft                         ft
        5035.355ft    5035.355ft
```
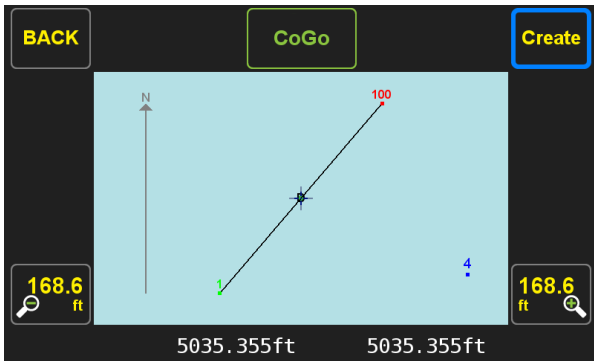
If you are satisfied with the calculation, click create and the point is saved as a Stake point. You can then press **Esc** or the **Home** button to exit the function.
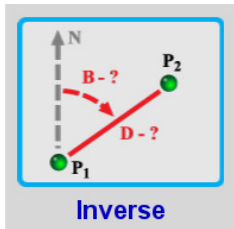

Inverse

Inverse calculates the bearing (**B**) and distance (**D**) of a line between two known points (**P₁** & **P₂**).

Press to switch the coordinates of **P₁** & **P₂**.

Clicking on the right side of output boxes such as **B**, Grid copies the value of the box into the selected clipboard box.
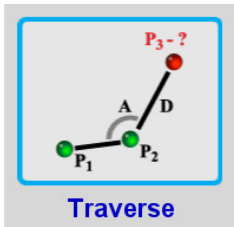
Traverse

Use this function to create a new point at a specified distance (**D**) from **P₂** and at an angle (**A**) from a line between two known points (**P₁** & **P₂**). This function is useful for entering a shot from a total station.
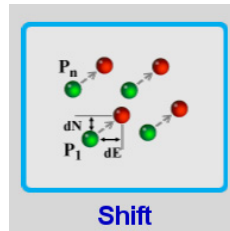
Shift

This function shifts a list of selected points or an alignment by an inputted **ΔN**, **ΔE** and **ΔH**.
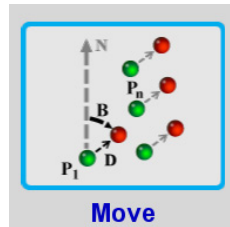
Move

Use this function to move a list of selected points or alignment by a distance (**D**) and bearing (**B**).

CoGo Offsets

CoGo Offsets
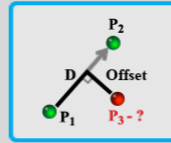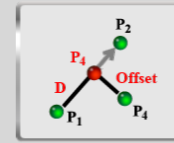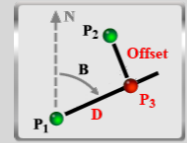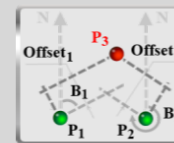
Offset · To Line 1 · To Line 2 · Bearing-Bearing
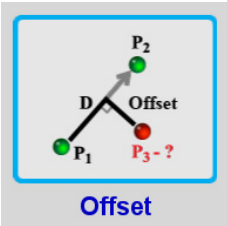
Offset

Offset calculates the coordinate of an offset point (**P$_3$**) along a line between two known points (**P$_1$** & **P$_2$**) at a distance (**D**) along that line and at a specified perpendicular **Offset**.

Press to switch from the right offset to the left offset. This functionally is similar in the other CoGo functions.

To Line 1

This function calculates a new point (**P$_4$**) along a line between two points (**P$_1$** & **P$_2$**) that is offset perpendicular from a third point (**P$_3$**). It also displays the distance (**D**) along that line and the **Offset** distance.
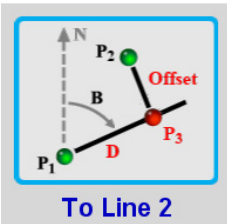
To Line 2

Use this function to calculate a new point (**P$_3$**) at a given bearing (**B**) from a point (**P$_1$**) that is offset perpendicular from a second point (**P$_2$**). It also displays the distance (**D**) between **P$_1$** & **P3** and the Offset distance between **P$_3$** & **P$_2$**.

Bearing-Bearing

Bearing-Bearing is used to calculate offset points at centerline intersections. **P$_1$** & **P$_2$** are points on the two intersecting centerlines and **B$_1$** & **B$_2$** are the respective bearings of those centerlines. The right-of-way offsets are entered as **Offset$_1$** and **Offset$_2$**. The resultant point, **P$_3$** is at the intersection of the two right-of-ways.

Use the button to switch between 4 different offset scenarios.

CoGo Intersections
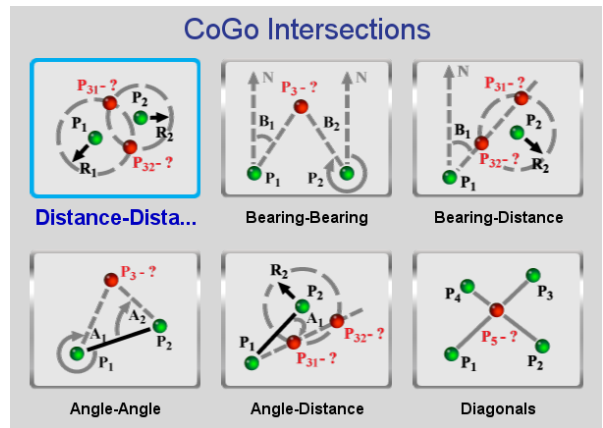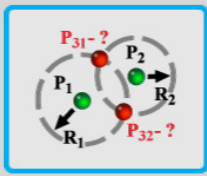
Distance-Distance

Distance-Distance

Distance-Distance calculates the coordinate of the intersection of two circles (P_3) given the centers of the two circles (P_1 & P_2) with radii of R_1 and R_2.

Bearing-Bearing

Bearing-Bearing

This function calculates the coordinate of the intersection (P_3) of two bearings (B_1 & B_2) from two points (P_1 & P_2).

Bearing-Distance

Bearing-Distance

Use this function to calculate the coordinate of a new point (P_3) at the intersection between a bearing (B_1) from a point (P_1) and a circle with a center at P_2 and radius of R_2.

Angle-Angle

Angle-Angle

Angle-Angle calculates the coordinate of a new point (P_3) at the intersection of two angles (A_1 & A_2) from endpoints of a line with endpoints of P_1 & P_2. The angles are measured as angle rights from the line.

Angle-Distance

Angle-Distance

This function calculates the coordinate of the intersection (P_3) between an angle right from a line between (P_2 & P_1) and the radius of a circle (R_2) with a center at P_2. The angle is measured from P_2 to P_1 to P_3.

Diagonals

Diagonals

Use this function to find the intersection (P_5) of two lines. The first line has endpoints P_1 & P_3 and the second line has endpoints of P_2 & P_4.

