Procedure

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Management System

GPS MINE SITE CALIBRATION

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1 PURPOSE

This procedure describes the steps required to complete a Trimble RTK Site Calibration.

This procedure also provides a tie-in of the local mine grid with the national grids (MGA94) via surrounding SSM's. It based on mine grid being a plane projection, with a constant height difference between local height datum and AHD.

2 SCOPE

This document applies to all mine sites using Trimble 5700/5800 GPS Receivers with TSCe controllers, or later models.



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3 DEFINITIONS



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4 PROCEDURE

4.1 Overview - Performing a Site Calibration

To calibrate a site using a Trimble RTK GPS, the general procedure is as follows:

- (1) Key in, transfer or use a conventional instrument to measure the grid coordinates of the control (calibration) point. This is the mine grid primary survey control points. The list of these mine grid points should be categorised as to their order of precision.
- (2) Obtain the details of 3 Government SSM that surround the site.
- (3) Set up the GPS Base in a convenient and central location not over any survey control point. Start base receiver.
 - At New Job: use No projection/No datum
 - Set the *Coordinates* field to *Ground*, and enter an average site height.
 - Do not select the Use geoid model check box.
 - At the Survey, Point Name: use here now for WGS84 values of the base point
- (4) Set up the rover over the primary survey control point.
 - The origin of the horizontal adjustment is the first point in the calibration.
 - The origin of the vertical adjustment is the first point in the calibration with an elevation [TSCe].
- (5) Check or set the calibration tolerances.
 - Do not tick either: [fix hz scale to 1] or [auto calibrate]
- (6) Name or select the pairs of points to be used for the calibration. A pair of points consists of the grid coordinates and the WGS-84 coordinates for the same point.
- (7) Measure the control points using GPS.
- (8) Repeat the pairing of points, and measurements on all control points.
- (9) Perform the calibration.
- (10) Check residuals, and re-calibrate if necessary.
- (11) Apply the calibration.
- (12) Set up base receiver over a known survey control point
- (13) Obtain mine grid coordinates with Rover GPS on 3 surrounding SSM's.

NOTE:

Carry out the complete calibration before staking out any points, computing off set and / or intersection points, or computing a re-section from GPS points.

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4.1.1 Upload Mine Grid Control

4.1.1.1 Keying in Grid Coordinates

To key in grid coordinates:

- (1) From the main menu, select *Key in / Points.* The *Key in/Point* screen appears. Move the highlight to the *Point name* field and press [>].
- (2) Type the point name. Press [Enter].
- (3) Type details or features of the point in the Code field. Press [Enter].
- (4) Set the *Type* field to Coordinates. Check that the coordinate fields are *North, East,* and *Elevation.* If they are not, press [Options] and change the *Coordinate view* setting to Grid. Key in the known grid coordinates and [Enter].
- (5) Set the *Search class* field to Control. (This ensures that the point is not overwritten by a measured point). For more information on Search class rules, refer to the *Trimble Survey Controller User Guide*.
- (6) Repeat Steps 2 and 3 for all grid coordinate points. Then press [Esc] or [OK] to return to the *Key in* screen. Press [Esc] again to return to the main menu.
- Tip Use a minimum of four 3D points. Up to 20 can be used in a combination of 1D, 2D, or 3D mine grid coordinates.
- Tip The preferred convention is to use calibration points around the perimeter of the site, as in theory this is the limit of the validity of the calibration. However, in mine sites this is in almost all cases not a practical reality.

4.1.1.2 Transferring Grid Coordinates

Transfer coordinates using Trimble Geomatics Office, Data Transfer, or ASCII transfer.

Make sure that these coordinates are:

- Transferred as grid coordinates (N, E, E), not as WGS-84 coordinates (L, L, H).
- Control class points.

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4.1.2 Obtain SSM Data

Obtain approx project height (AHD) from any available mapping data

4.1.3 Set up Base Reciever

Establish a New Job

Tap the *Coord. sys* button and select *No projection/no datum.*

Set the *Coordinates* field to *Ground*, and enter a value (average site height) in the *Project height* field [for TSC2 use here toggle] [for old TSCe use ellipsoid height quoted for nearby ssm] to use ground coordinates after a site calibration.

