

Survey-Grade GPS Guide

NRCS Pacific Islands Area

Basic Survey Procedure

1. **Turn on Data Collector (DC), tap Windows icon and then start Magnet Field program**

Job  > New Job  or Job > Existing Job

****always tap  to get to the main menu of Magnet Field****

2. **Set up Tripod with Base Receiver**
 - a. Measure slant height from center of survey marker to horizontal groove in base receiver with tape measure, record in survey notes
 - b. Use External Radio and Car Battery if needed, see Notes Pg. 4
 - c. Turn on Base Receiver
3. **Set up Rover Receiver and Surveying Rod**
 - a. Measure height from end of rod to horizontal groove in rover receiver with tape measure, record in survey notes
 - b. Turn on Base Receiver
4. **On DC and in Magnet Field,  and start new job or open existing job**
5. **Connect DC to Base Receiver via Bluetooth**
 - a.  MAGNET Field >  (Connect)
 - b. On first screen, use drop down to select Internal Antennae (HIPERV INT) or Pacific Crest External Antennae (HIPERV EXT PACCREST) > fill the circle next to Base >
 - c. Select Base Receiver ID from List > > to finish
 - d. Base will announce “Bluetooth Connected” and light in the upper right hand corner of the base display will be a solid blue. In the DC , the  icon in the upper RH corner will change to an image of a GPS receiver 

6. Set Base Location and Start Base

-  MAGNET Field > Set Up > Start Base
- Enter Base Height from Step 2a (Pg. 1) into the box labeled “Ant Ht”
- For a new job, enter a Point Number (i.e. 100) and Code (i.e. “BASE” or “INS”) for the base shot on the parent screen then  to determine the approximate N/E location of the base and  to store location data

**** For an existing job, pull up the base shot from the survey and make sure Point Number and Code are correct, do NOT determine the N/E location again****

-  and the DC will indicate 
-  to finish

7. Connect DC to Rover via Bluetooth

-  MAGNET Field >  (Connect)
- Tap “disconnect” to disconnect the DC from the base
- Tap circle to select “GPS” and use drop down to select either Internal Antennae (HIPERV INT) >

- Select Rover Receiver ID from List >  >
 to finish
-  MAGNET Field >  (Set Up) >  (Status)
- Tap “Sys” (System) Tab
- Must have 100% radio link and a “Fixed” position prior to starting your survey, the rover will say “RTK fixed”

****If you are unable to get fixed position, pick up rover and DC and move further away from base station****

8. Topo Survey – Taking Individual Shots

-  MAGNET Field >  (Survey) >  (Topo)

- b. Tap the “Settings” button at the top of the screen 
 - i. Select “Fixed Only” from drop down for both quick and precise
 - ii. Precision Solutions should be 3 for the for the Precise and 1 for the Quick shot
- c. Enter rod height from Step 3a (Pg. 1) into box on lower left-hand corner of screen
- d. Enter Point Code for first shot into first box on the lower left-hand corner of screen > Tap  to take Topo Point > Wait 3 seconds > Tap  to save

9. Auto Topo Survey – Taking Shots on Specified Interval

- a.  MAGNET Field >  (Survey) >  (Auto Topo)
- b. Enter Point Code
- c. Enter rod height from Step 3a (Pg. 1) or from backpack or four wheeler into box on lower left-hand corner of screen
- d. Tap the “Settings” button at the top of the screen  > set Auto Topo method and interval
- e. Tap “Start”  to record a shot immediately, and then start moving to record shots based on interval setting
- f. Screen will indicate “Logging Pt” and DC will record based on time or distance until you tap “Pause”  or “Stop” 
- g. To override the interval settings and record a shot in-between, tap the Log Now  button to record a rapid shot

10. End Survey

Make sure last survey point saved > tap  in upper right hand corner to close down MAGNET Tools

In-Depth Survey Guide

This guide provides background information on Real Time Kinematic (RTK) topographic surveys with the Topcon HiperV and FC-500 system. There are also guides for downloading survey points for use in CAD and GIS and how to create and execute a project stakeout.

Hardware Required (Pg. 5)

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Survey Job File Setup (Pg. 13)

Download Survey (Pg. 14)

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Trouble-Shooting (Pg. 18)

Note on Accuracy and Precision

The terms accuracy and precision are often used interchangeably in the survey world when they mean very different things. Accuracy is how close a measured value is to the actual value and precision is how close measured values are to each other.

RTK data collected using the Topcon system may have accuracies of 10mm + 1 ppm horizontal and 15mm + 1ppm vertical. That means that the global position of any point collected may be within 0.4 inches of the actual location and 0.6 inches of the actual elevation.

