TRIMBLE ACCESS™

TRIMBLE ACCESS ROADS USER GUIDE – GENIO

TRANSFORMING THE WAY THE WORLD WORKS

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Introduction

Trimble® Roads software is a specialized Trimble Access™ application for surveying roads. Use the Roads software to:

- Upload an existing road definition.
- Key in a road definition including horizontal and vertical alignments, templates, and superelevation and widening records.
- Review the road definition.
- Survey the road
- Generate a report for surveyed road data to check data in the field, or to transfer data from the field to your client or to the office for further processing with office software.

When starting a survey you are prompted to select the survey style you have configured for your equipment. To learn more about survey styles and related connection settings refer to the appropriate topics in the *Trimble Access Help.*

To switch between applications, tap the application icon in the status bar and then select the application to switch to.

To customize the terminology used in the software, tap ≡ and select **Settings** / **Language**. Select:

- **Use railroad terminology** if you are surveying a railroad and wish to use railroad-specific terminology.
- **Use chainage distance terminology** to use the term **Chainage** instead of **Station** for the distance along the road.

GENIO roads

GENIO files that define a road can be exported from a number of third party road design software packages, including Bentley MXROAD and 12d Model.

The file extension for the GENIO file must be *.CRD, *.INP, or *.MOS. Files with the extension MOS are exported from 12d Model.

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GENIO road definition

A GENIO file consists of a number of strings that define the geometry of the roads in the file. When you define a road you select the appropriate strings from the GENIO file. The road name and the names of the selected strings are saved as a comment to the end of the GENIO file.

NOTE – *Because GENIO files do not include the units for the values in the file, you must configure the appropriate units for the GENIO file you are working with in the job.*

To define a GENIO road

1. Tap ≡ and select **Define**.
2. In the **Select file** screen, select the GENIO file. The file must be in the current project folder.
3. Tap **Edit**.
4. Tap **New**. Enter the road name. Tap **OK**.

   The software shows all the strings in the selected file.
5. Tap the strings you want to add to the road. To select multiple strings, drag a box around them.

   Selected master strings are shown as solid red circles. Selected sub strings are shown as solid blue circles.

   TIP –

   - To pan around the screen, use the softkeys or tap and hold the pan softkey to make it active and then press the arrow keys.
   - To see your current position when defining a road, start a survey.
   - To deselect a string, tap it again. To clear your current selection, from the tap and hold menu select **Clear selection**.

   To select strings from a list, tap and hold on the screen and then select **List selection**. Tap string names to select them.

   Selected strings appear in the list with a check mark next to them.
6. Tap **Accept**.
7. Tap **Store**.

NOTE –

- *A road can include only one master string (6D). If the GENIO file does not include a 6D string but does include a 12D string, then the Roads software will generate a 6D string with the same geometry as the 12D string and positions every 5 meters / feet.*

- *Where available, Trimble recommends that you include the 12D string that is coincident with the selected master string in the road. 12D strings include the geometry for the vertical alignment that enables the Roads software to correctly interpolate elevations between positions along the master string.*

- *If a road includes a 12D string or if there is a 12D string in the GENIO file that is related to the 6D string in the road the station values in the 12D string that define the horizontal alignment are suffixed with their appropriate acronyms. For example, PC for the start of a curve.*

- *Because the station values for 3D and 5D strings are defined relative to the selected 6D string, select strings that obviously define a road.*

- *If required, you can exclude the master string at stakeout. See* **To exclude the master string at stakeout**.

- *Unselected master and geometry strings appear as hollow red circles. Unselected sub strings (3D and 5D) appear as hollow dark gray circles.*

- *Tap and hold on a string to browse the string name. For a master (6D) string the station range is also displayed.*

- *To define a new 3D string, tap and hold on the screen and then select* ***New string***. *This option is not available until you have selected a master (6D) string.*

To create or edit strings derived from other strings

If required, you can define a new string derived from an existing string in the GENIO file. You can then edit or delete strings derived from existing strings, as required, from the tap and hold menu.

To define a new string, you must have selected a master (6D) string in the new GENIO road. New strings are created as 3D strings.

1. Select a GENIO file and define a new road or select an existing road and tap **Edit**.

2. From the tap and hold menu, select **New string**.

3. Enter the string name.

4. Select the string that the new string will be derived from. You cannot define a new string relative to a 5D string.

5. Select a string derivation method and then enter values that define the new string.

   The following figure illustrates the **Offset and calculated slope** method where the **Derived from** string (1), the **Offset** value (2) and the **Calculated from** string (3) define a new string (4) on the slope between the **Derived from** and **Calculated from** strings.
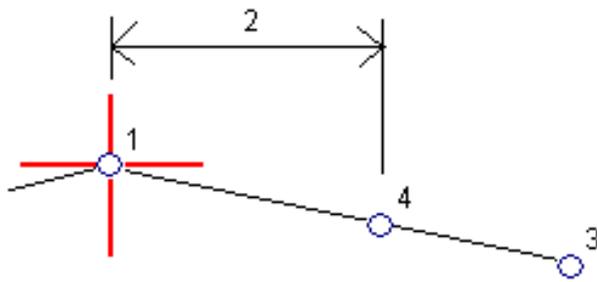
6. Tap **Accept**.

The new string appears, colored teal.

*NOTE – When you define a new string by the **Offset and calculated slope** method, the new string is defined only where the station values for the **Derived from** and **Calculated from** strings match.*

To exclude the master string at stakeout

If the master string (6D) has a vertical geometry that is unrelated to the road design, you can exclude this string. To do this, when defining the GENIO road, tap and hold on the screen and select **Exclude master at stakeout**.

The master string is still part of the road and is used to calculate the station values at stakeout.

At stakeout, the master string appears grayed out in the plan view and does not appear in the cross section view. The master string is not available from the string selection list.