CoGo Area

CoGo Area

Area/Perimeter

Polyline Length

Hinge

Parallel

Using CoGo
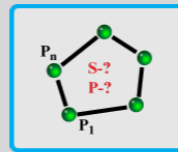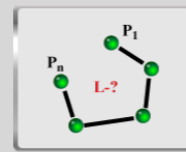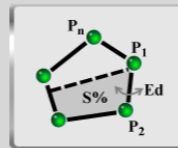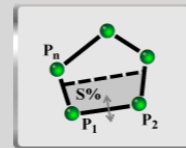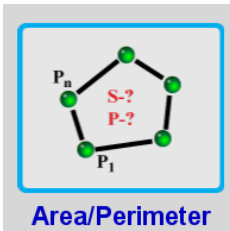
Area/Perimeter

Area/Perimeter

Area/Perimeter calculates the length of the perimeter (P) and area (A) of a closed polyline specified by a list of chosen points or the perimeter and area of a chosen polygon.

Polyline Length

Polyline Length

This function calculates the length (L) of a polyline specified by a list of chosen points or a chosen alignment.
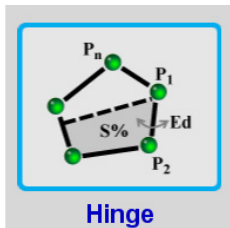
Hinge

Hinge

Use this function to calculate the a new polygon having a specified percentage of the area (**Keep area**, **%**) of the original polygon. The polygon is specified by a list of chosen points or a chosen polygon. A **1st nodal point** is specified. This is the point which the hinge is calculated around. The **2nd nodal point** will lie in the perimeter of the new polygon. It is specified so that the direction of the hinge is known. A new point will be created at the end of the hinge on the perimeter of the original polygon.

In addition the option of **Keep area**, **%**, other options of **Cut area**, **Cut area**, **%** and **Keep area** can be used.

Parallel

Parallel

Parallel is very similar to hinge. Instead of a hinge, a line parallel with a line of the original polygon is calculated to contain or remove the specified area. The line is parallel with a line between the 1st nodal point and 2nd nodal point.

CoGo Stakes

CoGo Stake

Divide Line   Stake Line   Stake Curve

Arc   3-Points Arc
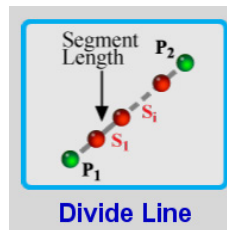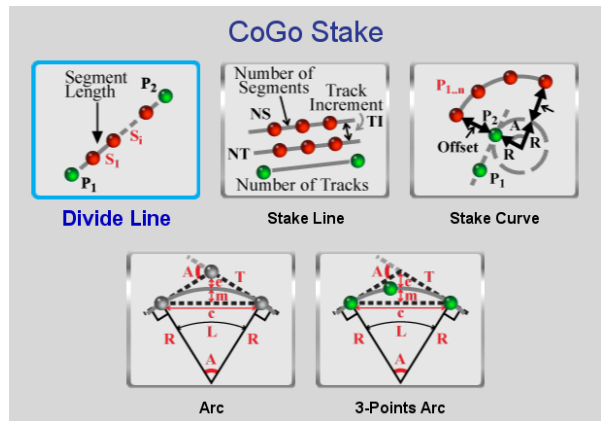
Divide Line

Divide Line

Divide Line is used create a specified number (**Points,n**) of equidistant points along a line with endpoints of P_1 & P_2. It can also be used to divide this line by specifying a **Segment Length** to

create points along the line.

The height of the created points can be calculated as an offset from **P$_1$** (**ΔH,P$_1$**), an offset from **P2** (**ΔH,P$_2$**), an offset from the average of **P$_1$** & **P$_2$** (**ΔH,Avg**) or an absolute height can be entered (**H,Abs**).

Pressing **Preview** and then **Create** will save the points as Stakes with the inputted prefix (**Result points prefix:**).

Pressing the **Stake Now** will prompt you for a name to save an alignment and then display the alignment **Stake Now** map. No points are calculated in this mode however the station and offset of the current position will be dynamically displayed at top of the map:
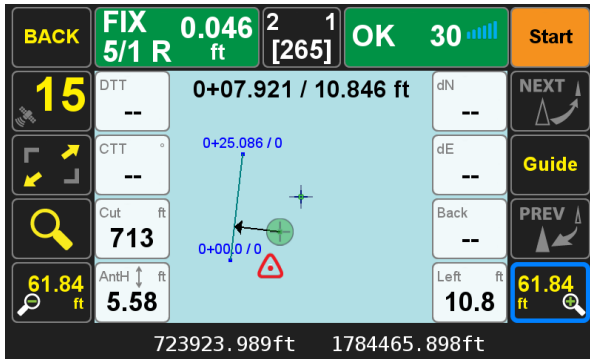
Pressing the **Create Alignment** will also prompt you for a name to save an alignment but then you will be taken to the **Alignment Summary** page where the alignment can be further edited. Alignments are discussed in detail in the *Stake Out* section ().
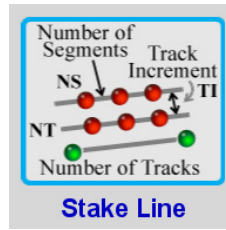
Stake Line

This function is similar to Divide Line. Instead of creating the points along the line between **P$_1$** & **P$_2$**, it creates equidistant points along a specified number (Tracks, m) of parallel lines offset from the original line by a Offset distance.
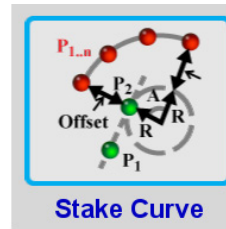
Stake Curve

Use this function to create a specified number of points (Points, n) along a curve. The curve begins at **P$_2$** (with Offset = 0) or at an Offset from **P$_2$**. It has a radius of R (or R + Offset when an offset is included), a delta angle of **A** and is tangent to a line between **P$_1$** & **P$_2$**.
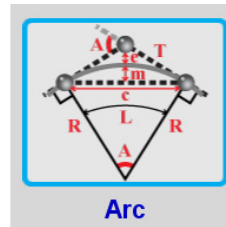
Arc

Arc is used to calculate all arc parameters given any two input parameters. The available parameters are delta angle (**A**), radius (**R**), arc length (**L**), tangent (**T**), chord (**c**), middle ordinate (**m**), external (**e**) and curvature (**D**, **arc**).
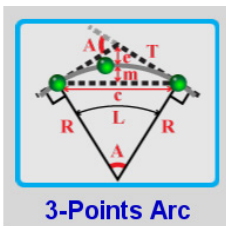
3-Points Arc

This function is used to calculate all arc parameters given the arc starting point (P_1), any point on the arc (P_2) and the arc ending point (P_3).