Track the precision of your survey as you collect points in the field by referencing the survey screen. The values for horizontal and vertical precision will be under the orange “H” and orange “V”. The accuracy of your survey can be improved by using a control point with a known elevation or through post processing. Post processing with the Online Positioning User Service (OPUS) can resolve most positions to within a few centimeters. More information can be found online at www.ngs.noaa.gov/OPUS.

Survey shots may be collected as rapid (quick) points, topo (precise) points and auto topo. Precision of your survey is affected by the observation time of the survey point and the settings of the rapid and topo point shots are user-defined (Step 8b, Pg. 2). The ROT is one second for rapid shots, three seconds for topo shots and 30-60 seconds for a control point. Rapid shots should only be used when there aren't enough satellites available for topo shots.

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Auto topo takes a rapid point at a user-specified distance or time. Ensure that the antennae height entered into the survey settings (Step 9c, Pg. 3) reflects the rover rod height with the backpack or four wheeler.

Note on External Radio

The radio range for the internal HiperV radio is about one mile and the external antennae signal may reach up to five miles. Use the external antennae for any survey that extends more than one mile from the base station and for survey areas with variable topography. An external antennae may provide better accuracies as it has the potential to pull information from a greater number of satellites.

Note on HiperV Batteries

The HiperV batteries may last anywhere from one to three hours, so use the car battery should be used to power the base station for any survey that may last more than two hours.

Hardware Required

The hardware required for surveys is outlined below and in photos on the next page.

1. FC 500 Data Collector
2. Two HIPER-V receivers – base receiver and rover receiver
3. Four HIPER-V receiver batteries
4. Tribrach
5. Base Attachment to Tribrach
6. DC Attachment to Rod
7. Measuring Tape
8. DC Serial Port to Receiver Cord, Receiver to Battery Cord
9. Pacific Crest Radio
10. Antennae and Extensions
11. Antennae Attachment to Tripod
12. Radio to Antennae Cord, Radio to Base Receiver Cord
13. Car battery
14. Tripod
15. Survey rod



MAGNET Field Configuration on Data Collector

Navigating to MAGNET Field

Turn on the FC-500 data collector (DC) by pressing the power button once. Use the stylus for all work on the screen.

When the collector turns on, you will be directed to the blue FC-500 home screen. Press the Windows button and select MAGNET Field. The Bluetooth “Select Receiver” screen will pop up, tap the blue house key  in the upper right corner for the home screen.

Survey Settings

The following settings are for the basic configuration of the Internal Radio (HIPERV INT), External Radio (HIPERV EXT PACCREST) and Static (STATIC) in MAGNET Field. Once these settings are saved, they will become default for all surveys. Static must be used when you want to post-process with the OPUS.

The only changes that should be made to the basic configuration are settings that impact the accuracy and precision of your survey points. These settings are found for both internal and external radio configuration in the Topo Survey menu (Step 13), Stake Settings menu (Step 16) and the Advanced Options menu (Step 19).

Internal Radio (HIPERV INT) Settings

1.  MAGNET Field >  Configure >  Survey
2. Settings Menu
GPS+ Configuration Name: HIPERV INT > 
3. Configuration Menu
Make sure HIPERV INT is highlighted > 
4. Configuration Menu
Name: HIPERV INT
Type: RTK


- Receiver Make Menu
No Check in Simulation Mode or Post Processing,
Manufacturer for both Rover and Base: TopCon

Next >>

- Base Receiver Menu
Check in Ext. Receiver: Bluetooth
Receiver Model: HiPer V
No Serial Number
Elevation mask: 13 deg
RTK Format: CMR+
Antenna: HiPer V
Ant Ht 0.00 IFt

Next >>

- Base Radio Menu
Device Type: Internal Radio
Device Model: Digital UHF II
Port: Blank
Baud: 115200

Next >>

- Base Radio Param Menu
Power: 1 W
Protocol: PDL
Modulation: 4FSK
Scrambling: On
FEC: On

Next >>

- Rover Receiver Menu
Check in Ext. Receiver: Bluetooth
Receiver Model: HiPer V
No Serial Number
Elevation mask: 13 deg
RTK Format: CMR+
Antenna: HiPer V
Ant Ht 5.45 IFt

Next >>

- Config. Rover Modem Menu
Modem Connect: Receiver

Next >>

11. Rover Radio Menu

Device Type: Internal Radio

Device Model: Digital UHF II

Port: Blank

Baud: 115200

Next >>

12. Rover Radio Param Menu

Protocol: PDL

Modulation: 4FSK

Scrambling: On

FEC: On > [Next >>](#)

