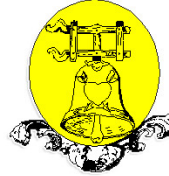


**GLOCKNER
ENGINEERING &
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SERVICES**



Management System

Trimble S6/S8 Underground Procedure

Document No: 90721

Revision: 0

Document Owner		GEMS Chief Operating Officer			
Rev Code	Issue Date	Changes	Signatures		
			Originator	Checked	Approved
0	21/07/2009	First Draft	G Valli	O.Glockner	O.Glockner

Table of Contents

1	PURPOSE.....	3
2	SCOPE	3
3	PROCEDURE	4
3.1	Startup and Job Setup:	4
3.2	Station Establishment:	4
3.2.1	<i>Conventional: Station Setup</i>	4
3.2.2	<i>Resection</i>	5
3.3	Forward Station Establishment:.....	6
3.4	Feature Surveys:	7
3.5	Marking Out:	7
3.6	Drillhole Surveys:.....	8
3.6.1	<i>Option 1: Extended Rod Survey Method:</i>	8
3.6.2	<i>Option 2 – Trimble Dual Prism Offset Method:</i>	9
3.7	Extra Settings and Pointers:.....	9
3.8	Exporting Data from TCU to the Computer:.....	10
3.9	Processing in Data Gemcom Surpac:	10
4	LEICA GPR1 WALL STATION PRISM	12
4.1	Leica GPR1 Prism Constant Calculation:.....	12
4.2	Adding Prism Details to S6/S8:.....	12
5	GEMS_UG STYLE SHEET	13
5.1	GEMS_UG Style Sheet Output Example	14
5.2	GEMS_UG Style Sheet History	15
6	REFERENCES.....	16
7	DOCUMENT REVISION HISTORY	16

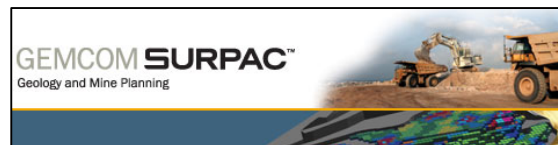
Document Name	Trimble S6/S8 UG Procedure	Document Number	90721
Revision Number	0	Review Date	1-Oct-09
		Page 2 of 16	
		Printed: 12-Aug-09	

1 PURPOSE

This procedure describes the method to complete underground surveying tasks using the Trimble S6 or S8 Total Station. This procedure is to be used in conjunction with the GEMS_UGv2.0.xsl style sheet to enable processing in Gemcom Surpac using the Geodat 600 data recorder.

2 SCOPE

This document applies to all mine sites using the Trimble S6 or S8 Total Station in conjunction with Gemcom Surpac software.



Document Name	Trimble S6/S8 UG Procedure	Document Number	90721	Page 3 of 16
Revision Number	0	Review Date	1-Oct-09	Printed: 12-Aug-09

3 PROCEDURE

This procedure details how to use the Trimble S6/S8 total station to complete routine underground surveying tasks including: standard station setup, resection, forward station establishment, feature surveys and extended rod drillhole surveys. The field procedure relies on the use of the GEMS_UGv2.0.xsl style sheet to export data from the TCU to allow straightforward processing in Gemcom Surpac using Geodat 600 data recorder function.

3.1 Startup and Job Setup:

- (1) Attach the TCU and Turn On the total station.
- (2) Double tap the *Survey Controller* icon to execute the Survey Controller program.
- (3) Once the TCU has connected to the total station, level the instrument and tap *Accept*.
- (4) Select *Files* from the main menu and create a new job by selecting *New job* or open an existing job by selecting *Open job*.
New job: Enter the Job name then tap the *Coord. sys.* button to choose a coordinate system. If working in a local grid select *Scale Factor Only*, tap *Next* then ensure the *Scale Factor* is *1.0000000000* then tap *Store*. Tap *Linked Files* and link the control file to the job by selecting it from the list then tap *Accept*. Tap *Accept* to save the new job properties.
Open job: Select an existing job from the list by tapping the job name or highlight the job name and tap *OK*.

3.2 Station Establishment:


The two methods of station establishment that can be used are conventional station setup and resection.

3.2.1 *Conventional: Station Setup*

To complete a conventional station setup (backs station setup), follow these steps:

- (1) From the Main Menu tap *Survey*.
- (2) Tap *VX & S Series*.
- (3) Tap *Station Setup*.