CoGo Tools
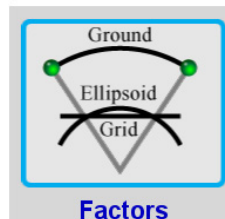
Factors

Factors is used to calculate the following scale factors from a chosen point or the average factors from a list of points:

- *Combined Factor*
- *Grid-to-Ground Factor (reciprocal of Combined Factor)*
- *Elevation Factor*
- *Geo-to-Ground Factor (reciprocal of Elevation Factor)*
- *Grid-to-Geo Factor*
- *Grid Scale Factor (reciprocal of Grid-to-Geo Factor)*
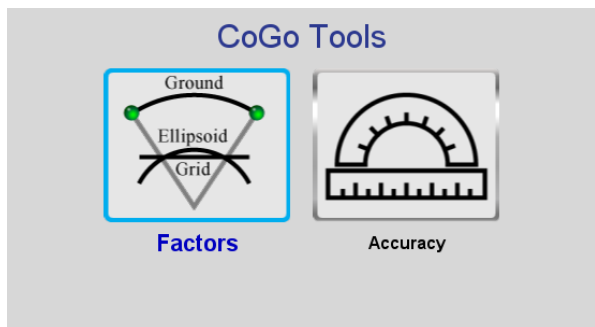
It also calculates the Grid Convergence and Magnetic Declination.

The units shown for the factors are ppm or shown as a ratio. This is determined by the Units settings in Advanced Settings found in the Advanced menu of Setup.
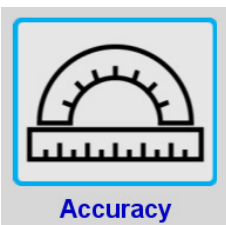
Accuracy

In the Accuracy tool, the typical **Angular** and **Distance** accuracies of measurements are set. These are used to calculate the **Est. Error** shown in some of the CoGo functions.

Terms and Concepts

Project

In J-Field a project is created or opened in either the Collect Screen or the Stake Screen. The project is defined by the project name and coordinate system. Predefined projections (such as UTM and State Plane) are attached to transformations. Therefore, it is important to select a coordinate system that matches the reference frame the control coordinates are based on (such as HARN for a HARN based monument or NAD83 2007 for a CORS based control point).

Page

J-Field's use of Pages is a new concept in land surveying software. J-Field Pages are sub-projects within a project. J-Field supports up to ten Pages in a single project, with each Page being defined by a name (the default is Page 0, Page 1, Page 2...), a coordinate system which includes a transformation and a coordinate system, and unit. The coordinate system of Project is default for the ten pages. A user is free to work entirely in the default opening Page of a new project, Page 0, however there are several advantages to using multiple Pages for some projects. Pages can be used to divide a project into phases. Consider an extensive real-estate development project. A surveyor might initially perform a control survey, a boundary survey, a topographic survey, stakeout utility construction, stakeout road construction, stakeout lots and stakeout buildings. Each of these can be placed within its own Page, and as necessary, the visibility of each Page can be controlled by the user. The points in the topographic phase can be kept within the project, but can be turned off to reduce screen clutter. In this example it is likely that all of the Pages will be in a single coordinate system (such as State Plane).

Because Pages can have different coordinate system definitions within the same project, a user can mix different coordinate systems in the same project. This may be useful if points from different projections and transformations need to be included in a single project. For instance, a user may name his or her main collection Page "Main" and set the coordinate system to State Plane Coordinate System of 1983, NAD83, Kansas North, and because the project is based on HARN control, select the NAD83 to WGS84 (47) / EPSG-USA KS/NAVD 88/SPCS83/Kansas North zone transformation, and select NAVD 88 for the height system and Geoid12A as the geoid. Perhaps some points have been provided in a different projection (such as UTM) or a different transformation (based on NGS CORS). The user could create a new Page called "Given Data" and enter that data in the coordinate system the data was provided in. Internally, all of the coordinates are stored as ITRF2005 coordinates, but are viewed in the coordinate system for their particular Page. Coordinates can be shared between Pages and all coordinates from all Pages can be viewed together or selectively disabled.

Another benefit Pages offers is working with an Unknown coordinate system. A surveyor retracing a boundary using multiple surveys (whether sourced from a plat or a description) could create a Page named "Record Calls" with an unknown coordinate system. The user could also create a primary collection Page named "Survey" with a predefined coordinate system. As the user occupies one of the points from the records, he or she could perform a localization that would place the record calls on the ground. Using the stakeout feature he or she could navigate to another point and once recovered, occupy this point and perform

another localization defining the rotation. The user could continue repeating the procedure until all of the record calls are found, refining the localization each time, improving the predicted position of the remaining points. As can be seen, Pages can offer an unprecedented ability to separate data, to work with multiple coordinate systems, and to incorporate data from unknown coordinate systems into a geo-referenced system. Of course, a surveyor can keep all project work in a single Page if he or she desires.

ShapeTags

ShapeTags are used in *J-Field* to control connections between collected points. Points collected with the same ShapeTag name are connected together by a line or curve (as the user has selected). Points collected with the same ShapeTag name continue to be connected until the user ends the line. Polylines can be ended open or closed back to the first point. Once a ShapeTag is ended, it can be reused for another polyline collected later.

The benefit of using ShapeTags is particularly evident in the J-Field Auto Sequence. By building a list of ShapeTags to be collected, J-Field can automatically switch from one polyline to the next according to the user-defined list. This is particularly beneficial to cross-section data collection. Consider a cross-section of a road that has a ditch on either side. The cross-section sequence would be Left Natural Ground (LNG), Left Top Bank (LTB), Left Ditch Flow Line (LFL), Left Edge of Pavement (LEP), Centerline (CL), Right Edge of Pavement (REP), Right Ditch Flow Line (RFL), Right Top Bank (RTB), Right Natural Ground (RNG). The Auto Sequence would increment from one line to the next based on the ShapeTags (LNG, LTB, LFL...RTB, RNG). Auto Sequence also allows for reversing the sequence once complete (RNG, RTB, RFL...LTB, LNG).

Codes

Codes are used in a unique way within *J-Field*. Codes are designed by the user and function similarly to layers in AutoCAD. Codes also carry default symbol types and default attributes. The Code "Boundary" might contain a default circle symbol, and the attributes "Type", "Size", "ID Cap". Each point collected with the Code "Boundary" will use the circle symbol by default, and prompt for the attributes Type, Size and ID Cap. Upon Export to dxf (drawing exchange file) from J-Field, Codes can be used to define the layers of the exported polylines. When creating a ShapeTag, you must create its Code first. A Code may belong to several ShapeTags.

ShapeTags and Codes provide a very powerful data structure . When collecting standalone points, you can also use ShapeTag, Code and other attributes to make your data collection easy in the field and provide versatile documentation.

