Total Station How to do it Manual No. 1: Simple Surveying Set-up

Jeremy Green

Introduction

These are some working notes to help people set up the Leica TCR 305 for survey work. In this How to Do Manual I will try and explain the Position–Azimuth and the Two Station set-up systems in the situation when you know the location of two points. The two points will be P1, your survey station where the Total Station is located, and a second point, P2 some distance away. These positions can either be predetermined from a previous survey, or determined using a differential GPS such as OmniStar.

Total Station Position and Azimuth

Locate the positions of the two points P1 and P2 with OmniStar. In this example P1 will be the base station and P2 is the remote station. OmniStar provides Data in Lat/Long GDA94, so, as the Total Station operates in metres, not degrees (in other words UTM) you will have to convert the Lat/Longs to UTM using GeoCalc.

Setting up OmniStar

Follow the OmniStar instruction manual and establish the antenna over the point. Connect the data cable from OmniStar to the COMS port on your computer. Open the OmniStar program View8400. exe. Under the File menu select Connect. If everything is set up properly various figures should start appearing in the blank boxes of the View8400 window. Wait until all the red warning numbers (usually in the Subscription Details window) turn black. This means that OmniStar is connected and is recieving DGPS data. You now want to log location for about an hour or more to get a good average. The longer you log the better the accuracy. It is probably best to log data using the Scatter Plot in the View menu. This will give you a visual image of the scatter and all the necessary information about position, etc. (see below). In the Scatter Plot window there is the Current Position, the Average Position, number of Positions Recorded and the Sigma 1, 2 and 3 values. In the Position window you also have the Lat and Long with the Standard Deviation and Height. I find that the best way is to make a Screen Grab of the window (Print Screen button on keyboard), open Adobe Photoshop Elements, create a new file and Paste the screen grab in to window. Then you have all the information recorded.
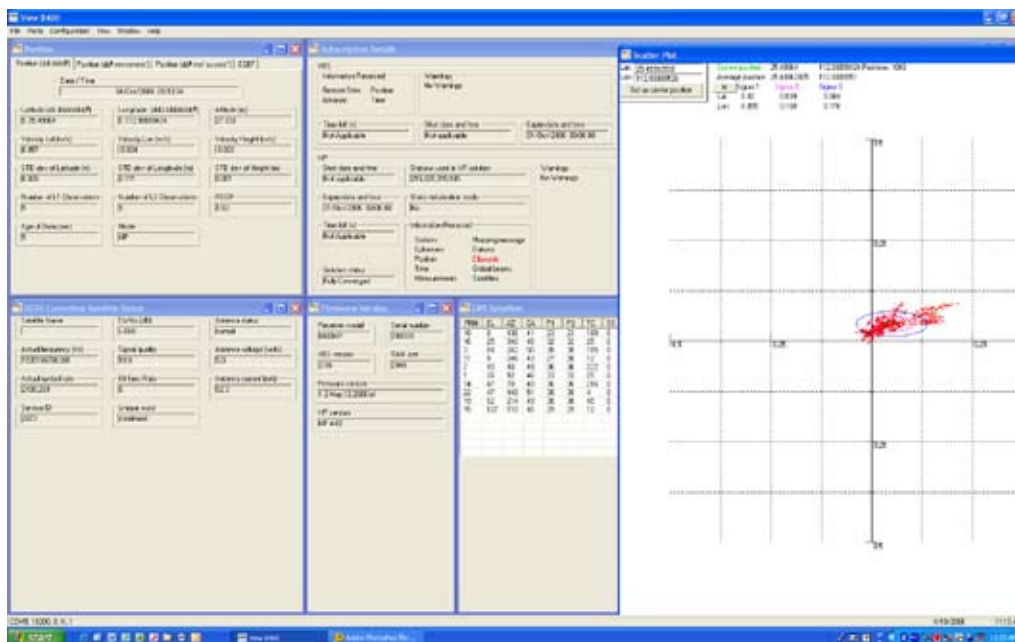
Calculating the Coordinates

I have made up some test coordinates Lat/Longs as follows:

	Lat Decimal Degrees	Long Decimal Degrees	UTM Easting metres	UTM Northing metres
P1	-21.12345	113.12345	720543.30	7662716.45
P2	-21.34567	113.54321	763763.56	7637463.59

Use GeoCalc to Convert Lat/Longs to UTM. Remember, choose correct UTM Zone, 49S, 50S, etc., which will depend on your Longitude. The figure below is what GeoCalc looks like with the example of P2. I have entered the Lat and Long in the right hand side Coordinate Point Definition. In the Coordinate System I have selected Geodetic Laitude/Longitude and WGS84 Datum. Note the DEG alongside the Lat and Long Coordinate Point Definition box. This means GeoCalc treats the values as Decimal Degrees. There are other options you can choose by clicking on the DEG box in the Coordinate System box, but it will just confuse matters.
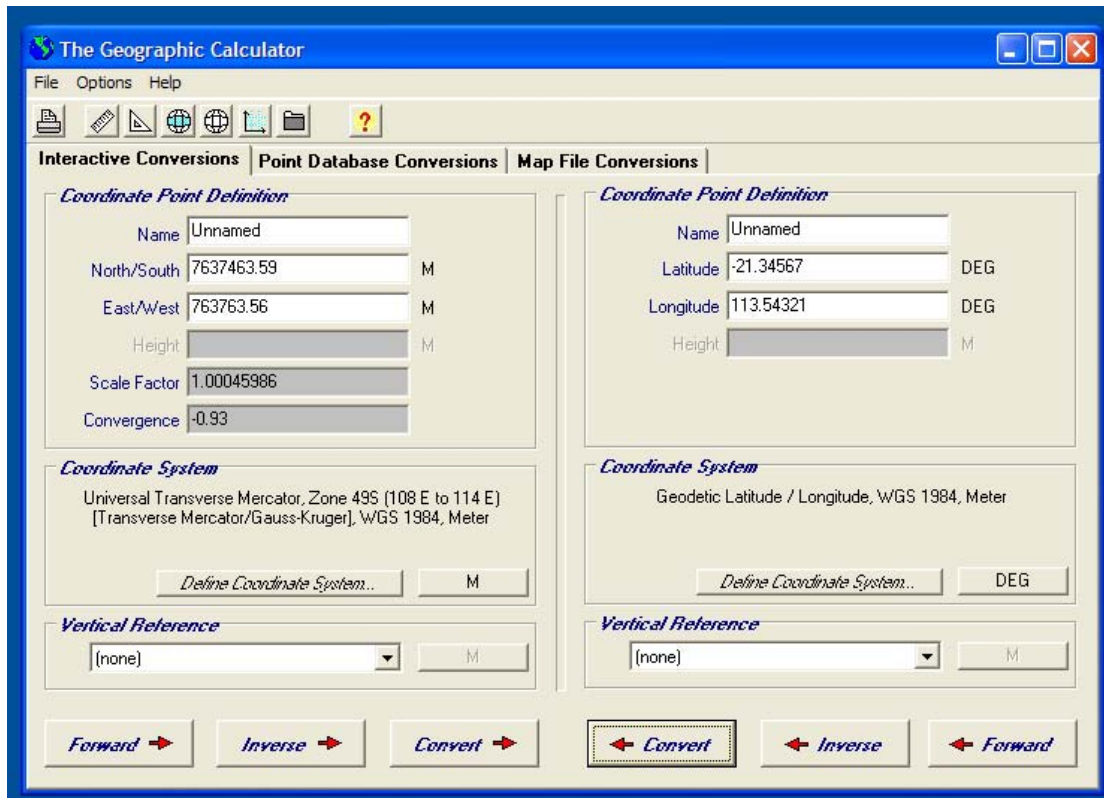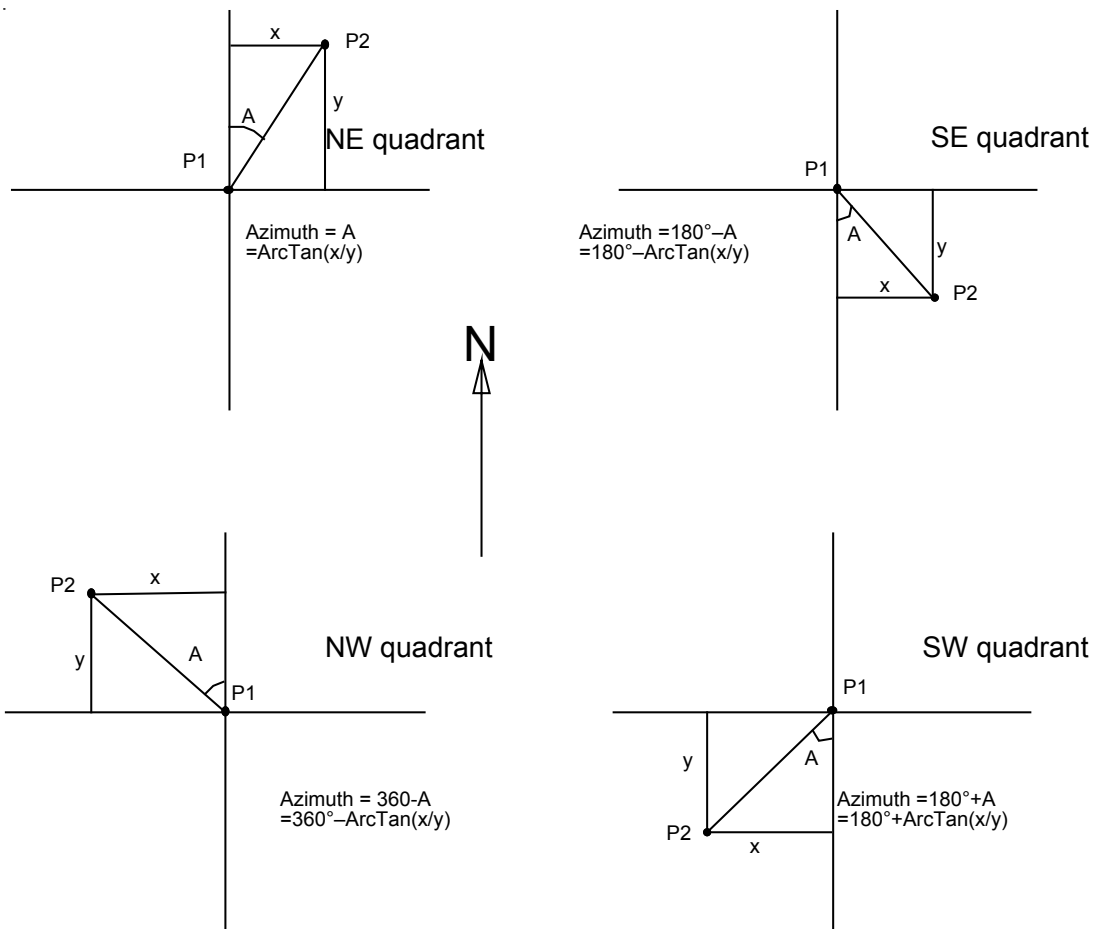