Document Name	Trimble S6/S8 UG Procedure	Document Number	90721	Page 4 of 16
Revision Number	0	Review Date	1-Oct-09	Printed: 12-Aug-09

- (4) Check that the *Pressure (instrument)* is set to *From instrument* by tapping the  button. Key in a *Temperature* value, ensure *Curvature correction* and *Refraction correction* are unchecked then tap *Accept*.
- (5) Enter the *Instrument point name* and *Instrument height* then tap *Accept*.
- (6) Enter the *Backsight point name* and choose the *Method* (usually *H.Angle only* or *Angles and distance*). Enter *Backsight height* if required. Sight the Backsight and tap *Measure* then tap *Store*.


Station Setup is complete. Continue to [3.2.3 Forward Station Establishment](#), [3.2.4 Feature Survey](#) or [3.2.5 Marking Out](#).

3.2.2 Resection

There are a few basic rules for when completing Resection to allow processing with the Geodat 600 data recorder, which are:


- The first resection observation must be to the nominated Backsight station;
- Resection observations must be to stations in clockwise order (only important if more than two stations are used);
- A maximum of 20 resection observations are allowed for the calculation of a resection station (single face observations) or 20 pairs (F1 & F2) for double face observations;
- Horizontal and Vertical angle readings must be taken for all resection observations, but the slope distances are optional. It is acceptable to have some observations with slope distances and some without;
- If angles and slope distances are present then resection observations to a minimum of two known stations are required. If only angles are present then resection observations to a minimum of three known stations are required.
- When completing double face observations for resection the *Face Order* must be set to *F1/F2...*

To setup using resection, follow these steps:

- (1) From the Main Menu tap *Survey*.
- (2) Tap *VX & S Series*.
- (3) Tap *Resection*.
- (4) Check that the *Pressure (instrument)* is set to *From instrument* by tapping the  button. Key in a *Temperature* value, ensure *Curvature correction* and *Refraction correction* are unchecked then tap *Accept*.
- (5) Enter the *Instrument point name* and *Instrument height*. Ensure that *Compute station elevation* is checked. Tap *Options*. Set the *Face Order* to *F1/F2...* (for double face resection) or *F1 Only* (for single face

Document Name	Trimble S6/S8 UG Procedure	Document Number	90721	Page 5 of 16
Revision Number	0	Review Date	1-Oct-09	Printed: 12-Aug-09

resection) and the *Observation Order* to 123...123. Ensure that *Automate Rounds* and *Measure dist on face 2* are checked. Set *Backsight* as *Zero* and enter *1* as the *Number of rounds*. Tap *Accept*. Tap the total station icon in the status bar tap the *Autolock On* icon. Tap the target icon in the status bar and select the appropriate target (for wall stations section 4 Prism: Leica GPR1 Wall Station). Tap *Accept*.

- (6) Enter the *Point name* and *Target height* of the first station (nominated backsight). Ensure that *Backsight* is checked. Select the *Method* as *Angles and distance* (to observe HA, VA and SD) or *Angles Only* (to observe HA and VA). Aim to the station and tap *Measure*. The total station will then change to Face 2 if completing a double face resection. Aim to the station (if manually sighting) then press the *Enter*  button other just press *Enter*. Repeat this step until adequate observations have been and at this point the observations will tabulate on screen. Tap *Results*.
- (7) The calculated coordinates for the new station will be displayed along with the residuals. Check these and if not acceptable press *Escape* to go back to add or remove observations. If the residuals are acceptable tap *Store*. Note: if a *Duplicate Point* warning screen appears that point name already exists in the current job file or the linked file. The options are rename the new station, overwrite the existing station or discard the resection station.

Station Setup is complete. Continue to [3.2.3 Forward Station Establishment](#), [3.2.4 Feature Survey](#) or [3.2.5 Marking Out](#).

3.3 Forward Station Establishment:

To establish a new forward station or wall station, follow these steps:

- (1) From the Main Menu tap *Survey* then tap *Measure rounds*.
- (2) Tap *Exclude* to exclude the backsight then enter the *Point name*, *Code* and *Target height* for the new forward station or wall station. Tap *Options*. Set the *Face Order* to *F1/F2...* (for double face observation) or *F1 Only* (for single face observation) enter *1* as the *Number of rounds* and enter *1* as the *Sets per point*. If *Automate rounds* is checked the F2 observation will be completed automatically. Tap *Accept*. Sight the station and tap *Measure*.
- (3) Once observations are complete tap the *End face* button. Tap *Close* and tab *Yes*.