Javad GNSS geodesists, aided by professional land surveyors, have meticulously programmed the heavy lifting of geodesy into J-Field, resulting in simplified and technically correct software. In order to use it effectively, and for your reference, we explain some terminologies and concepts here.

RTK Positioning and Verification

Positions measured by GNSS receivers contain errors caused by inaccuracies in the satellite and receiver clocks, the satellite orbits and by the ionosphere and troposphere. When a base station is used, these errors are nearly identical

Terms & Concepts

to both the rover and base station receivers when the baseline distance is short. By removing these common errors through RTK double difference processing, centimeter level accurate vectors can be calculated between the base and the rover.

When the double difference ambiguities are estimated as real numbers, a float solution is obtained. When the ambiguities can be constrained to fixed integers, a fixed solution is achieved. Determining the correct integer ambiguities of a fixed solution is a statistical process and the probability of fixed solutions providing inaccurate position solutions increases in poor environments.

Multipath, the reflections of GNSS signals from nearby structures and objects (including the ground), combine with the direct GNSS signals from the satellites to the GNSS receiver and shift their signals. It's as if your measuring tape is bent around an obstacle like a tree instead of a free and clear line of sight between two points. The worst case is when the receiver doesn't receive the direct signal at all; e.g., the satellite is behind a building, but it's still receiving the signal reflected off of the nearby structure. Such Non-Line-Of-Sight (NLOS) signals can be strong, unhelpful and misleading.

The other aspect impacting the veracity of a fixed solution is when there are weak GNSS signals. Frequently, weak signals are due to their penetration directly through tree canopy.

While J-Field can't move the obstacles that are creating multipath out of the way, its sophisticated engineering is designed to handle even the weakest signals like no other system with its *RTK Verification and Validation System* (patent pending).

Ellipsoids

Ellipsoids (Spheroids) are mathematical models of the general shape of the Earth. An ellipsoid is formed by an ellipse rotated about the semi-minor (polar) axis and is defined by semi-minor axis and semi-major axis or semi-minor axis and inverse flattening.

Geoids

Geoids model the local effect of Earth gravity. Geoids are models and improve as gravitational measurements and density of measurements improve. Geoid models are important to land surveyors because these models allow GNSS determined positions to accurately determine orthometric heights related to sea level (such as might be determined by differential leveling) instead of being related to an imaginary shape such as the ellipsoid. Differences in orthometric heights between two points, based on a geoid model, will determine the way in which water will flow between them.

Transformations

Coordinates for a point on the Earth can vary depending on when and how those coordinates were determined. Reference Frames, or Datums, refer to the time and basis of a coordinate system. A transformation is a mathematical process that converts a coordinate related to one datum to another. The geodetic team of Javad GNSS elected to set the *J-Field* internal database to the ITRF2008 reference frame. This means that any coordinate input as a NAD83_ adjustment xx (which is set in the project settings) is transformed internally to ITRF2008. When a position is recalled from the database, the ITRF2008 position is transformed back to a NAD83_adjustment xx position (or

whatever coordinate system is set in the project settings). This is why it is important to set the transformation of your project correctly as determined by the published control the user is related to. With the database set to ITRF2008, future adjustments of a reference frame (such as NAD83) can be handled by the software automatically once the new transformation parameters are uploaded to *J-Field*.

Projections

Projections allow surveyors to visualize flat grid coordinates on the curved surface of the Earth. By projecting points on the ellipsoid onto a grid surface, surveyors can use plane trigonometry with geodetic positions. J-Field is preloaded with projections from around the world and also allows the user to enter his or her own custom, Low Distortion Projection. Furthermore, J-Field can develop a projection through the localization process for coordinates with an unknown coordinate system.

Localization

Localizations in J-Field can accomplish two tasks. By observing points in a defined coordinate system, *J-Field* can determine the location of the reference station relative to the defined coordinates. In an unknown system (a system of coordinates that are not geo-referenced, such as from a total station survey), J-Field can create a projection from points observed on the ground. In this case, it is important that the reference station coordinates already be related to a known coordinate system.

Auto Naming and Sequencing

Point Names will auto increment based on the Naming Template that is defined for each ShapeTag. When collecting lines and curves, ShapeTags can be changed manually to define a new shape; or can be auto sequenced (automatically switch to another shape) by creating a sequencing scenario and making it active. This feature is helpful in application like collecting cross sections.

Collect and Stake

The workflow for "Collect" is shown on the Collect screen and its "Help" explanation. For the Stakeout workflow also read the "Stakeout" document.

Setup, Profiles and Projects

Parameters related to satellite tracking, mode of operation (Rover, Base, Standalone), communications, favorite Codes and ShapeTag and similar are saved with "Setup" profiles. You can save and recall many "Setup" profiles according to your projects needs. While Reservoir of Codes and ShapeTags are stored as global values, favorite Codes and ShapeTags are saved with Setup profiles. If you recall another Setup profile, you will recall Favorite Codes and ShapeTags with it. Geometries (points, lines, and curves), their ShapeTags, Codes, attributes , pages and coordinate systems are saved with "Projects".

Beware of this distinction and use them as it fits your job requirements. In Collect and Stake screens, pay attention to Projects and Setup boxes in Collect and Stake screens to make sure they are selected as you intend. Please refer the charts in next pages to see which items are saved with "Projects" and which items with "Setup" profiles.

Terms & Concepts

Compass and Levels

Calibrate the compass and levels periodically. When calibrating the levels, the unit only needs to be held within 5 degrees of level; the internal three-axis accelerometer calibration software will take care of the rest. Levels are temperature dependent, and should therefore be calibrated at the temperature of the environment the unit will be used in.

Electronic compass works only in magnetically uniform environment. Move any electronic compass around your computer, for example, and its direction may change by 180 degrees. Calibrate compass in the area that you are going to use. Make sure that your environment is uniform enough for using electronic compass. Move around and see if its reading changes substantially.

Compass does have tilt compensation, but it is better to hold the unit level when using compass to remove the need for compensation.

CAUTION: Electronic compass works in uniform electromagnetic environments only. Try the one in your phone and move it around in your office. It changes by 180 degrees when you pass the power supply of your computer, or your office phone. Rely on compass in uniform electromagnetic environment and calibrate it there. This is nothing unique to TRIUMPH-LS. Try many other types. Mechanical compass are also somewhat sensitive. Move them around and see.

Trouble Shooting

Symptom	Remedy
J-Field becomes unresponsive; this may be due to various causes. The most frequent cause is power cycling; e.g., during an update J-Field will automatically reboot, or when powering off the TRIUMPH-LS and in both instances leaving the USB cable connected to the PC. This is a known bug with the operating system and is being worked on.	Hold down the power button for a full 10 seconds forcing a full power off and thus allowing a full or so-called cold boot of the system
There are rare instances when you may need to coerce J-Field to reinstall a piece of firmware or software. Such an occasion may arise when a file becomes corrupt or is suspect of being corrupt by your support specialist.	Familiarize yourself first with the procedures for doing an Update and then proceed as outlined on (p. 141). Once completed, and no longer needed, be sure to uncheck the Forced option as it is persistent.