13. Topo Survey Menu

Precise Menu

Solution: Fixed Only

No Check on Meas. Continuously

Average: 3

No Check for Precision so that it defaults to HMRS

0.05, VRMS 0.1

No Check for Auto Store

Quick Menu

Solution: Fixed Only

Average: 1

No Check for Precision so that it defaults to HMRS

0.05, VRMS 0.1

Next >>

14. Auto Topo Survey Menu

Solution: Fixed Only

Method: By Horiz Dist

Interval: 25.00 lft

Next >>

15. Stake Settings Menu

Horiz. Distance Tolerance: 0.16 lFt

Screen Orientation: North

Display Reference: None

Next >>

16. Stake Settings Menu

Precise Menu

- I. Solution: Fixed Only
- II. No Check on Meas. Continuously
- III. Average: 3
- IV. No Check for Precision so that it defaults to HMRS
0.05, VRMS 0.1
- V. No Check for Auto Store

Quick Menu

- VI. Solution: Fixed Only
- VII. Average: 1
- VIII. No Check for Precision so that it defaults to HMRS
0.05, VRMS 0.1

17. Grade Stake Marking

Working Stake Length: 2.46 IFt

Top Stake Spacing: 0.33 IFt

Bottom Stake Spacing: 0.33 IFt

Cut/Fill Interval: 1.64 IFt

18. Stake Settings

Point: Design Pt Suffix _stk

Note: Design Point

19. Advanced Menu

RTK Position: Extrapolation

Check Multipath Reduction

No Check Canopy Environment

No Check High-Vibration Environment (QLL)

Base Station make: <Automatic Detection>

20. to save and close

Internal Radio (HIPERV INT) Settings

Settings are the same as for Internal Radio (HIPERV INT) except for the following:

Step 3 - Configuration Menu

Highlight HIPERV EXT PACCREST



Step 4 - Configuration Menu

Name: HIPERV EXT PACCREST

Type: RTK 

Step 7 - Base Radio Menu

Device Type: External Radio

Device Model: Generic

Port: A

Baud: 38400

Data: 8

Parity: None

Stop: 1



to save and close

Static (STATIC) Settings

Settings are the same as for Internal Radio (HIPERV INT) except for the following:

Step 3 - Configuration Menu

Make sure STATIC is highlighted > 

Step 4 - Configuration Menu

Name: STATIC

Type: PP Static





Step 7 - Base PP Setup Menu

File Name: User Defined

Log To: Receiver

Logging Rate: 15.00 secs

Min SVs: 0



Step 8 - Occup Times Menu

Num SVs	Single Freq.	Dual Freq.
4	60	120
5	40	120
6+	20	120



 to save and close

Configure Job File

Create a new job file for each surveying project as shown in Step 1, Pg. 1 of the quick survey procedure. This can be done in the office or on the job site.

1. Job  > New Job 
2. Complete "Name", "Created by" and "Comments" fields >

3. GPS+Configuration Name: HIPERV INT
Optical Configuration Name: <Default>

4. Projection: UTMNorth-Zone_5 : 156W to 150W for Hawaii Island, UTMNorth-Zone_4 : 162W to 156W for all other islands
Use Grid/Ground: No Check
Geoid: g2012ah0

5. Distance Unit: IFeet
Distance Precision: 0.12
Area Unit: Square IFeet
Volume Unit: Cubic IFeet

6. Coord Type: Grid
Coord. Order: Northing, Easting, Height
Geoid, Azimuth Origin: North
Disp Dir As: Azimuth
Disp CL Pos As: 12+34.00
 >  (upper RH corner) to finish
7. To open an existing job, Job  > Open Job  > Tap job name with stylus >  (upper RH corner) to finish

Download Survey to Computer

This section provides information for downloading data directly from the FC-500 DC with ActiveSync in a comma delimited format.

In FC-500

1.  MAGNET Field >  Exchange >  To File
2. Data: Multiple
Format: Topcon Text Custom (*.txt)
Check "Select File Units"
Check "Use type for attributes"
Check "Use quotes for text values"

3. Check boxes for Points and Codes > 
4. Distance Units: IFeet > 
5. Points: All Points > 
6. Name the file >  to finish

In Windows Explorer for CAD

1. Plug FC-500 into USB port
2. Windows Mobile will pop up, select "Connect without setting up your device"
3. Once connected, select "File Management" and "Browse the contents of your device"
4. In windows explorer, navigate to Program Files > MAGNET Field > IE Files and open the text file you created in the FC-500
5. Open excel, then copy and paste with the Text Import Wizard and select delimited by comma and hit "Finish"
6. Delete the column headings and make sure that columns A through D are all numbers (i.e. change "base" to a number)