Do NOT Select the Use geoid model check box.

Any points measured using GNSS are displayed only as WGS84 coordinates.

The Trimble Survey Controller software performs a calibration that calculates a Transverse Mercator projection and a Molodensky three-parameter datum transformation, using the supplied control points.

The project height is used to compute a scale factor for the projection so that ground coordinates can be computed at elevation.

From the Survey menu, choose Start base receiver.

Access the *Point name* field and enter the point name.

Tap Key in to access the Key in point screen.

Tap *Here* and the current position is displayed.

Tap Store to accept and store this position.

Enter values in the Code (optional) and Antenna height fields.

Set the *Measured to* field as appropriate.

In the *Station index* field, enter a value. This value is broadcast in the correction message, and must be in the range 0-31.

Tap Start

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4.1.4 Setting the Calibration Tolerances

To set the tolerances on the Controller :

- Click on the Configuration icon.
- Select Survey Styles > then RTK [TSC2 has both RTK and GNSS RTK styles to set] > then Site Calibration.
- Set the following screen [for old TSCe]:

The TSC2 model will include a *Vertical adjustment* prompt: set this to *Constant adjustment only*

🔊 Site	e calibre	lian				? _ ×
Fix H.	.Scale to 1.	0:	Auto	Calibra	ate:	
Observ	vation					A Q
Observ	vation Type:					O C
Observ	ved Control	Points	2121	2124 W V2		网海
Max Ho	oriz. Residu	als:	Max.	Vert. A	Residuals:	
	U.UIUm			0.02	Um	¥ 2.000
Min. H	Horiz. Scale	:				Man
Morr I	U.9999 Haris Scalo		Mox	glopo		Mah
Max. I	1.00001		na.	10.0	ppm	M <u>e</u> nu
Calib	ration Point	name				- · · ·
2005454	Method:			Add:		+avontes
	Add Suffi:	< c		_GPS		
						Switch to
_	RTK:Fi	xed H:0.00	5m \	/:0.010	Im RMS:8	, Eda
Esc	Add	Delete	Re	sults	Apply 1	LUR

4.1.5 Set up the rover over the primary survey control point.

- The origin of the horizontal adjustment is the first point in the calibration.
- [For old TSCe] The origin of the vertical adjustment is the first point in the calibration with an elevation.

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4.1.6 Selecting the Points Pairs to Perform the Calibration

The following steps describe how to select the points for a calibration and then perform the calibration using Trimble Survey Controller. Do this once you have entered grid coordinates, checked the settings in the Survey Style, and measured the points using GPS.

- (1) From the main menu, choose *Survey*. Select a real-time Survey Style.
- (2) From the Survey menu, choose Site calibration. The Site calibration screen appears.
- (3) Press [Add] .The following dialogue appears:

📯 Calibration point	? _ X
Grid point name: Nail A	
GP5 point name: Nail A-GPS	留書。
Use: Horizontal & vertical	<u>M</u> ap
	M <u>e</u> nu
	F <u>a</u> vorites
	Switch to
Esc RTK:Fixed H:0.005m V:0.009m RMS:8	Enter

(4) Enter the name of the grid point. To do this, highlight the *Grid point* field and press [List]. Select a point that you have keyed in, transferred, or measured using a conventional instrument. Do the same for the *GPS point* field. The two point names do not have to be the same, but they should correspond to the same physical point.

Tip Pair up the primary or datum height point of the mine grid first.

Tip The origin of the horizontal calibration is the centroid of the measured calibration points.

However, for old TSCe the origin of the vertical adjustment is the first point in the calibration that has an elevation, whilst with the TSC2 an averaged constant adjustment will be on final display.

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4.1.7 Using GPS to Measure Calibration Points

Use GPS to survey the points. Trimble Survey Controller automatically matches the grid points to the WGS-84 values and then calculates, stores, and applies the calibration.