If your GNSS equipment malfunctions and needs to be repaired or replaced, you will need to first obtain a **Return Merchandise Authorization** (RMA) number before sending it back to the factory.	Call to obtain an RMA before shipping to: 900 Rock Avenue, San Jose, CA 95131 USA Phone: +1(408)770-1770 Fax: +1(408)770-1799

Other trouble shooting issues	For all other troubleshooting and support related questions, please visit: **https://support.javad.com** There you will find the so-called **5PLS Team**, U.S. professional land surveyors, the awesome team of developers, scientists and even Javad Ashjaee himself to answer all of your technical questions regarding your GNSS equipment.

Forced Update

From the Home screen open **Support** > **Software Updates**.

Tap on **Configuration** icon
Tap on **Advanced Settings** > **Apps Settings**
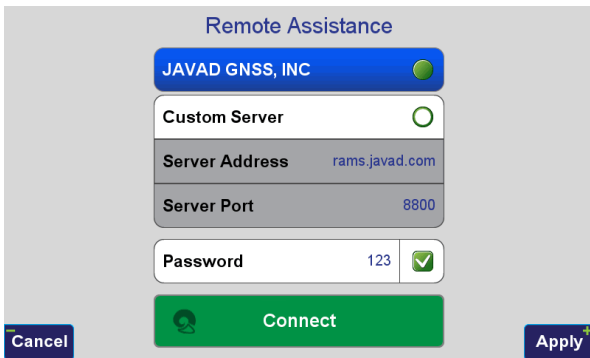
Check the **Force** boxes for the software and firmware to force to be updated.

Tap on **Apply and then OK** to return to the Update Software screen. Press **Update** to then proceed with the update.

Trouble Shooting
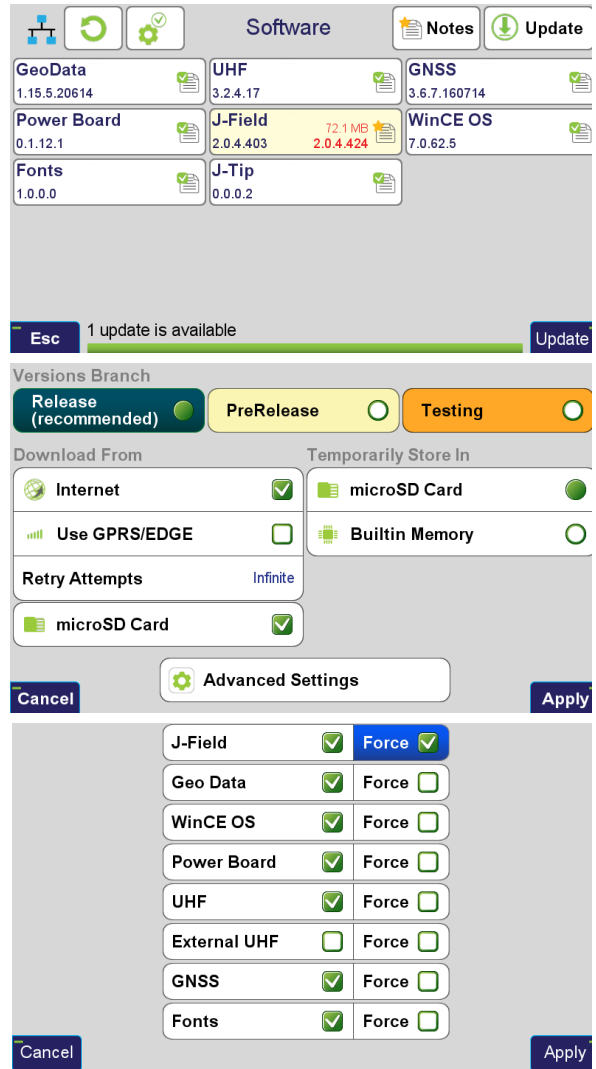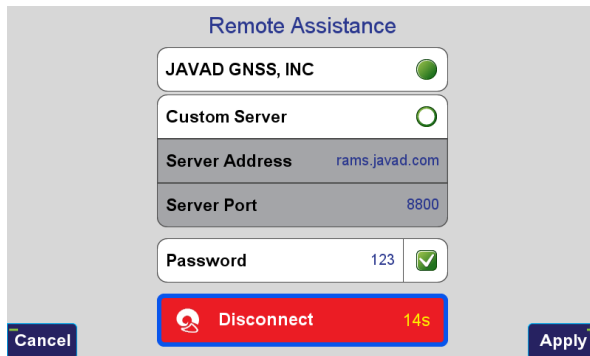
Remote Assistance and Monitoring Service

J-Field has the ability to be supported remotely whenever an Internet connection is established. To allow a technical support member to remotely access and control your TRIUMPH-LS open *Support* > *Remote Assistance*.
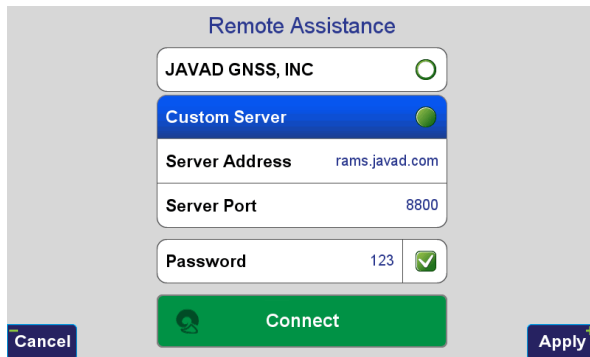
Select the *JAVAD GNSS, INC* server, enter and enable a password if desired and then tap **Connect**. If you haven't entered your name in the *Operator* field of *System* > *Receiver Details* you will be prompted for it before the connection is established. When the connection is established the *Connect* button will change to *Disconnect*.

If you would like to use *Remote Assistance* for your own personal use a free server is available for this using Server Address: **rams.javad.com** and Server Port: **8800**

Connect as shown and then use any web browser to open the RAMS viewer at http://javadgnss.net/rams-viewer/. Once there add **rams.javad.com:8800** as a *Server connection*.