*NOTE – To make sure that the master string is available at stakeout, deselect **Exclude master at stakeout**.*

To export GENIO files from 12d Model

To export a road as a GENIO file from 12d Model:

1. Start 12d Model and select a project.

2. Select **File I/O / Data output – GENIO**.

3. From the **Write GENIO File for** dialog, select the alignment string as the data to write.

4. Enter a file name.

5. Set the **Alignment dimension** field to 6D.

6. Select the **77 Format** check box.

7. Write the file but do not select **Finish**.

8. Select the remaining strings that define the road as the data to write. Use the filter option to aid string selection.

9. Retain the file name used to write the alignment string.

10. Set the **Alignment dimension** field to 3D.

11. Write the file and then select **Yes** to append to the end of the existing file.

12. Select **Finish**.

To review a GENIO road

You can review the definition of the road at any time. View the road in 3D to visually confirm the road definition.

1. Tap ≡ and select **Define** / **GENIO road**.

2. Select the GENIO file and tap **Edit**. Select the road you want to view and tap **Edit**.

3. Tap the Up arrow softkey and tap **Review**.

   Black hollow circles represent any portion of the horizontal alignment that has no elevations and so is drawn on the ground plane.

   TIP – To move the ground plane closer to the road, tap ⬤ and select **Settings** and then edit the ground plane elevation.

   Black solid circles represent the positions on the strings at each cross section.

   Gray lines represent the strings and connect the cross sections.

4. Tap a station on a string.

   Information about the selected station is shown at the top of the plan view.

5. To select a different station or string, you can:

   - Tap the station on a string.
   - Tap the **Station** or **String** softkey to select a station or string from a list.
   - Press the up or down arrow key to select another station, or press the left or right arrow key to select another string.

   Use the map toolbar to navigate around the map and to change between views.

6. To view cross sections, tap ⤢.

   By default, each cross section is displayed so that it fills the screen, providing the best view of the cross section. To view cross sections relative to each other, tap the **Fixed scale** button 🔍 so that it changes to 🔍. Each cross section is displayed with the scale fixed so that the widest cross section fills the screen.

   The alignment is shown as a red cross. The black circles represent the strings defined by the template. The larger blue circle represents the currently selected string. The line work preceding the selected string is shown as a bold blue line. Values defining the selected string and the line preceding the string are displayed at the top of the screen.

   To view the cross section at a different station, you can:

- Press the up or down arrow key.
- Tap **Station** to key in a station or to select a station from the list.

To select a different string, you can:

- Tap the string.
- Press the left or right arrow key.
- Tap **String** to select a string from the list.

7. To return to the plan of the road, tap 〜 .

8. To view an automated 3D drive through the road:

    a. In the plan view, tap **3D drive**.

    b. Tap ▶ to start the drive through. Tap ‖ to pause.

    c. To move forward and back along the road, press the up and down arrow keys.

    d. To exit 3D drive, tap **Close**.

9. To exit the road review, tap **Close**.

TIP –

- To review a position defined by a nominal station value, where the station does not have to coincide with a cross section, from the plan or cross section view tap **Station** and then key in a station value.
- To review a position defined by a nominal offset value, where the offset does not have to lie on a string, tap **String** and then key in an offset. The offset is computed from the alignment. The elevation for the resultant position is defined by interpolation of the cross section at the entered station and offset.

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GENIO road survey

When you open a GENIO road, the software calculates the station values for all 3D strings relative to the 6D string for the road.

The software interpolates elevation values along the string. For more information, see String interpolation.

If the master string has been excluded, the master string appears grayed out in the plan view and does not appear in the cross section view. To stake it out, return to **Define** and from the tap and hold menu select **Exclude master at stakeout**.

By default, the software converts all 5D strings to side slopes. However, if the road includes multiple side slopes that define benched side slopes, only the 5D / Interface string that is furthest from the master string is converted to a side slope.

To configure the software to treat 5D strings as 3D strings, in the **Stakeout options** screen clear the **Auto side slope** check box. To view the **Stakeout options** screen, tap **Options** in the screen where you enter the **Antenna height** or **Target height**.

For GENIO files defined from 12d Model, Roads treats all strings with a name that includes the letters INT as a 5D string and converts the string to a side slope, unless you have cleared the **Auto side slope** check box in the **Stakeout options** screen. The calculated slope value is defined by the slope between the interface string and the adjacent 3D string.

TIP – To quickly measure a check point during a conventional survey, press **Ctrl** + **K** on the keypad, or tap and hold in the map. If there are no points selected, **Check backsight** is available; if one point is selected **Check shot** is available.

To start surveying a GENIO road

⚠️**CAUTION –** Do not change the coordinate system or calibration after you have staked out points, or computed offset or intersection points. If you do, the previously staked out or computed points will be inconsistent with the new coordinate system and any points computed or staked out after the change.

1. Tap ☰ and select **Survey**.
2. Tap **Survey roads**.
3. If you have not yet started a survey, the software prompts you through the steps to start the survey.
4. In the **Select file** screen, select the GENIO file. The file must be in the current project folder.

> **TIP –** To configure the software to display the road selection screen instead of the map when you measure and store a position, tap **Options** and select the **Display the road selection screen on escape** check box.

5. Tap **Next**.

6. Select the road to survey. Tap **Next**.

7. Enter a value in the **Antenna height** or **Target height** field and make sure that the **Measured to** field is set correctly.

8. Tap **Options** to:

   - Configure preferences for **Grade**, **As-staked point details**, **Display** and **Available stations**.

   - Enable staking out relative to a digital terrain model (DTM).

9. Tap **Next**.

   The plan view of the road appears.

10. Select the entity to stake out. For the next steps, refer to the topic for the appropriate stakeout method.

    Once the position has been measured and stored, the software returns to either the navigation screen where you can continue measuring points on the road/string, or to the plan screen where you can select the next position to stake or select a different stakeout method.

To stake out positions relative to a GENIO road

1. Start the survey and select the road to survey.

   If nothing is selected in the plan view, then by default you are ready to measure your position relative to the GENIO road.