On the left hand side I have chosen in the Coordinate System box UTM Zone 49S (because Longitude is 113°E and thus lies between 108°E and 114°E).
Now click on the Convert bottom to Convert from Geodetic to UTM (Convert with left pointing arrow under Right Box. You will now see the UTM coordinates.
Do the same for the P1 and record the UTM coordinates.
Either work out in your mind where P2 is in relationship to P1 (NE, NW, SE or SW quadrant), or draw a mud map with UTM coordinates. You now need to calculate the azimuth, or compass bearing from true North of P2 FROM P1. This must be done in UTM because this is system that the Total Station will work in. So North is 0° and angle increases CLOCKWISE. Visualise the angle that you want from the figure below.

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NE quadrant

Azimuth = A
=ArcTan(x/y)

SE quadrant

Azimuth =180°–A
=180°–ArcTan(x/y)

N

NW quadrant

Azimuth = 360-A
=360°–ArcTan(x/y)

SW quadrant

Azimuth =180°+A
=180°+ArcTan(x/y)

When you have determined where P2 is in relationship with P1 you will need to calculate x and y. In the example in the Table above I have taken arbitrary Lat Longs and converted them using GeoCalc. Note that Latitude decreases as we move South because it is negative in Southern Hemisphere and the UTM increase as we proceed Northwards since the UTM northings are positive. Because the longitude is 113° E we use Zone 49 E (which runs from 108° to 114°) and get the Eastings and Northings. We can see that P2 will be the SE quadrant because P1x is smaller than P2x so P1 is West of P2 and P2y is smaller than P1y so P2 is South of P1.

x = P2x–P1x = 763763.56 – 720543.30 = 43220.26 and

y = P2y–P1y = 7637463.59 – 7662716.45 = -25252.86

So (x/y) = -1.711499608361

Ignore the minus sign because the coordinate system for Trigonometry is different from the Geographic system (in Trig 0° is on X axis and angles increase anti-clockwise whereas in Geographical 0° is on Y axis and increases clockwise)

ArcTan (x/y) = 59.702985278942°

Azimuth = 180-ArcTan(x/y) = 120.297014721058° so that this is the bearing from True North of P2 from P1. The Total Station will normally be set in Decimal Degrees but it could be set in Degrees Minutes and Seconds so this is 120° 17' 49.253"
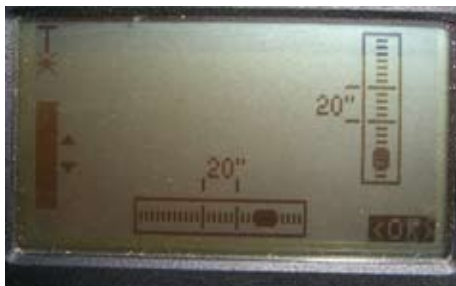
Setting up the Total Station

The Total Station needs to be levelled and set up over the point P1 (which I am going to call A, I am using A because I did not know that in the Total Station, to change from characters to numbers you need to press the SHIFT button!). Also, and obviously, you need to be able to see P2 from P1. What we will do is assign in the Total Station the X and Y coordinates of P1 and then swing the instrument so it is aligned to P2, and then assign the Azimuth to this bearing. From then on all point measurements will be set according to UTM.

Switch on the Total Station (as below).

You may have to level the Total Station first as shown on screen below.

To set up the Total Station so that it operates in decimal degrees. Select MENU button (Shift/PROG), ALL SETTINGS/UNIT SETTINGS/Angle and select dec.deg, since all GIS is in Decimal Degrees this will make life easier for you.

Note there are some Variables that appear in the screen that you will need to know the meaning of are:

hr = Height of reflector above ground
hi = Height of Total Station above survey point
E0 = Station Easting
N0 = Station Northing
H0 = Station Height

Now we set up Station and Azimuth. Press PROG button and select SURVEYING.

Setting up: Orientation Method

Sᴇᴛ Jᴏʙ

Select Set Job (Select is press Red Button as I am doing below)

In the SELECT JOB Screen select (NEW) in screen below.

In the NEW JOB screen name job
Job: In this case 1 and Name Operator if you wish Opr: (in this case JNG, see above).
Select (SET).

SETSTATION
The screen then goes to SURVEYING SetStation (see below)

If you are starting from scratch you will not have set up a Base Station. So here you are going to name the Station P1 as A. You need to be very careful here because you can have stations with the same name that are different positions because they are different jobs. It is best to spend some time and call Stations something very descriptive, like SALOURN1 or JMATT1 so there is no chance when selecting stations you get muddled up (which is what usually happens when there is a problem).

If there are no new Stations or you name a station that does not exist in the list (A in this case), it will automatically give a message saying Point Not Found and then default to a NEW POINT Window (below). Note hi refers to the height of the centre of the Total Station above the survey point and that needs to be measured each time you set up the Total Station on a survey point.

Enter the coordinates of A in NEW POINT window (as below). Note these are the coordinates for the imaginary station that was created earlier. Select (OK).

It will give a message saying Point Stored and then default back to the SET Station window (below).