7. Save the File as a “.csv” and hit yes to any error messages
8. Import .csv file into CAD as a points file

In Windows Explorer for ArcGIS Shapefile

1. Open .csv file created for AutoCAD import (Steps 1 through 7, Windows Explorer for CAD)
2. Add one row at top of spreadsheet and the following titles:
 - a. Point (Col. A); Northing (Col. B); Easting (Col. C); Elevation (Col. D) and Code (Col. E)
3. Convert Cols. B and C into meters, multiply by 0.3048 (easiest way is to put equation into Cols. G and H, then copy back into Cols. B and C as values)
4. Make sure there aren't any spaces in any of the cells (i.e. instead of “P TANK”, change it to “P_TANK” or “PTANK”)
5. Save spreadsheet as an Excel Workbook, you may want to tack “GIS” to the name so that you'll remember that it is formatted for GIS
6. Close spreadsheet and then open ArcGIS
7. Click on the vertical tab on the right-hand side of the screen called “Catalog” (note if the Catalog window is not visible in ArcMap, you can open it by clicking the Catalog  button on the Standard toolbar or by clicking Windows > Catalog on the main menu)
8. Navigate to the folder where you saved the spreadsheet and click the plus sign next to the file name (note if spreadsheet is open in Windows this step will not work)
9. The expanded file should have an apostrophe in front of the name (i.e. '2015-06-09HallGIS.xlsx); Right Click > Create Feature Class > From XY Table
10. The “Create Feature Class from XY Table” dialog should pop up, input the following properties –
 - a. X Field: Easting, Y Field: Northing and Z Field: Elevation
 - b. Click “Coordinate System of Input Coordinates” box
 - c. Click Select > Projected Coordinate Systems folder > UTM folder > NAD 1983 > Select NAD 1983 UTM Zone 5N.prj (_4N for all islands except Big Island) >Add > OK

- d. Select which folder to save the new shapefile to
 - e. Hit OK from the “Create Feature Class from XY Table”
11. Drag your new shapefile from the Catalog on the right-hand side of the window into ArcMap

If your shapefile shows up in the wrong spot, check the following common errors:

1. Did you convert the Northing and Easting (feet) to meters in Step 3?
2. Did you follow the procedure for inputting Northing and Easting into the XY Table in Step 10a?
3. Did you select the correct coordinate system in Step 10c?

Stakeout Procedure

In Windows Explorer

1. Create Stakeout File in CAD that includes base and control points and save to CSV or TXT file format as-is, don't add headers
2. Plug FC-500 into USB port
3. Windows Mobile will pop up, select "Connect without setting up your device"
4. Once connected, select "File Management" and "Browse the contents of your device"
5. In windows explorer, navigate to Program Files > MAGNET Field > IE Files and drag your CSV file from CAD

In FC-500

6.  MAGNET Field >  Exchange > From File
7. Data: Multiple
Format: Comma Delimited (*.csv) or Topcon Text Custom (*.txt)
Check "Select File Units"
Check "Use type for attributes"
Check "Use quotes for text values"
8. Check boxes for Points and Codes >
9. Distance Units: IFeet >
10. Points: All Points >
11. Name the file >  to finish

In Field

12. Follow Basic Survey Procedure (Pg. X) and on Step 6 pull up the base shot from the survey
13.  MAGNET Field >  Stake

Trouble-Shooting

External Antenna

Certain site conditions will require the use of the external antenna. Some conditions will be unknown until you start the survey, so the best practice is to set up the external antennae on all survey jobs. Obvious site conditions that require the external antennae include varied and undulating topography, survey areas larger than three miles and survey days with dense cloud cover.

Once you start surveying, the necessity of the external antennae will be shown through various errors that range from losing the Bluetooth signal every time you take a shot to MAGNET field freezing and having to be restarted.

Position does not progress from “Fixed”, stays “Autonomous” or “Float”

When you are going through the basic survey procedure Step 7g and the position does not “fix”, the rover receiver is likely too close to the base receiver. Pick up the rover receiver rod and move further from the base.

Satellite Signal is Lost under Tree Canopy

When surveying under tree canopy, powerlines, near buildings, etc. it may help to turn on the Magnet field canopy feature -  MAGNET

Field > Configure  > Survey  > Settings Menu >  to Rover Receiver Menu, check the box next to “Canopy Cover”.

References

This guide references material provided to NRCS PIA engineering staff during the September 2014 training by Holman's USA and the following documents:

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TopCon Position Systems, Inc. *HiPer V GNSS Receiver Operator's Manual*. PDF Format dated December 2012. Available at www.positionpartners.com.au.

Topcon Positioning Systems, Inc. *MAGNET Field Help*. Version 2.0. PDF Format dated September 2013. Available at www.positionpartners.com.au.

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