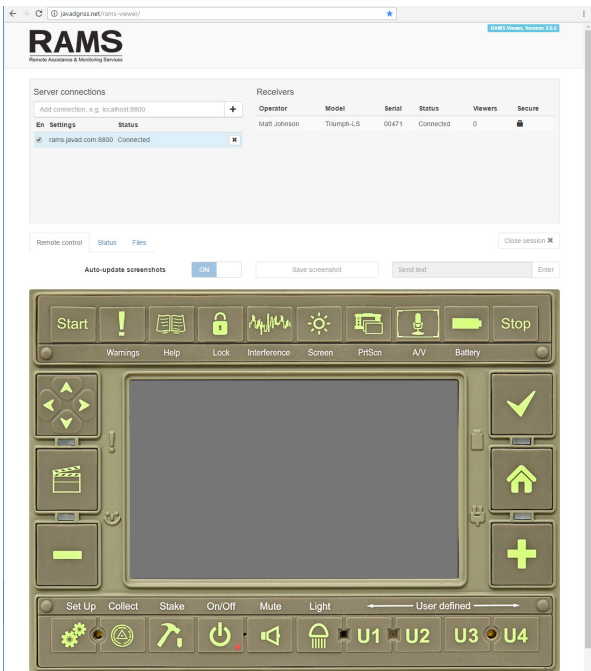
Highlight the server that was just add you should see the *Receivers* connected to it. Click on a *Receiver* to connect to it. You will now have full control of this receiver. If it is being operated directly enable the **Auto-update screenshots** option to view the updated screenshots in the *RAMS Viewer*.

The *Files* tab allows files to be explored, uploaded and downloaded remotely.

TRIUMPH-LS

Internal GNSS Antenna

Versatile High Performance Geodetic Antenna

Antenna Type	Microstrip (Zero Centered)
Ground Plane	Antenna on a flat ground plane
LNA Gain	32±2 dB

GNSS Receiver

Total 864 channels: all-in-view (GPS L1/L2/L5, Galileo E1/E5A/E5B, GLONASS L1/L2/L3, QZSS L1/L2/L5, Beidou B1/B2, SBAS L1/L5) integrated receiver, rugged magnesium housing

Signals Tracked	GPS C/A, P1, P2, L2C (L+M), L5 (I+Q) Galileo E1 (B+C), E5A (I+Q), E5B (I+Q), AltBoc GLONASS C/A, L2C, P1, P2, L3 (I+Q) QZSS C/A, L1C(I+Q), L2C (L+M), L5 (I+Q), SAIF Beidou B1, B2 SBAS L1, L5
Autonomous Accuracy	<2 m
Static, Fast Static Accuracy	Horizontal: 0.3 cm + 0.5 ppm * base_line_length Vertical: 0.5 cm + 0.5 ppm * base_line_length
Kinematic Accuracy	Horizontal: 1 cm + 1 ppm * base_line_length Vertical: 1.5 cm + 1.5 ppm * base_line_length
RTK (OTF) Accuracy	Horizontal: 1 cm + 1 ppm * base_line_length Vertical: 1.5 cm + 1.5 ppm * base_line_length
DGPS Accuracy	< 0.25 m (post-processing) < 0.5 m (real-time)
Cold Start	<35 seconds
Warm Start	<5 seconds
Reacquisition	<1 second

Environmental

Enclosure	Molded magnesium alloy and plastic, IP67
Color	Gray
Operating Temperature**	-30° C to +55° C
Storage Temperature**	-20° C to +45° C
Humidity	100% condensing
Dimensions	7.20 x 4.88 x 4.17 inches (183 x 124 x 106 mm)
Weight	4.63 lbs (2.1 kg)

Specifications

Main Features*

- 864 channels
- RTK rate up to 100Hz
- 6-parallel RTK Engines
- RAIM
- Advanced Multipath Reduction
- In-Band Interference Rejection
- GLONASS .2mm Dynamic Calibration
- Integrated Controller and FieldCAD Software
- Interference Viewing
- Visual Stakeout
- Offset Survey with Photogrammetry
- Lift & Tilt
- Data Recording up to 16 GB
- Real-time Data Input/Output JPS, RTCM SC104 v. 2.x and 3.x, CMR
- Real-time Data Output NMEA 0183 v. 2.x and 3.0, BINEX
- WiFi, Bluetooth, Ethernet
- Internal 4G LTE Mini Card
- Internal Radio Modem
- Lifetime Firmware & Software Updates
- 3-Year Unlimited Warranty

* For the full list of standard and optional features see www.javad.com

**Li-Ion batteries are the temperature limiting factor

TRIUMPH-LS

Radio

4G LTE Mini Card	LTE, HSPA+, HSDPA, HSUPA, WCDMA, GSM, GPRS, EDGE (up to 100 Mbps) LTE, EV-DO, 1xRTT CDMA (up to 100 Mbps)
MicroSIM card slots	Two; user accessible, fully sealed
Radio Modem	Internal 406-470MHz UHF radio Internal 902-928/ 868-870 MHz ISM radio (optional)
Base Power Output	1 Watt

I/O

Communication Ports	Wi-Fi (IEEE 802.11b, g, n, d, e compliant) Bluetooth V2.1+EDR power Class 2 Full-duplex 10BASE-T/100BASE-TX Ethernet High Speed USB 2.0 Host High speed USB 2.0 Device RS232 (optional) up to 460800 bps
Other I/O Signals	1 PPS, Event Marker External GNSS Antenna External Radio Antenna

Controller

ARM MPU	DM3730 Up to 1-GHz ARM® Cortex™-A8 Core; 1GB RAM
Operating System	Microsoft Windows Embedded Compact 7
SD card slot	High Capacity microSD Card (microSDHC) up to 32GB Class 10; user accessible,fully sealed
Display	Active matrix color TFT LCD Module Diagonal 4.3''; 800 x 480 pixels
Touchscreen	Low reflective resistive touch panel
Buttons	Navigation button Home - main screen Action button Zoom -/Zoom + Enter (Ok) button - activates enter function Three user programmable buttons On/Off button Ten quick access button
LED Indication	Battery charging status, battery status, sleep mode, warning status
Voice recording	integrated
Audio Output	integrated
Photo Camera	Two integrated cameras 3 Mpixels
Inclinometers	integrated
Compass	integrated

Power Management

Battery	Rechargeable, lightweight Li-Ion battery 85 Wh (nom.)
Operation Time	25 hours on one charge
External Power Input	10-30 V DC
Charging	Power management notifies user when battery needs charging and protects battery from overcharging

Specifications

AC Power Cable

AC Power Adapter

Extension cord not included

Acces. Power Cable

TRIUMPH-2

Ext Power/Charger
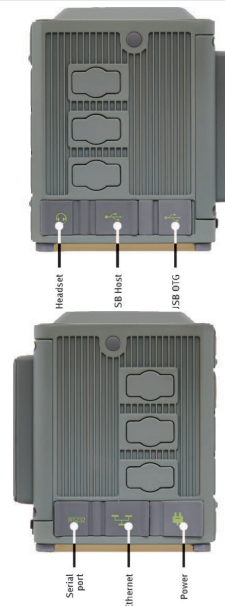
TRIUMPH-2

TRIUMPH-2 + Charging Kit

Shown assembled while the **TRIUMPH-2** is being charged

Depending on the which options you purchased with your TRIUMPH-LS, you may have in your RTK kit the TRIUMPH-2 to serve as the RTK Base. The above illustration is how the assembled charging system looks for the TRIUMPH-2 while it's being charged.