2. To stake points offset from the road, leaving the roadway clear for construction, define a construction offset.

3. Tap **Start**.

4. Use the plan or cross section view to see your position relative to the road.

   If your current position is:

   - Within 30 m of the master string, the plan view shows a dashed green line drawn at a right angle from your current position to the string.

   - More than 30 meters from the master string, the software navigates you to a position on the master string. This is calculated by projecting your current position at right angles to the master string.

5. When the point is within tolerance, measure the point. Tap **Store**.

   The software returns to the navigation screen.

6. Continue measuring points along the road.

7. To exit this stakeout method, tap **Esc**.

NOTE –

- *To understand how your position is calculated between strings, see String interpolation.*
- *If the road consists of only a master string (6D), the **V.Dist** value will report the vertical distance to this string.*

To stake out a position relative to a string in a GENIO road

To stake out a position relative to a string on a GENIO road, start the survey and then:

1. Tap the line work that represents the string. The name of the selected string appears at the top of the screen.

   To select a different string, use the left/right arrow keys. Alternatively, tap and hold in the plan view and select a string from the list. The strings in the list are determined by the templates assigned at your current position relative to the road.

2. To edit the elevation, from the tap and hold menu select **Edit elevation**. To reload an edited elevation, select **Reload original elevation**.

3. If required, add the following features:

   - To stake points offset from the road, leaving the roadway clear for construction, define a construction offset.

   - To stake cut/fill catch positions, Side slopes.

   - To confirm the construction of the road surface, define a cross slope.

4. Tap **Start**.

5. Use the plan or cross section view to navigate relative to the string. See Stakeout navigation.

   If your current position is within 5 m of the selected string, the plan view shows a dashed green line drawn at a right angle from your current position to the string.

   If you are staking a catch point (5D / Interface string) with construction offsets, navigate to the catch point and then tap **Apply** to add the construction offsets. You are prompted to apply the offsets from your current position. If you are not on the catch position, select **No**, navigate to the catch position and then tap **Apply** again. To store the catch position and the construction offset, see Construction offsets.

6. When the point is within tolerance, measure the point. Tap **Store**.

   The software returns to the navigation screen.

7. Continue measuring points along the road.

8. To exit this stakeout method, tap **Esc**.

NOTE –

- *If the string selected to stake is a 5D string Roads converts this string to a side slope. The calculated slope value is defined by the slope between the 5D string and the adjacent 3D string.*

- *For 5D / Interface strings, the target may not coincide with the design position because the target is calculated relative to your current position.*

To stake out a station on a string in a GENIO road

To stake out a station on a string in a GENIO road, start the survey and then:

1. In the plan or cross section view, tap the station on the string.

   To select a different position, use the left/right arrow keys to select a different string and the up/down arrow keys to select a different station.

   To select the station from a list, from the tap and hold menu tap **Select string** and select the string and then from the tap and hold menu tap **Select station**.

   To stake out a station defined by nominal station and offset values, from the tap and hold menu tap **Select string to stake** and then key in the **Station to stake** and **Offset** values. For more information, see String interpolation.

2. To edit the elevation, from the tap and hold menu select **Edit elevation**. To reload an edited elevation, select **Reload original elevation**.

3. If required, add the following features:

   - To stake points offset from the road, leaving the roadway clear for construction, define a construction offset.

   - To stake cut/fill catch positions, Side slopes.

   - To confirm the construction of the road surface, define a cross slope.

   - To stake points on surfaces other than the finished road surface, define a subgrade.

4. Tap **Start**.

5. Use the plan or cross section view to navigate relative to the string. See Stakeout navigation.

   If you are staking a catch point (5D / Interface string) with construction offsets, navigate to the catch point and then tap **Apply** to add the construction offsets. You are prompted to apply the offsets from your current position. If you are not on the catch position, select **No**, navigate to the catch position and then tap **Apply** again. To store the catch position and the construction offset, see Construction offsets.

6. When the point is within tolerance, measure the point.

   The software returns to the selection screen.

7. Continue selecting and measuring points along the road, or select a different stakeout method.

NOTE –

- *For 5D / Interface strings, the target may not coincide with the design position because the target is calculated relative to your current position.*
- *If the string selected to stake is a 5D string Roads converts this string to a side slope. The calculated slope value is defined by the slope between the 5D string and the adjacent 3D string.*

Staking out relative to a secondary road

To reference stakeout details from a secondary road to a position being staked on a primary (current) road:

1. Tap ☰ and select **Survey**.
2. Tap **Survey roads**.
3. Select the GENIO file. Tap **Next**.
4. Select the primary road. The road must be a 3D string. Tap **Next**.
5. Enter a value in the **Antenna/Target height** field. Tap **Next**.

   The primary road is displayed.
6. Select the position to stake on the primary road.
7. From the tap and hold menu, tap **Select secondary road** and then select the string representing the secondary road.

   In the plan view the secondary road appears as unavailable.

   TIP – To deselect a secondary road, select a position on a 3D string and then from the tap and hold menu, select **Select secondary road** and then tap **None**.
8. To select the position to stake on the secondary road:
   a. Tap and hold in the plan or cross section view and select **View secondary cross section**.
   b. from the displayed cross section for the secondary road (1), tap the line (2) preceding the position you want to stake.

      Refer to the following diagram:
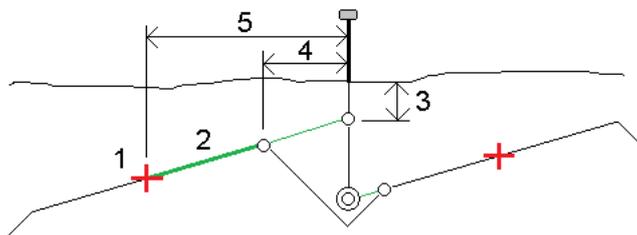
      Stake details for the secondary road reported in the **Confirm staked deltas** screen include V.Dist to road (3), Horizontal construction offset (calculated) (4) and Distance to alignment (5).
9. Tap **Accept**.