The new forward or wall station has been recorded. The Geodat 600 data recorder will support multiple pairs of double face observations however current the GEMS_UGv2.0.xsl style sheet supports only one single face observation or one



Document Name	Trimble S6/S8 UG Procedure	Document Number	90721	Page 6 of 16
Revision Number	0	Review Date	1-Oct-09	Printed: 12-Aug-09

double face observation. Support for this Geodat 600 feature will be added to future revisions of the style sheet.

3.4 Feature Surveys:

To complete feature surveys such as development heading surveys follow these steps:

- (1) From the Main Menu tap *Survey* then tap *Measure topo*.
- (2) Enter a *Point name*, *Code* (Geodat 600 uses this as the String Number) and *Target height*.
- (3) Change to DR mode by tapping the total station icon in the status bar and tapping the *Laser On* button.
- (4) Measure points by tapping *Measure* if in Standard Measure Mode. To change to Tracking Mode tap the total station icon in the status bar and tap the *TRK* button. To record points when in Tracking Mode tap *Store*.

Tip: use the *Enter*  and *Power*  buttons instead of the touch screen to *Measure* and *Store* points.

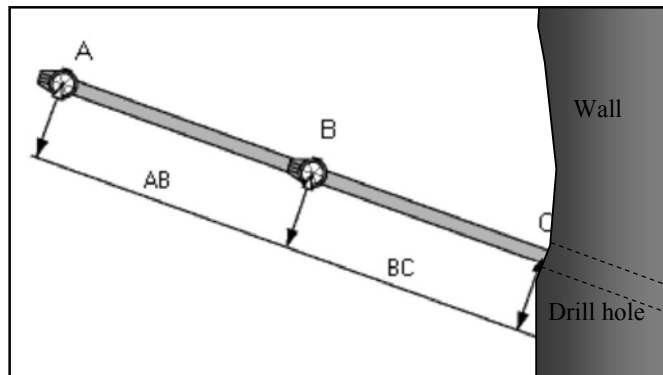
3.5 Marking Out:

Coming Soon.

Document Name	Trimble S6/S8 UG Procedure	Document Number	90721	Page 7 of 16
Revision Number	0	Review Date	1-Oct-09	Printed: 12-Aug-09

3.6 Drillhole Surveys:

To complete drill hole surveys there are two options, both of which will process exactly the same with the Geodat 600 data recorder. Below is diagram showing an example extended rod survey.



The method requires that observations are made to two points on the rod which protrudes the drill hole. For Option 1 the first observation must be taken to the point closest to the collar (Point B). For Option 2 the first observation must be taken to the point furthest from the collar (Point A). The distance between the first observation and the collar (BC) is required as well as the distance between the two observed points (AB).

3.6.1 Option 1: Extended Rod Survey Method:

- (1) From the Main Menu tap *Survey* then tap *Measure topo*.
- (2) Enter the *Point name* as the drill hole name eg DDH8470.
- (3) Sight the first point on the rod (Point B). In the *Code* field enter *DH* then the distance from the first point to the collar (*DistanceBC*) then the distance between the two points of the rod (*DistanceAB*) then an approximate dip value (*Dip*) separating each value with a comma eg *DH,0.3,1.4,-50* . The *DistanceAB* and *Dip* values are optional and will only be used as a check after processing in Surpac). Tap *Measure*.
- (4) Sight the second point on the rod (Point A) then modify the automatically incremented *Point name* by adding a -1 eg DDH8470-1. This will ensure

Document Name	Trimble S6/S8 UG Procedure	Document Number	90721	Page 8 of 16
Revision Number	0	Review Date	1-Oct-09	Printed: 12-Aug-09

the second point for the extended rod survey is not stored as the next incremented point number which may be the next drill hole name that needs to be surveyed. Enter *1* for *Code*. Tap *Measure*.


- (5) To survey another drill hole start again from Step 2.