You can also enter the height of the Total Station above the survey point by measuring this with a tape measure and entering it in hi: as outline above. This will make all height measurements relative to the survey point, rather than the Total Station.

Select (SET). It will give a message Station Set and then default back to next screen Set Orientation see below.

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SET ORIENTATION
The SetOrientation screen is shown below.

Swing the Total Station so that the cross-wires are aligned with the mark on Point P2. Then enter the value of the Azimuth. In this case 120.2970°

Ensure the Base Point is is correct and the angle has been put in. Select (SET).

Select Start and you are in surveying mode.

It is important to check every now and again to ensure that the Azimuth to the P2 station is correct. In addition you can confirm the accuracy of the system by placing the prism on P2 and shooting the distance. It should give, within reasonable tolerance, the X, Y coordinates of P2 and the Azimuth.

RETURNING TO SURVEY STATION
Now that you have completed survey, you may want at a later date to return to the survey point P1 = A and continue to survey. This means that you have already have point A recorded in the Total Station and that it has not, for some reason, been deleted.

Switch the machine on and on the start up screen go to (SETUP). We will assume we are using the same Job (which was 1 in our earlier example) but we have been working on another project Job 2. W now need to go back to Job 1 and re-establish the Station (Stn) is. On starting we choose (SETUP) and if the screen indicates the Job is not A, as is shown below where it is B, then we need to change back to Job 1.

You will now have to select (STN), and then obtain the STATION Screen as below.

We now need to change Stn: B to Stn: A by scrolling down and inserting Station name. If the name does not exist then you will get the same message as in the previous example (Point Not Found). Select B by scrolling in Stn list and then select (SET).

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START SURVEYING

When you are using the reflector prism it is usually on a 1 m pole, so provided ALL measurements are made to this, then you have a relative height. If you want ABSOLUTE heights then the distance from the centre of the prism to the base of pole needs to be taken into account and this value is enter red in the hr.

Make sure also that the pole is level. The pole operator needs to centre the bubble in the bubble level. If the Total Station is misaligned to the prism then you will get an error message:
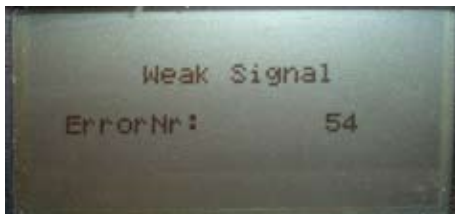
Otherwise, the display will show the following example:
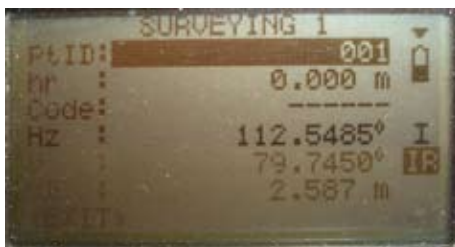
Showing the Point ID (PtID) which increments each reading that is taken.

SETTING UP ON AN OLD SURVEY POINT

This situation is where you are returning to a survey point and want to continue survey. In this case I have renamed the survey point JMATT1 in Job 1 so that we can see the problems with misidentification of points.

Go to PROG/SURVEYING. SetJob as Job 1. Set Station and in Stn use CE button to clear the Stn entry. See below.

Once the entry is blank (as below), select (SET).

It will default to FIND POINT screen (below). Scroll through the Point ID list by using Left or Right button on the PtID. Note because you have set up in Job 1, the Job cannot be changed. Find JMATT1, in this case I have some silly coordinates to help show the point up. In the screen below we are on point A.
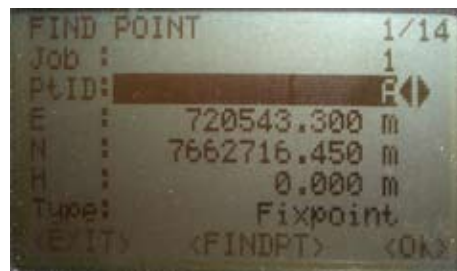
The next screen shows JMATT1.

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OK this point and you will get the SET STATION screen below with JMATT1.

Select (SET) and you now have your Station set so all you need to do is finish off the SetOrientation and you are ready to start over again.