Depending on the which options you purchased with your TRIUMPH-LS, you may have in your RTK kit a UHF radio for transmitting corrections from the TRIUMPH-2 or other receiver serving as the RTK Base.

The illustration to the right is how the assembled charging system looks for the Battery Kit while it's being charged.

The battery kit that is shown may be used to power modems such as the HPT404BT and HPT435BT UHF radios.

⚠ **NOTE!!!**
The AC wall charger is not a power source for the radio
DO NOT CONNECT THE BATTERY CHARGER TO THE RADIO

Battery Kit

Extension cord not included

Battery Charger

Power Cable

Power Cable

12v Battery + Charging Kit
Shown assembled while the battery is being charged

Ancillaries

Note: The UHF antenna is shown connected to the HPT401BT for illustrative purposes and isn't actually required for charging the radio's attached battery; however, to safeguard against accidental transmissions, it's always good practice to keep the antenna on the radio.

AC Power Adapter

AC Power Cable

HPT401BT

Extension cord not included

⚠ Never use the radio without attaching the antenna

Ext Power/Charger

Acces. Data Serial Power Cable, DB9/DB15/SAE

HPT401BT + Charging Kit

Shown assembled while the HPT401BT is being charged

Depending on the which options you purchased with your TRIUMPH-LS, you may have in your RTK kit a UHF radio for transmitting corrections from the TRIUMPH-2 or other receiver serving as the RTK Base.

The illustration above is how the assembled charging system looks for the HPT401BT UHF radio while it's being charged.

This is also a similar configuration that you could use when connecting the HPT401BT to your 9-pin serial serial connection with your PC.

Ancillaries

Accessories
for the TRIUMPH-LS

Mounting Bracket
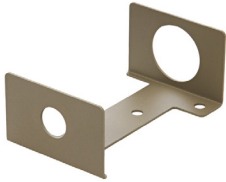
**Triumph-VS Soft
Carrying Case**

This bracket works with the following radios:
- HPT401BT
- HPT404BT
- HPT435BT

Shown attached to
the HPT404BT

Shown attached to
the HPT401BT

The HPT435BT
attaches similarly

For a complete listing of
all Javad GNSS accessories
please visit our website at:

http://javad.com/jgnss/products/accessories/

Appendix A - Blinking LEDs

To **turn ON** the receiver press the power button. To turn OFF the receiver, press and hold the power button until LEDs are off and then release the button.

The **MinPad** is the receiver's minimum interface used to display and control data input and output.

Function	Symbol	Green	Yellow	Red	OFF
BATTERY [1]	▭	Full	Half	Almost empty	OFF/No power
WLAN	📶	Connected	Initialization	Error	Not Active
SATELLITES[2]	⬗	8 or more	5 to 7	Less than 5	No Satellite
POSITION	⊛	Fixed/Diff/ OK (Base)	Float/No-Diff	No Position	Receiver OFF
RECORDING[3]	⊙⊙	Recording	Less than 10 min memory left	Memory Full	Not Active

1. Blinking every 1 sec according to the battery means receiver is ON without external power. LED solid according to the battery means external power is connected.

2. Effective number of satellites are total number of satellites tracked minus the number of non-GPS systems tracked. For example if 8 GPS and 5 GLONASS are tracked the effective number of satellites is 12.

3. RECORDING LED blinks on each recording.

Function	Symbol	Blue	Yellow	Red	OFF
BLUETOOTH	✳	Connected	Searching	No connection	Not Active

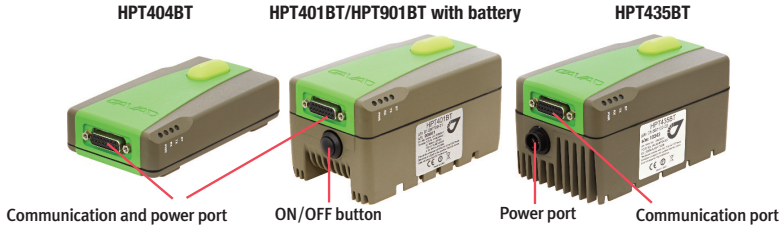The record button starts/stops data recording.

Power port is used to connect the receiver to an external power source and to charge the batteries. Input voltage: +10...16 VDC.

USB port is used for high-speed data transfer and communication between the receiver and an external device.

The bottom 1/4-20" thread connector allows mounting TRIUMPH-2 on the monopode, install 1/4-20" to 5/8-11" adapter to mount TRIUMPH-2 on the pole.

To operate TRIUMPH-2 as RTK base station it could be equipped with Bluetooth® capable external radio like either one of three UHF 406.1-470 MHz radio transceivers: 35W HPT435BT, 4W HPT404BT, 1W HPT401BT or license free frequency hopping 902-928 MHz 1 W HPT901BT radio transceiver.

HPT404BT   **HPT401BT/HPT901BT with battery**   **HPT435BT**

Communication and power port   ON/OFF button   Power port   Communication port

WARNING! To avoid serious damage of the equipment, do not use the radio without the antenna.

TRIUMPH-2 communicates with radio via Bluetooth wireless link. Up to 50 ft (~15 m) is the practicable range of the communication between TRIUMPH-2 and HPT401BT/HPT404BT. Actually in the field they keep reliable connection up to 130 ft (~40 m). TRIUMPH-2 and radio are paired at the factory, so they automatically connect together after power applied.

To turn ON the radio without the internal battery, connect the external power using the cable included to the kit.

To turn ON the radio with the internal battery, either connect the external power or press and hold the power button for more than 5 seconds to operate from the battery. To charge the internal battery, connect the external power.