10. Tap **Start**. Use the plan or cross section view to navigate to the point.

11. When the point is within tolerance, measure the point and mark up the stake with the deltas for the primary and secondary roads.

To stake out a skew offset

Use this stakeout method to stake out a position that is not defined at a right angle to the horizontal alignment, for example when staking culverts, bridge abutments, and similar features.

Example skew offset

The diagram below shows a point defined by skew forward and offset to the right. The point to stake (1) is defined from the station (3) by an offset (5) along the skew (2). The skew can be defined by a forward or backward delta angle to a line (6) at right angles to the road being staked (4) or, alternatively, the skew can be defined by an azimuth.
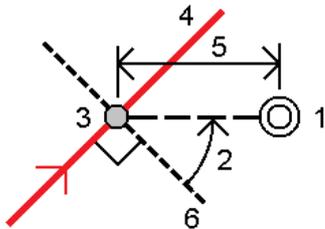
To stake out a position at a skew offset

1. In the plan or cross section view, tap the station on the master string.

   TIP – To stake out a skewed offset relative to a nominal station value (where the station does not have to coincide with a cross section), select any station on the master string and then from the tap and hold menu tap **Select station** and key in a station value.

2. From the tap and hold menu, select **Stake skew offset**.

3. To define the skew offset:

   a. From the tap and hold menu, select **Stake skew offset**.

   b. Enter the **Offset** and **Skew** values. Tap ▶ to change the offset or skew direction.

   c. To define the elevation for the point, select:

      • **Slope from string** to compute the elevation by a slope from the elevation on the string at the selected station

      • **Delta from string** to compute the elevation by a delta from the elevation on the string at the selected station.

- **Key in** to key in the elevation.

  If the road only has a master string, you must key in the elevation.

  d. Tap **Accept**.

4. To stake points offset from the road, leaving the roadway clear for construction, define a construction offset.

5. Tap **Start**.

6. Use the plan or cross section view to navigate to the point. See Stakeout navigation.

7. When the point is within tolerance, measure the point.

String interpolation

The following rules apply to keyed-in station values:

- For a 6D string, the coordinates for keyed-in station positions are computed respecting the geometry of the string. Elevation values are computed by linear interpolation. However, if there is a 12D string coincident with the 6D string, the software uses the vertical alignment data available in the 12D string to compute the elevation values.

- For a 3D string, the coordinates for keyed in station values respect the horizontal geometry of the associated 6D string. Elevation values are computed by linear interpolation. However, if the deflection angle of the 3D string compared to that of the associated 6D string is greater than 30 minutes, the geometry of the associated 6D string will be ignored and the coordinates will be computed by linear interpolation instead. This is to avoid unexpected behavior when there is an acute change in direction in the 3D string for features such as slip lanes, bus bays, and so on.

- Interpolation between points along a transition is calculated using a clothoid spiral for 12D and 6D strings and approximated for 3D strings.

When measuring your position relative to a GENIO road or where your station and offset are nominal values your position is computed by linear interpolation from the nearest positions on adjacent strings.

In all situations where your position is interpolated, closer station intervals give greater accuracy.

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Stakeout features for all road types

Depending on the selected stakeout method, you can add more features to the road or edit existing features when surveying the road.

Plan and cross section view

The plan view of the road always appears for a GENIO road.

To switch between the plan view and the cross section view, tap ∕ or ⊢, or press the **Tab** key.

Plan view

Tap and hold in the plan view to access the stakeout method menu or to add features for stake out. You can also access the tap and hold menu by pressing the space bar.

To clear the current selection in the plan view, tap the selected item again or tap in a clear space.

The plan view shows:

- Horizontal alignment/master string as a red line
- Other strings as blue lines
- Construction offsets as green lines
- Skew offsets as dashed black lines
- A dashed green line is drawn from the current position to the:
  - horizontal alignment/master string when measuring your position relative to the road and you are within 30 m of the alignment/string
  - selected string when measuring your position relative to a string and you are within 5 m of the string
- Positions that have not been staked as hollow circles
- Positions that have been staked as solid circles

Before stake out

The top of the screen reports the following values:

- Relative to road (when measuring your position relative to the road)
- Station (when staking a station on a string)
- String name (when staking a station on a string or measuring your position relative to a string)

    For a Trimble road, the software uses the string name from the template definition. When the offset is 0.000 m, the string name defaults to CL.

- Design elevation of the selected position (shown in red if edited)
- Construction offsets
- When staking a side slope, the top of the screen also shows the:
    - Design side slope values
    - Cut ditch width (Trimble roads only)
- When staking a skew offset, the top of the screen shows the:
    - Skew offset
    - Deflection angle/azimuth

During stakeout

The top of the screen shows the following additional information during stakeout:

- Elevation of your current position (shown in blue)
- When staking a side slope, the top of the screen shows the:
    - Side slope value defined by your current position (shown in blue)
    - Design side slope value (shown in red if edited)
- **Off road** is displayed at the top of the screen if your current position is before the start of the road or beyond the end of the road.
- **Undefined** is displayed at the top of the screen when consecutive horizontal alignment elements are non tangential and your current position is beyond the end tangent point of the incoming element but before the start tangent point of the next element and you are on the outside of the road. See position 1 in the diagram below.
- When consecutive horizontal alignment elements are non tangential and your current position is before the end tangent point of the incoming element but after the start tangent point of the next element, and your position is on the inside of the road (see position 2 in the diagram below), the station, offset and vertical distance values are reported using the closest horizontal element to your position to determine

which portion of the road to use.
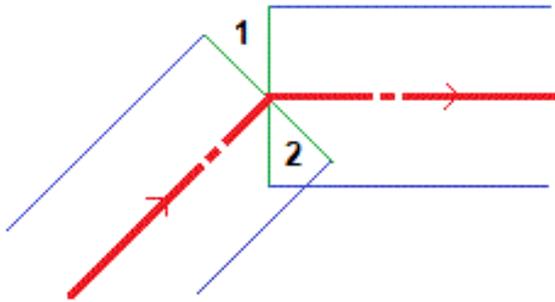
Cross section view

The cross section that appears is orientated in the direction of increasing station. Your current position and the target are shown. If the target has construction offsets specified, the smaller single circle indicates the selected position and the double circle indicates the selected position adjusted for the specified construction offset(s). The construction offset(s) appear as green lines.