When one point has been calibrated or a projection and datum transformation have been defined, the [Find] soft key appears. You can use this to navigate to the next point.

As you measure another calibration point, the new calibration is calculated, stored, and applied to the job.

To measure a calibration point:

- (1) From the main menu, choose *Survey*.
- (2) From the Select Survey Style menu, choose your RTK Survey Style.
- (3) Select Measure points. Arrow down and change the Type field to Calibration point.
- (4) Access the *Grid point name* field and press [List] .A list of keyed in grid coordinates appears. Highlight the point to be measured and press [Enter] .The point name is inserted into the *Grid point name* field. The *GPS point name* field is filled in by Trimble Survey Controller depending on the settings in the *Calibration point name* field in the *Site calibration* option in the Survey Style.
- Tip If you have not yet keyed in the grid coordinates for this point, press [Key in] while the cursor is in the *Point name* field. The *Key in/Point* screen appears. Enter the coordinates and then press [Enter].
 - (5) Enter values for the Code and Antenna height fields. Press [Enter] to accept the screen.
 - (6) When the antenna is cantered and vertical over the control point, press [Measure] or [Enter]. The data collector starts to record data.

Keep the antenna vertical and stationary while data is recorded.

- (7) When the preset required time has elapsed, the [Store] soft key appears. Inspect the precisions. If they are satisfactory, press [Store] to store the point.
- (8) The calculations are then done automatically and the results are stored. While this is happening, the following messages appear:
 - Please wait, storing point.
 - Calculating calibration.
 - Storing calibration.

NOTE:

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When Trimble Survey Controller is performing an automatic calibration, the results of the calibration are not normally displayed. However, if a calibration exceeds the tolerances that have been set, the residuals **are** displayed. For more information, see the next section.

(9) Enter the next calibration point name in the *Point name* field and press [Find]. The graphical display screen appears, with the azimuth and distance to the next point displayed on the right.

To use the arrow display, start moving with the TSCe data collector held in front of you as normal. The arrow points in the direction of the next calibration point. Walk towards the point. About 10 feet (or 3 metres) from the point, the arrow disappears and the point is displayed.

When the point is located, press [Esc].

(10) Go back to Step 4 and measure the next calibration point. Repeat the procedure until all the calibration points are measured.

4.1.8 Repeat the pairing of points, and measurements on all control points.

4.1.9 Perform the Calibration

Residuals will appear one more than three points are measured (if automatic calibration is not ticked in the survey styles), or at the end of the measurement process.

The following dialogue appears:

🔊 Si	te calibra	tion					? _ ×
Poi	nt	H.Resid	V.Res	sid	Use		
Nail	А	1.104m	0.023	m	H,V		1 8
Nail	В	0.543m	0.018	3m	H,V		PR Ma
S \$7	75	1.159m	0.004	m	H,V		
SS7	76	1.061m	0.009	m	H,V		¥ 2.000
							<u>М</u> ар
							M <u>e</u> nu
							Favorites
							Switch to
F	RTK:Fi	xed H:0.00	5m V:0.010	0m RM	MS:8		5.0
ESC	Add	Delete	Results	App	oly	1	LOR

The residuals for each point are not displayed until at least three 3D points are included in the calibration to provide redundancy.

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Press [Results] to see the horizontal and vertical shifts that the calibration has calculated. The following dialogue appears:

Calibration results	? _ ×
Number of points: 1	- 100x 100x 00x
- Horizontal	N A
Scale factor: Rotation:	P 2.000
Max H Residual:	Map
0.000m	M <u>e</u> nu
	Favorites
Vertical —	Switch to
Esc RTK:Fixed H:0.005m V:0.009m RMS:8 Details	Apply

To add more points, press = to return to the Calibration screen.

Repeat previous steps until all the points are added.

Do one of the following:

- If the residuals are acceptable, press [Apply] to store the calibration.
- If the residuals are not acceptable, recalculate the calibration.

4.1.10 Checking the Residuals

The calibration residuals displayed may show points where the calibration tolerances are exceeded.