3.6.2 Option 2 – Trimble Dual Prism Offset Method:

- (1) From the Main Menu tap *Survey* then tap *Measure topo*.
- (2) Change the *Method*: to *Dual-prism offset*.
- (3) Enter the *Point name* as the drill hole name.
- (4) Sight the first point on the rod (Point A). Enter the approximate dip into the *Code* field (optional, will only be used as a check after processing in Surpac). Enter 1.000m for *Tolerance AB*. Enter *Distance AB* to the nearest metre. Tap *Meas A*.
- (5) Sight the second point on the rod (Point B) then enter the distance along the rod between the first point and the drill hole collar into the *Distance BC* field. Tap *Meas B*. A warning may display stating the computed distance AB is outside of the tolerance limit. Tap *OK* to accept the measurement or *Cancel* to discard.
- (6) To survey another drill hole start again from Step 3 or to return to measuring points change the *Method*: to *Angles and distance*.

Note: A known problem with this method is when using DR mode the instrument will revert back to a prism target after each measured point.

3.7 Extra Settings and Pointers:

- To turn on the Face 2 backlight Goto Instrument -> Instrument Setting and check *Face 2 Backlight* or press and hold .
- Direct Reflex (DR) Settings: To ensure the laser pointer comes on when changing to DR (reflectorless mode) Go to *Instrument* → *Direct Reflex* and check the *Direct Reflex* and *Laser Pointer* boxes. Here you can also change the min/max range distances and the standard deviation. If measuring distances in DR mode is found to be quite slow it may be necessary to increase standard deviation value. Bear in mind the minimum distance that can be observed in DR mode is just less than 2.000m.
- To enable the onscreen touch key board press *Ctrl* then 7.

Document Name	Trimble S6/S8 UG Procedure	Document Number	90721	Page 9 of 16
Revision Number	0	Review Date	1-Oct-09	Printed: 12-Aug-09

3.8 Exporting Data from TCU to the Computer:

- (1) Connect the TCU to the docking station in the survey office.
- (2) Turn on TCU and execute Survey Controller.
- (3) Go to File → Open Job and open the job that contains the survey information (eg job210709).
- (4) Go to File → Import/Export → Export Custom Files, use GEMS_UGv2.0 and ensure NO is selected for export as coordinates.
- (5) Use ActiveSync to copy the exported file (eg job210709.inp) from the Trimble Data\Export folder on the TCU to the local drive of the computer. Go to [5.1 GEMS UG Style Sheet Output Example](#) to see an example output file.

3.9 Processing in Data Gemcom Surpac:

- (1) Open Gemcom Surpac (any version from 4.1 to 6.1.2).
- (2) Open the survey database.
- (3) In the menu bar go to Survey → Data Recorders → Geodat → 600
- (4) Check the *Process input file* radio button and select the job file (eg job210709.inp) location under the *Location* field. Click *Apply*.
- (5) Enter the name of the surveyor in the *Surveyor* field (this is optional). The *Survey Date* field will automatically populate. Click *Apply*.
- (6) The *Job name* field will automatically be populated from the job file however this can be edited here. Click *Apply* twice.
- (7) Enter the output file name under the *Location* and *ID number* fields (eg job and 210709). Click *Apply*.
- (8) The Geodat 600 will then process the file and the user will be prompted to add stations to the database (if new stations were surveyed) and checks tables will be shown if forward stations were used. If processing is successful the Geodat 600 will produce a string file (*{location}{Id number}.str*) (eg job210709.str), a resection report (eg job210709_resection.not), a forward station report (eg job210709__multi_face.not) and a drill hole survey report (eg job210709_drillh_collar.not). Note the resection, forward station and drill hole report will only be created if these methods were used in the job. For new wall station surveys the forward station and resection report can be

Document Name	Trimble S6/S8 UG Procedure	Document Number	90721	Page 10 of 16
Revision Number	0	Review Date	1-Oct-09	Printed: 12-Aug-09

combined together, printed and filed as a station summary record. See Example Report below.