When you view the cross section, the appropriate cut or fill side slope appears for the side of the road that you are currently on.

Tap and hold in the cross section view to define a cross slope or subgrade.

Current position information

The base of the plan view or cross section view reports your current position relative to the item being staked:

- To select the delta display, tap the arrow to the left of the navigation deltas.
- Tap **Options** for further delta display options.

NOTE –

- *If you are using a conventional instrument, the road values only appear after you take a distance measurement.*
- *If the road consists of only a horizontal and vertical alignment the **V.Dist** value reports the vertical distance to the vertical alignment.*

GNSS tilt sensor information

When using a GNSS receiver with a built-in tilt sensor, you can:

- Tap **eBubble** to display an electronic bubble
- Configure the survey style to prompt a warning when the pole is outside a specified **Tilt tolerance**
- To configure quality control, precision, and tilt settings, tap **Options**.

Stakeout navigation

During stakeout the software helps you to navigate to the selected position on the road. The display orientation assumes you are moving forwards at all times.

Stakeout display orientation

Select the display orientation when defining your survey style or, when in a survey, from the **Options** softkey. The options are:

- Direction of travel – the screen will orientate so that the top of the screen points in the direction of travel.
- North – the screen will orientate so that the north arrow points up the screen.
- Reference azimuth – the screen will orientate to the azimuth of the road.

Understanding the navigation directions

As shown in the diagram below, the values in the **Go Forward/Go Backward** (1) and **Go Right/Go Left** (2) fields are relative to the cross-section of the point that you are staking out (3). They are **not** relative to the current direction of travel (4), or to the direction of increasing station (5) at your current position (6).
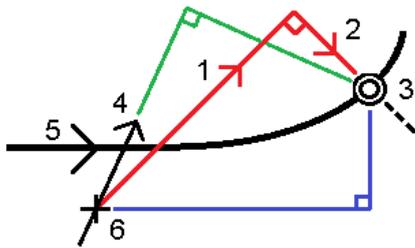

Keyed in and selected offset/feature behavior

The behavior at stake out differs depending on whether the offset/string was selected graphically, selected from a list, or keyed in.

- If you graphically select a string or select a string from the list, the Go Right/Go Left value at stakeout updates to reflect any changes in geometry due to template changes or widening.
- If you key in a numeric offset value (effectively defining a string on the fly) that value is maintained for the entire length of the road.

Consider the following diagram:
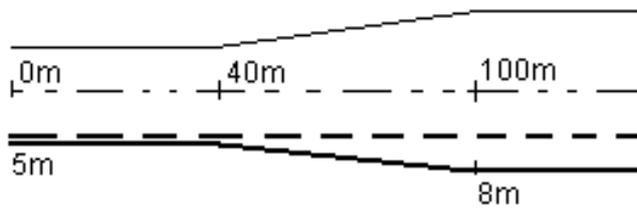
If you select an offset/string that has an offset value of 5 m, the offset value updates to follow the solid line for subsequent stations. In this example, the offset changes from 5 m to 8 m between stations 40 m and 100 m and then is maintained at 8 m for subsequent stations.

If you key in 5 m for the offset, the offset follows the dashed line. That is, the offset of 5 m is maintained for subsequent stations.

To navigate to the point in a conventional survey

If you are using the **Direction and distance** mode:

1. Hold the display screen in front of you as you walk forwards in the direction that the arrow is pointing. The arrow points in the direction of the point that you intend to measure (the "target").

2. When you get to within 3 meters (10 feet) of the point, the arrow disappears, and the in/out and left/right directions appear, with the instrument as a reference point. Follow the instructions below to navigate in this mode.

If you are using the **In/out and left/right** mode:

1. The first display shows which way the instrument should be turned, the angle that the instrument should display and the distance from the last point staked to the point currently being staked.

2. Turn the instrument (two outline arrows will appear when it is on line), and direct the rod person on line.

   If you are using a servo instrument, and the **Servo auto turn** field in the survey style is set to **HA & VA**, or **HA only** the instrument automatically turns to the point. If you are working robotically, or when the **Servo auto turn** field in the survey style is set to **Off**, the instrument does not turn automatically.

3. If the instrument is not in **TRK** mode, tap **Measure** to take a distance measurement.

4. The display shows how far the person holding the rod should move towards or away from the instrument.

5. Direct the person holding the rod, and take another distance measurement.

6. Repeat steps 2–5 until the point has been located (when four outline arrows are displayed), then mark the point.

7. If a measurement to the target is within the angular and distance tolerances, tap **Store** at any time to

accept the current measurement. If the instrument is in TRK mode and you require a higher precision distance measurement, tap **Measure** to take an STD measurement and then tap **Store** to accept that measurement. To discard the STD measurement and return the instrument to TRK mode, tap **Esc**.

If you are operating a robotic instrument remotely from the target:

- the instrument automatically tracks the prism as it moves
- the instrument continuously updates the graphical display
- the graphical display is reversed and the arrows are shown from the target (prism) to the instrument

To navigate to the point in a GNSS survey

1. Hold the display screen in front of you as you walk forwards in the direction that the arrow is pointing. The arrow points in the direction of the point that you intend to measure (the "target").

2. When you get to within 10 feet (3 meters) of the point, the arrow disappears and a bull's-eye target appears.

   When the bull's-eye target is displayed, do not change your orientation. Keep facing in the same direction and only move forwards, backwards, left or right.

3. Continue moving forwards until the cross, representing your current position, covers the bull's-eye target, representing the point. Mark the point.