External radio status indication:

Function	Color	Description
PWR	Green	**Radio with internal battery:** Solid - external power is connected, battery charger is off. Blinking every 1 second - external power is connected, the battery is being charged Blinking every 4 seconds - external power is not connected, internal battery is being used as power source Blinking every 0.5 second - external power is not connected, the battery is near to full discharge OFF - external power is not connected. **Radio without internal battery:** Solid - external power is connected OFF - external power is not connected
RX	Green	ON - radio receives data
TX	Green	ON - radio transmits data
BT	Blue	OFF - Bluetooth® is OFF; Solid blue - Bluetooth® is ON; Blinking if radio receives or transmits data over Bluetooth®

Appendix B - NGS AntCal Data

JAVTRIUMPH_LS+NONE
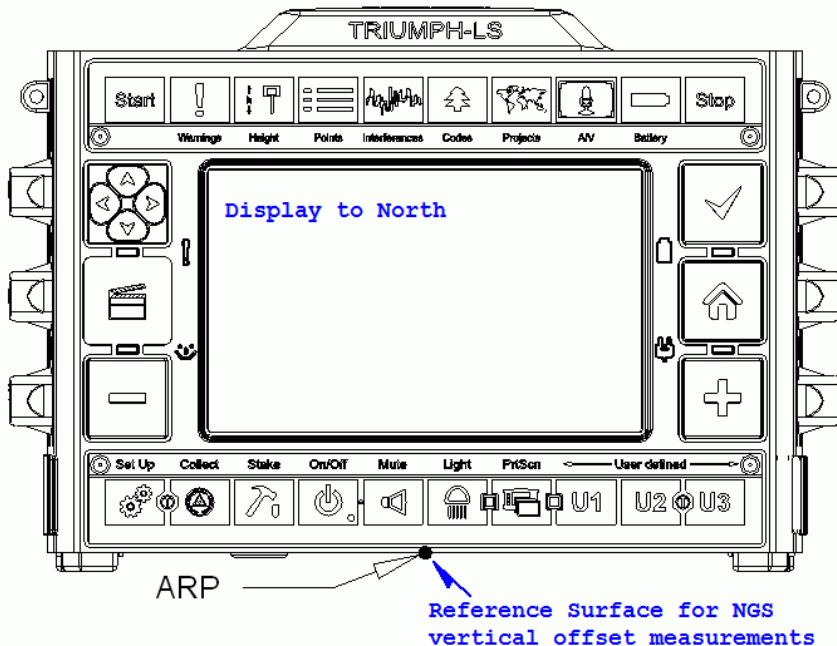
Display to North

ARP

Reference Surface for NGS
vertical offset measurements

Model Name: JAVAD TRIUMPH-LS
Antenna Code: JAVTRIUMPH_LS

The receiver was mounted using a pole adapter
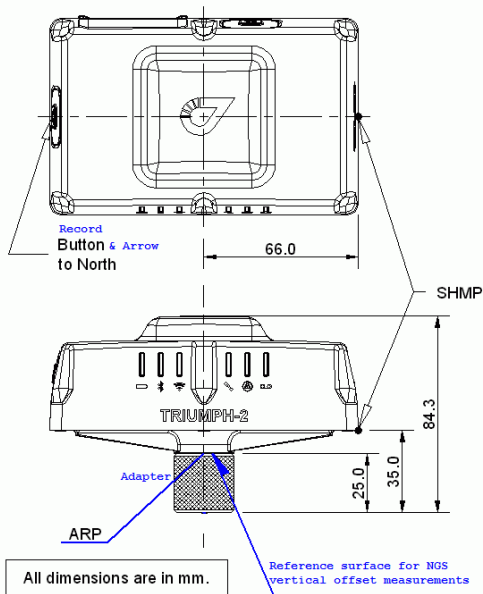(P/N 10-590293-01) 1/4-20 to 5/8-11.
Height of the adaptor is 25mm from the bottom of the
adaptor to the ARP.

Appendix B - NGS AntCal Data

Model Name: JAVAD TRIUMPH-2 with Adapter
Antenna Code: JAVTRIUMPH_2A

JAVTRIUMPH_2A+NONE

Record Button & Arrow to North

66.0

SHMP

TRIUMPH-2

84.3

25.0

35.0

Adapter

ARP

Reference surface for NGS vertical offset measurements

All dimensions are in mm.

ARP - Antenna Reference Point
SHMP - Slant Height Measurement Point

JAVTRIUMPH_LSA+NONE

TRIUMPH-LS

Start | Stop

Warnings | Height | Points | Interferences | Codes | Projects | A/V | Battery

Display to North

Set Up | Collect | Stake | On/Off | Mute | Light | PxScn | User defined

U1 | U2 | U3

ARP

Reference surface for NGS vertical offset measurements

Model Name: JAVAD TRIUMPH-LS
Antenna Code: JAVTRIUMPH_LS
The receiver was mounted using a pole adapter (P/N 10-590293-01) 1/4-20 to 5/8-11. Height of the adaptor is 25mm from the bottom of the adaptor to the ARP.
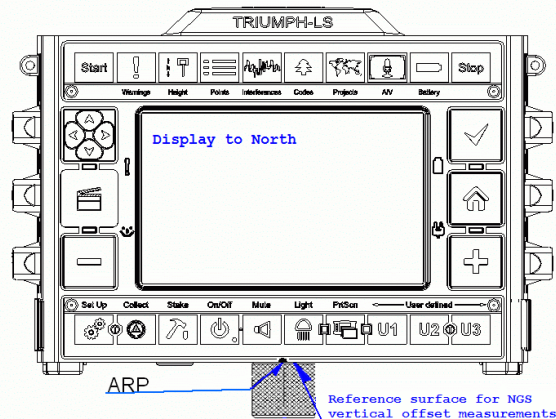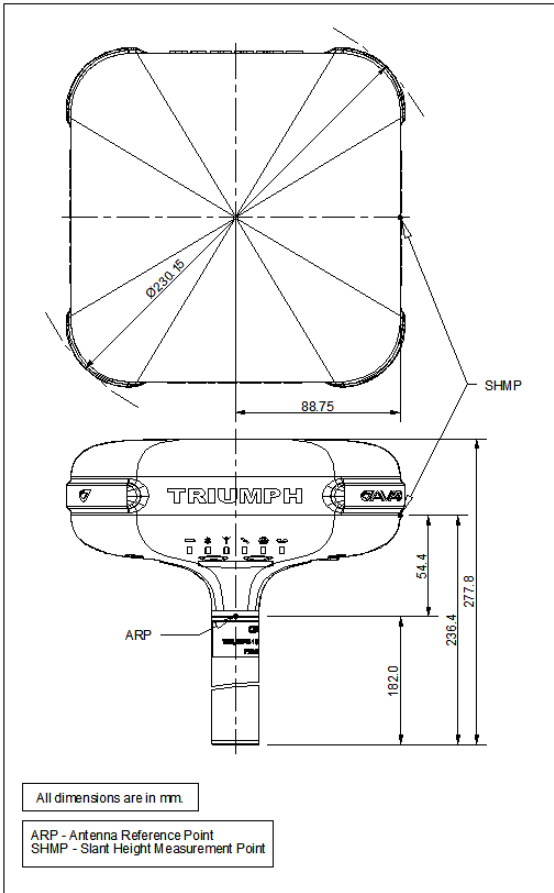
Appendix B - NGS AntCal

Model Name: JAVAD TRIUMPH-1M with Radio Antenna
Antenna Code: JAVTRIUMPH_1MR

Ø230.15

88.75

SHMP

TRIUMPH

GAVA

ARP

54.4

277.8

236.4

182.0

All dimensions are in mm.

ARP - Antenna Reference Point
SHMP - Slant Height Measurement Point

TRIUMPH-LS shown above and its slant height measurement point (SHMP). A similar mark is also on the opposite side of the TRIUMPH-LS.

TRIUMPH-2 shown above and its slant height measurement point (SHMP).

Appendix B - NGS AntCal

www.javad.com

FIELD

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