Surpac Minex Group		RESECTION REPORT		Jul 23, 2009	
Purpose :					
Setup Information :					
Resected station	991				
Instrument height	0.000				
Backsight station	1003				
Backsight reference angle	359.59598				
Stations Used	Y	X	Z	Target	Height
-----	-----	-----	-----	-----	-----
1003	1001.501	98.786	10.654	0.000	0.000
1004	1001.527	101.449	10.808	0.000	0.000
UNADJUSTED OBSERVATIONS					
Station	H. Angle	V. Angle	Slope	Dist.	
-----	-----	-----	-----	-----	
1003	0.00000	71.42050	2.090		
1003	179.59597	288.17550	2.085		
1004	77.43015	70.09488	2.383		
1004	257.43011	289.50109	2.390		
Note: Double face observations are meaned before being used in the least squares Resection calculations.					
INSTRUMENT ACCURACIES					
Angle Standard Deviation (seconds)	: 3.000000				
Distance standard deviation	: 0.005000				
Distance ppm	: 2.000000				
Instrument height standard deviation	: 0.003000				
Instrument centring standard deviation	: 0.003000				
Target height standard deviation	: 0.003000				
Target centring standard deviation	: 0.003000				
Results					
Resected Station	Y	X	Z		
-----	-----	-----	-----	-----	
991	999.876	99.924	9.998		
Standard Deviation	0.0008	0.0016	0.0007		
Station 991 has been inserted into the database.					
OBSERVATION ADJUSTMENTS					
Station	H. Angle	V. Angle	Slope	Dist.	
-----	-----	-----	-----	-----	
1003	0.0000	-0.0003	0.000		
1003	0.0000	0.0003	0.004		
1004	0.0000	0.0051	0.005		
1004	0.0000	-0.0051	-0.002		
Note: The Observation Adjustments are tabulated above to help highlight any erroneous observations.					
Surpac Minex Group		TOTAL STATION TRAVERSE REPORT		Jul 23, 2009	
Purpose :					
Station	N	E	Z		
-----	-----	-----	-----	-----	
Backsight 1003	1001.501	98.786	10.654		
Instrument 991	999.876	99.924	9.998		
Foresight ws891					
Instrument height	: 0.000				
Target height	: 0.000				
OBSERVATIONS					
Backsight	Foresight	H. Angle	V. Angle	Slope Angle	Slope dist
-----	-----	-----	-----	-----	-----
0.0000	11.1201	11.1201	55.0005	34.5955	2.169
180.0000	191.1200	11.1200	304.5955	34.5955	2.166
Mean		11.1200		34.5955	2.168
New Station					
Station	N	E	Z		
-----	-----	-----	-----	-----	
Foresight ws891	1001.501	99.207	11.241		
Bearing to ws891	: 336.1105				
Distance to ws891	: 1.776				
Page 1					

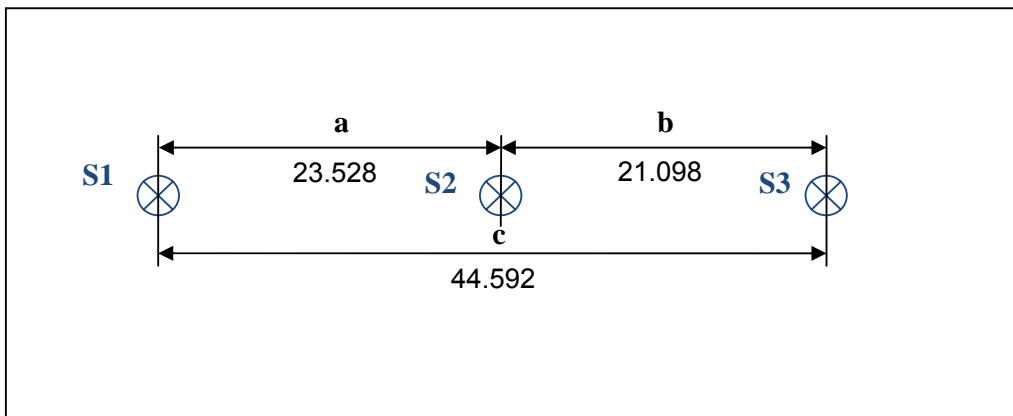
Document Name	Trimble S6/S8 UG Procedure	Document Number	90721	Page 11 of 16
Revision Number	0	Review Date	1-Oct-09	Printed: 12-Aug-09

4 Leica GPR1 Wall Station Prism

It is recommended that Leica GPR1 circular prisms housed in GPH1 holders are used for underground wall stations. These are readily available and widely used throughout the mining industry in Australia. This configuration is ideal for the application because they are optically centred.

4.1 Leica GPR1 Prism Constant Calculation:

Below is a "3 peg" test completed using a Trimble S6 total station to determine the prism constant for the Leica GPR1 prism.



Based on the test observations:

$$\begin{aligned}\text{Prism Constant (PC)} &= c - (a+b) \\ &= 44.592 - (23.528 + 21.098) \\ &= -0.034\text{m} \\ \text{PC} &= -34.0\text{mm}\end{aligned}$$

4.2 Adding Prism Details to S6/S8:

To add the GPR1 prism details to the Trimble S6/S8:

- (1) Tap the target icon in the status bar.
- (2) Since this target will be used many times reassign Target 1 by tapping the prism constant or target height for Target 1.
- (3) Set the *Target Height* to *0.000m*, change the *Prism type* to *Custom* then change the Prism constant *-34.0mm* and tap *Accept*.