Staking out relative to a DTM

You can stake out relative to a digital terrain model (DTM), where the horizontal navigation is relative to the road but the displayed cut/fill delta value is to a selected DTM.

1. From Roads, select **Survey** and then select the road to stake.

2. Tap the **Options** softkey and from the **Display** group box select the DTM and then select the **Display cut/fill to DTM** option. If required, specify an offset to raise or lower the DTM. Tap ▸ and select whether the offset is to be applied vertical or perpendicular to the DTM.

   The heading for the displayed cut/fill value changes to **V.dist DTM**.

NOTE –

- *When staking relative to a DTM you cannot view the cross sections.*
- *If the road includes templates the displayed cut/fill delta will be to the selected DTM, not the templates.*
- *When a horizontal construction is applied, the cut/fill value reported is to the DTM at the position selected for stakeout and not to the DTM at your current position.*

Construction offsets

To stake positions offset from the road, leaving the roadway clear for construction, define one or more construction offsets for the road. The construction offset is applied to all positions in the road.

In the plan or cross section view, a construction offset is indicated by a green line, and a double circle indicates the selected position adjusted for the construction offsets.

When you define a construction offset for a road, the offset is:

- used for all roads of the same file format in the same job.
- used for all subsequent surveys of the road in the same job, until a different construction offset is defined.
- not used for the same road when it accessed from a different job.

To define a construction offset, tap and hold in the plan view or cross section view and select **Define construction offsets**.

If you are surveying a Trimble road using the traditional menu selection, you can define construction offsets in the **Stakeout** screen.

Horizontal construction offsets

When measuring positions relative to or staking stations on the horizontal alignment/master string, you can define a horizontal construction offset where:

- A negative value offsets points to the left of the horizontal alignment/master string.
- A positive value offsets points to the right of the horizontal alignment/master string.

For all other strings, including side slope strings, you can define a horizontal construction offset where:

- A negative value offsets points toward the horizontal alignment/master string (in).
- A positive value offsets points away from the horizontal alignment/master string (out).

NOTE – *Construction offsets are not automatically applied to a side slope offset. When you stake a side slope, select the* ***Store both catch and construction offset*** *check box to measure and store the catch position. See* *Catch point.*

GENIO roads

For a GENIO road, tap ▶ next to the **Horizontal offset** field to specify if the offset is to be applied:

- Perpendicular to the master string for the sub string being staked
- Perpendicular to the sub string being staked

The following diagram shows a **Horizontal offset (1)** applied perpendicular to the master string (2) and a **Horizontal offset (3)** applied perpendicular to the sub string (4).
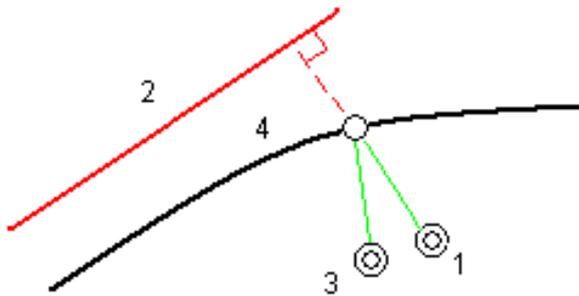
When staking stations on a string, you can define a horizontal offset by the distance from the selected position to the master string. To do this:

1. Tap ▶ next to the **Horizontal offset** field and select **At string.**

2. Navigate to the target which will be at the master string.

3. Measure and store the point.

   The calculated horizontal offset is reported in the **As staked deltas**.

This option is not available if the string being staked is a 5D string or if the horizontal offset is applied perpendicular to the sub string.

When measuring positions relative to a string or a station on a string, you can define a horizontal offset by the distance from the selected position to your current position. To do this:

1. Tap ▶ next to the **Horizontal offset** field and select **Calculated**.

2. Navigate to the position where you want to place the stake.

   The **Go left / Go right** navigation delta is replaced by the calculated horizontal construction offset.

3. Measure and store the point.

   The calculated horizontal offset is reported in the **As staked deltas**.

This option is not available if the horizontal offset is applied perpendicular to the sub string.

Vertical construction offsets

You can define a vertical construction offset where:

- A negative value offsets points vertically down.
- A positive value offsets points vertically up.

The **Vertical Offset** value is not applied to a DTM surface.

Tap ▶ next to the **Vertical offset** field to specify if the offset is to be applied:

- Vertically
- Perpendicular to the element in the cross section before the point being staked

The following diagram shows a **Vertical offset** applied vertically (1) and a **Vertical offset** applied perpendicular (2) to the previous cross section element (3).
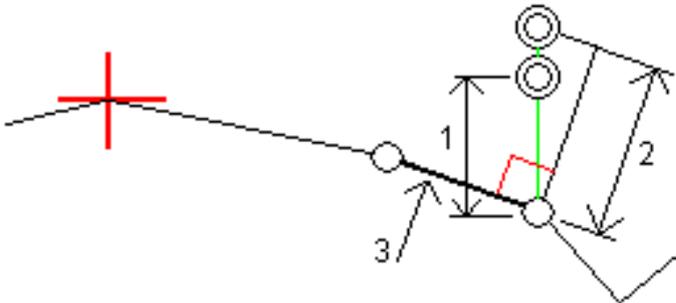
Station construction offsets

For roads derived from a GENIO file you can apply a station construction offset where:

- A positive value offsets the point in the direction of increasing station (Forward).
- A negative value offsets the point in the direction of decreasing station (Backward).

NOTE –

- *You cannot apply a station construction offset to a 5D string that represents the catch position.*
- *The station construction offset respects the geometry of the string being staked.*

Side slopes

In some situations, you may need to add or edit the side slope.

NOTE – *The side slope, and any edits to the side slope, are discarded after a position is measured or when you exit the stakeout screen.*

Adding a side slope

You can add a side slope when staking a station on a string or measuring your position relative to a string.

The current string is, by default, the hinge string but you can select a different string as the hinge string if required.