The residuals appear in the following dialogue:

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Poin	t I	H.Resid	V.Resid	Use	1002
Nail /	A B 5	1.104m 0.543m 1.159m	0.023m 0.018m 0.004m	H,V H,V	
SS77	6	1.061m	0.009m	H,V	₹2.000 <u>M</u> ap
					Menu
					Favorite
					Switch to
- 1	RTK:	Fixed H:0.005	m V:0.010m	RMS:8	E D
Esc	Add	Delete	Results /	Apply 1	Edit

If this happens, consider removing the point with the most extreme residuals:

- If at least 4 points are left after removing that point, recalibrate using the remaining points.
- If not enough points are left after removing that point, measure it again and recalibrate.

It may be necessary to remove (and measure again) more than one point.

To remove a point from the calibration calculations:

- (1) Highlight the point name and press [Enter].
- (2) Change the setting in the *Use* field to OFF and press [Enter].

The calibration is recalculated and the new residuals are displayed.

(3) Press [Apply] to accept the calibration.

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4.1.11 Recalculating and Applying a Calibration

Recalculate a calibration if the residuals are not acceptable, or if you want to add or delete points. Recalculate using one of the following:

- Some of the points.
- Only the horizontal component of a point.
- Only the vertical component of a point.

To recalculate a calibration:

- (1) From the main menu, select *Survey*. Select a real-time Survey Style.
- (2) From the *Survey* menu, choose *Site calibration*.
- (3) Do one of the following:
 - To remove (exclude) a point, highlight the point name and press [Delete].
 - To add a point, press [Add]. For more information, see Step 4 on page 267 of Trimble Real-Time Kinematic Surveying Training Manual.
 - To change which components are used for a point, highlight the point name and press [Enter]. Change the Use field as required. (Choose whether to use the vertical coordinate of the grid point, the horizontal coordinates, or both horizontal and vertical coordinates).
- (4) Press [Apply] to apply the new calibration.

NOTE:

Each calibration calculation is independent of the previous one. When a new calibration is applied, it overwrites any previously calculated calibration.

4.1.12 Set up base receiver over a known survey control point

4.1.13 Obtain mine grid coordinates with Rover GPS on surrounding SSM's.

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4.2 GPS Site Calibration for Grid Transformations

A GPS site calibration establishes the relationship between WGS-84 points collected by GPS receivers, and local grid positions on a local map grid. The local map grid includes elevations above sea level, and the GPS data includes WGS-84 heights.

Published coordinate systems and geoid models do not usually allow for local variations in the projection. A GPS site calibration can reduce these variations and obtain more accurate local grid coordinates.

- Tip Once a site calibration has been established from the mine survey control points, obtain mine grid coordinates of the SSM's. This will provide the transformation parameters between various grid systems and height datums.
- ^(C) **Tip** Set up the base receiver on one of the points used in the calibration.

On the Controller select Files > Open Job > select the site calibration file. Set up the 5800 Rover Receiver on a SSM. Record the mine grid values on the SSM as a control point into the same calibration job file.

Take reading on two other SSM's – if practical.

The coordinates obtained with be the ones used in grid transformations, such as the two point transformation in Surpac software.



4.3 Download the Site Calibration Job

Download the site calibration job for reference, and to be able to upload should the controller change, or loose its data.

Export as a fixed format: Trimble DC v10.0. This file can be re-loaded to controllers to provide.

Export as a custom format: detailed survey report. The html file downloaded can be printed out to provide a hard-copy record of the site calibration, for the Mine Survey Book.

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5 **REFERENCES**

1	Real-Time Kinematic Surveying Training Manual
	October 2001 release (Rev. B), Part Number 33142-40.
2	Trimble Survey Controller – Help file
	Version 12.42, Revision A, November 2008.

6 DOCUMENT REVISION HISTORY

Revision Events

Rev	Date	Changes	Originator	Checked	Approved
2	25/03/2008	References to differences between old TSCe and newer TSC2	OG		
1	14/03/2008	Base setup details included	OG		
0		Uploaded to GEMS web site; www.minesurveying.com.au	OG		
Α	9/05/2003	Initial development	OG		

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