Document Name	Trimble S6/S8 UG Procedure	Document Number	90721	Page 12 of 16
Revision Number	0	Review Date	1-Oct-09	Printed: 12-Aug-09

5 GEMS_UG Style Sheet

The GEMS_UGv2.0 XSLT style sheet is an extensively modified version of Trimble's GDM_Job XSLT style sheet. Both style sheets convert a Trimble job file into the Geodimeter format however only the GEMS_UGv2.0 style sheet outputs in a format that allows the data to be processed in Gemcom Surpac.

This procedure and style sheet has been made publically available as freeware. However the sheet is "use at your own risk" as neither the author nor the company Glockner Engineering & Mining Services will take any responsibility for any financial loss or personal injury that may occur from its use.

Any feedback or suggestions are welcome.

Please contact:

Greg Valli – Email: greg.valli@mineengineering.com.au
Phone: 1300 76 30 50
Website: www.minesurveying.com.au

To use the style sheet connect the TCU via ActiveSync and copy the style sheet to the Trimble Data directory where all the other style sheets reside.

Document Name	Trimble S6/S8 UG Procedure	Document Number	90721	Page 13 of 16
Revision Number	0	Review Date	1-Oct-09	Printed: 12-Aug-09

5.1 GEMS_UG Style Sheet Output Example

Below is an example output from the GEMS_UG style sheet with annotations explaining the coding. In this case the surveyor has used the resection method for establishing the new station (994) location. The resection has used double face observations to stations 1003 and 1004 with 1003 being the nominated backsight (hence is observed first).

Code 62 is the backsight name (62=1003) and has been assigned the back bearing of 359°59'59.8" (21=359.59598). An extended rod drill hole survey then has been completed for drill hole number 8905.

50=GEMS210709	←	Code 50 = Job header or Job Name
51=21-07-2009	←	Code 51 = Date of Survey
52=18:45:35	←	Code 52 = Time of Survey
2=994	←	Code 2 = Instrument Station
3=0.000	←	Code 3 = Instrument Height
62=1003	←	Code 62 = Backsight Station Name
21=359.59598		Code 21 = Backsight Reference Bearing
5=1003		
4=RES1003	}	Face 1 Observation to Resection station 1003
6=0.000		
7=0.00000		
8=73.11281		
9=2.281		
5=1003	}	Face 2 Observation to Resection station 1003
4=RES1003		
6=0.000		
7=179.59597		
8=286.48315		
9=2.277		
5=1004	}	Face 1 Observation to Resection station 1004
4=RES1004		
6=0.000		
7=70.18583		
8=71.27127		
9=2.554		
5=1004	}	Face 2 Observation to Resection station 1004
4=RES1004		
6=0.000		
7=250.18576		
8=288.32473		
9=2.560		
5=8905	}	Extended Rod Drill Hole Survey (drill hole id 8905) Geodat 600 Method (Option 1)
4=STARTDHS8905,0.3,1.0,35		
6=0.000		
7=62.00007		
8=86.46538		
9=2.184		
5=8906		
4=1		
6=0.000		
7=47.44041		
8=91.48042		
9=1.960		
5=8908	}	Measured Topo point record
4=1		
6=0.000		
7=68.06153		
8=84.48024		
9=2.349		

Code 5 = Point Name;
 Code 6 = Target Height;
 Code 4 = Point Code;
 Code 7 = Horizontal Angle;
 Code 8 = Vertical Angle;
 Code 9 = Slope Distance.

Document Name	Trimble S6/S8 UG Procedure	Document Number	90721	Page 14 of 16
Revision Number	0	Review Date	1-Oct-09	Printed: 12-Aug-09

For more information on the format and coding required for processing with the Geodat 600 data recorder see Gemcom Surpac Help under Survey → Data recorders → Geodat → 600.

5.2 GEMS_UG Style Sheet History

Below is the development history of the GEMS_UG style sheet. Version 2.0 and any future revisions will be available on the GEMS website.

Version	Changes/Notes
GEMS_UGv1.0.xsl (Not Released)	Original Sheet created based on Trimble GDM job.xsl style sheet. Removed "33=" Prism Constant output. Removed "23=" data file units as not required. Removed ability to output grid coords of Stations under "PointRecord Output" section. Style sheet output does not process successfully in Surpac with Geodat 600.
GEMS_UGv1.1.xsl (Not Released)	Removed second "4=" point code value when resection is completed. Removed Instrument Record Output both "0=" & "55=" not required although may look at writing instrument name to D3 field of measuring points. Removed "30=" PPM correction value. Removed "59=" & "58=6372000.000" both not required. Style sheet output does not process successfully in Surpac with Geodat 600.
GEMS_UGv1.2.xsl (Not Released)	All backsights used in resection station establishment have a code 4=RES(Stn name) eg 4=RES1001. Problem with xml coding: classifies all backsights as 4=RES(Stn name) even on conventional station establishment ie occupying known point and backsighting known point. Removed Grid Coord output of new resection station. Style sheet output does process successfully in Surpac with Geodat 600 but only for Single Face Resection (Face 1 only).
GEMS_UGv1.3.xsl (Not Released)	Attempted to fix problem with xml coding: classifies all backsights as 4=RES(Stn name) even on conventional station establishment ie occupying known point and backsighting known point. Unsuccessful. Style sheet output does not process successfully in Surpac with Geodat 600.
GEMS_UGv1.4.xsl (Not Released)	Attempted to fix problem with xml coding: classifies all backsights as 4=RES(Stn name) even on conventional station establishment ie occupying known point and backsighting known point. Unsuccessful. Style sheet output does not process successfully in Surpac with Geodat 600.
GEMS_UGv1.5.xsl (Not Released)	Fixed xml coding issue. Supports conventional setup ie occupying known point and backsighting known point. Supports Single Face Resection (Face 1 only) for processing with Surpac Geodat 600. Date format change required from YYYY-MM-DD to DD-MM-YYYY to suit Survey Database date format. Style sheet output does processes successfully in Surpac with Geodat 600.
GEMS_UGv1.6.xsl (Not Released)	Supports Single Face Resection (Face 1 only) for processing with Surpac Geodat 600. Date format changed to DD-MM-YYYY to suit Survey Database date format. Supports conventional setup ie occupying known point and backsighting known point. Style sheet output processes successfully in Surpac with Geodat 600.
GEMS_UGv1.7.xsl (Not Released)	Supports Double Face Resection and Single Face Resection (Face 1 only) for processing with Surpac Geodat 600. Style sheet output processes successfully in Surpac with Geodat 600.
GEMS_UGv1.8.xsl (includes progressive versions 1.8a to 1.8m) (Not Released)	Supports Double Face Resection and Single Face Resection (Face 1 only) for processing with Surpac Geodat 600. Average Backbearing assigned to Backsight when dual face observations are made. Forward Station (Double Face) support. Style sheet output processes successfully in Surpac with Geodat 600.
GEMS_UGv1.9.xsl (Not Released)	Supports Extended Rod Surveys. Style sheet output processes successfully in Surpac with Geodat 600.
GEMS_UGv2.0.xsl (Released for Trial)	Fixed problem with dual face backsight obs. Supports Dual Prism Offset method for Extended Rod Surveys. Style sheet output processes successfully in Surpac with Geodat 600.

Document Name	Trimble S6/S8 UG Procedure	Document Number	90721	Page 15 of 16
Revision Number	0	Review Date	1-Oct-09	Printed: 12-Aug-09

6 REFERENCES

Trimble Survey Controller Manual v12.44 http://trl.trimble.com/docushare/dsweb/Get/Document-452312/TSCv1244_Help_English.pdf
GEMS Trimble S6-S8 Prism Monitoring – Document No: 81208 – Revision 0 www.minesurveying.com.au
Gemcom Surpac Help (v4.1 → v6.1.2): Goto - Survey → Data Recorders → Geodat → 126, 400, 500, 600

7 DOCUMENT REVISION HISTORY

Revision Events				
Rev.	Author	Changes	Checked	Approved
0	GV Date: 11/08/09	Issue for Use	O.Glockner	O. Glockner
B	GV Date: 24/07/09	Second Draft: Fix spelling etc	B.Stone	
A	GV Date: 21/07/09	First Draft	G.Valli	

Document Name	Trimble S6/S8 UG Procedure	Document Number	90721	Page 16 of 16
Revision Number	0	Review Date	1-Oct-09	Printed: 12-Aug-09