You cannot add a side slope to the alignment.

NOTE – *Adding a side slope is available only for a Trimble road.*

Editing a side slope

If the design cut or fill slope value or the cut ditch width value is not applicable, overwrite the value with a new one.

In some situations, it may be preferable to adjust the cut or fill slope value to the value defined by the slope from the current string to the next string or from the previous string to the current string. In either the **Cut slope** field or the **Fill slope** field, select **Slope to next string** or **Slope from previous string**. The **Slope** field updates with the appropriate slope value.

The example below shows where you might select the **Slope to next string** or **Slope from previous string** option for a cut slope. A similar approach can be used for a fill slope.

NOTE – *The next or previous string slope options are available:*

- *Only if a next or previous string exists.*
- *In the* **Cut slope** *field, the options are available only if the next or previous slope values are positive, that is, if they define a cut slope.*
- *In the* **Fill slope** *field, the options are available only if the next or previous slope values are negative, that is, if they define a fill slope.*

Sometimes, particularly for LandXML road files, the side slope may specify only one slope value, where the other is null (?). If, when staking a side slope, the design and calculated side slope values at the top of the navigation screen are null, this indicates that the undefined slope value is required to stake the catch. Use the **Edit side slope** option to specify the slope value to enable the catch to be staked.

You can also:

- change the string name.
- select a different string as the hinge string, if required.

A side slope is shown in red if edited.

The diagram below shows a typical example of where you might use these options.

Selecting a different string as the hinge string

1. Tap and hold in either the plan or cross section graphics window and select **Edit Side Slope**.
2. From the **Hinge string** field tap the arrow and then select a string by one of these methods:
   - Tap a string on the screen
   - If appropriate for your controller, use the left/right arrow keys
   - Tap and hold on the screen and select the string from the list

   The current hinge string is shown as a solid blue circle.

Example – select hinge string and edit side slope

The diagram below shows a typical example of where you might select a different string as the hinge string. In this example, the original design with the hinge at string C is in fill, resulting in an unwanted fill zone (1). By selecting string B as the hinge string, the new design is now in cut and the unwanted fill zone is avoided.
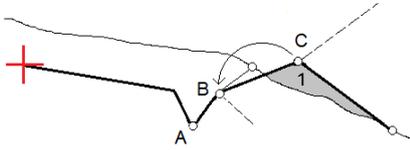
With string B selected as the hinge string, the cut slope can be defined by either retaining the design slope value or keying in another value. Alternatively, the cut slope can be defined by selecting one of the following:

- **Slope from previous string** option to define the cut slope as the slope from the previous string A to the new hinge string B, resulting in a catch position at (2).

- **Slope to next string** option to define the cut slope as the slope from the new hinge string B to the next string C, resulting in a catch position at (3).
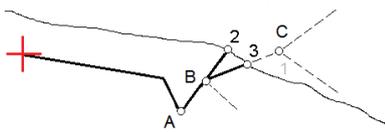
Catch point

The catch point is the point where the design side slope intersects with the ground.

The actual intersection position of the side slope with the existing ground surface – the catch point – is determined iteratively (by repetition). The software calculates the intersection of a horizontal plane passing through the current position, and either the cut or fill side slope, as shown in the following diagram , where x_n is the **Go Right/Left** value.
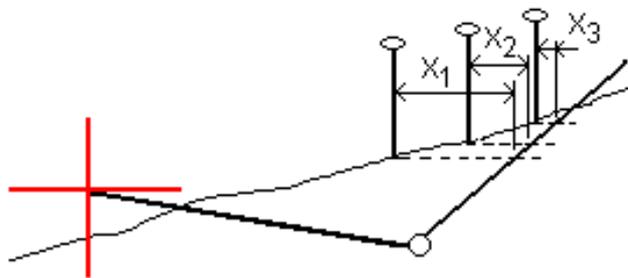
The plan view shows the calculated catch position. The calculated slope value (in blue) and the design slope value appears at the top of the screen.

The cross section is displayed looking in the direction of increasing station. Your current position and the calculated target are indicated. A line is drawn (in blue) from the hinge position to your current position to indicate the calculated slope.

Green lines indicate if the catch point has construction offsets specified. The smaller single circle indicates the calculated catch position and the double circle indicates the selected position adjusted for the specified construction offset(s). The construction offsets appear only after you have applied them.

NOTE – *For side slope offsets where the slope changes between templates, the software calculates the side slope for intermediate stations by interpolating the slope value.*

Catch point staked deltas

To view the **Catch point deltas report** screen, tap **Report** in the **Confirm staked deltas** screen or **Review job** screen.

The horizontal and vertical distances from the catch point to each string are shown, up to and including the horizontal alignment. If the template includes a cut ditch, the report includes the hinge position at the toe of the cut slope. The reported values exclude any construction offset specified.

See the diagram below:
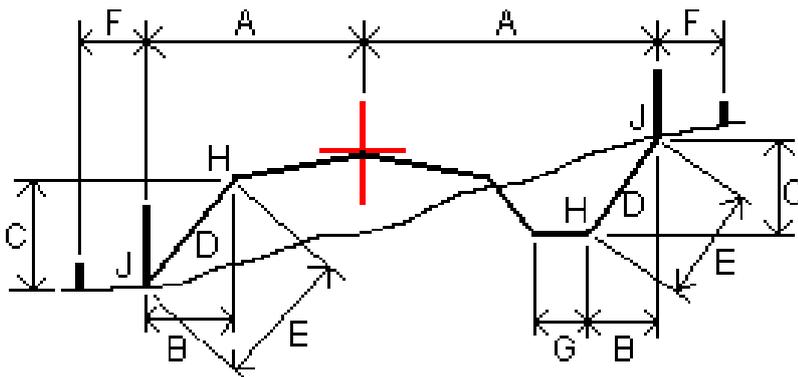
Where:

A	=	Distance to horizontal alignment
B	=	Horizontal distance to hinge point
C	=	Vertical distance to hinge point
D	=	Slope
E	=	Slope distance to hinge point
F	=	Horizontal construction offset
G	=	Ditch offset
H	=	Hinge point

J	=	Catch point

NOTE –

- *When you stake a fill side slope with a subgrade, the as staked deltas include the distance from the catch to the intersection of the subgrade with the side slope.*

- *The value in the **S.Dist to hinge + Constr off** field includes any construction offset values specified and reports the slope distance from the hinge to the as-staked position. The value is null (?) if there is no horizontal construction offset specified or the horizontal construction offset is applied horizontally.*
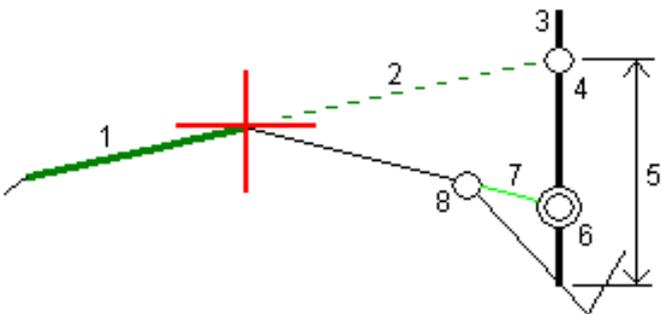
Cross slopes

Define a cross slope when you need to confirm the construction of a road surface – typically the carriageway. Refer to the following diagrams:
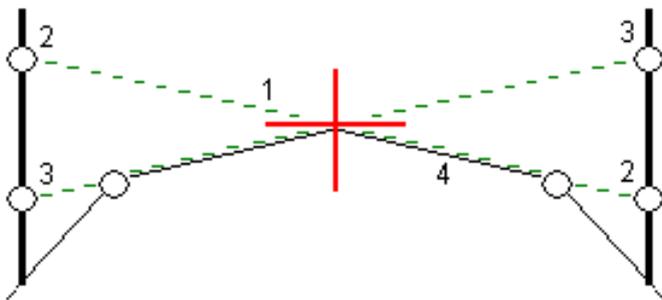
Typically a wire (1) is stretched from one side of the road to the other fixed at position (2) on each stake. The wire is then checked to see that it lies on the formed road surface (4). The process is then repeated for the other side of the road by fixing the wire to the stakes at position (3). The cross slope can be offset vertically so that the wire is above the surface making it easier to confirm the construction. If the cross slope is offset, the measured distance from the wire to the surface should be consistent. The cross slope option reports the deltas, enabling the stake to be marked up with positions (2) and (3).

NOTE –

- *A cross slope must be defined in the cross section view.*
- *A cross slope cannot be defined when measuring your position relative to the road or when staking a side slope.*

To define a cross slope

1. From the cross section view, define a horizontal construction offset, typically at **Slope previous**, and enter a vertical offset if required.

   The smaller single circle (8) indicates the selected position and the double circle (6) indicates the selected position adjusted for the specified construction offsets. The construction offset(s) appear as a green line (7).

2. Tap the line (1) that will define the cross slope. The selected line appears as a bold green line.

   NOTE – You cannot select a line that defines a side slope to define a cross slope.

3. From the tap and hold menu, select **Define cross slope**, enter a **Cross slope offset** if required, and tap **OK**.

   A dashed green line (2) extends from the selected line to intersect with a vertical line (4) at the target stake (3).

4. Navigate to the target and then stake the position.

5. Use the **V.Dist. cross slope** value (5) to mark the stake with the second position.

   NOTE – To de-activate the cross slope function, tap the selected line (1).

Subgrades

Define a subgrade when the cross section represents the finished road surface and you need to stake the points defining other surfaces in the road – typically the subgrade.

Subgrade points are computed by creating a temporary line that is parallel to, and offset from, a line between two strings in the cross section. The points can then be selected for stakeout:
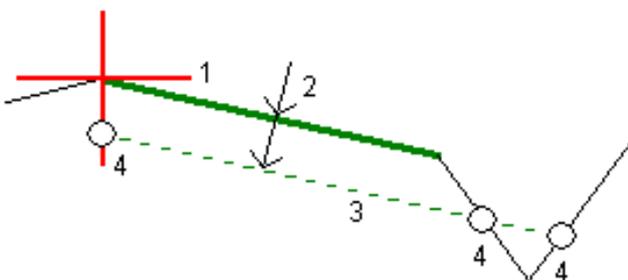
NOTE – You must be in the cross section view to define a subgrade. You cannot define a subgrade from the Stakeout method screen or when measuring your position relative to a road or a string.

To define a subgrade

1. From the cross section view, tap the line (1) that will define the subgrade. The selected line appears as a bold green line.

   NOTE – *You cannot select a line that defines a side slope to define a subgrade.*

2. From the tap and hold menu, select **Define subgrade**, enter the depth to subgrade (2) where the depth is from the selected line to the subgrade surface, and tap **OK**.

   A dashed green line (3) extends to intersect with all encountered lines in the cross section. If no intersection(s) are found, computed points are created at the same start and end offsets as that of the selected line. The single circles (4) indicate the computed positions.

3. Tap the position that you want to stake.

4. Navigate to the target and then stake the position.

5. To exit the subgrade function, tap the selected line (1).

5

Survey reports

Use the **Reports** function in the software to generate reports for surveyed data. Use these reports to check data in the field, or to transfer data from the field to your client or to the office for further processing with office software.

Roads stakeout reports

To display the **Confirm staked deltas** screen before you store a point, select the **View before storage** check box in the **Stakeout options** screen and then select the required format in the **Stakeout deltas format** field.

When staking out roads, in addition to the usual translated stakeout reports provided by Trimble Access, the following stakeout reports are available:

Road – Catch + offsets

Provides details of all the standard road staked deltas plus a list of the horizontal and vertical distances to each of the cross-section positions from the staked offset position. The reported horizontal and vertical distances include the applied horizontal and vertical construction offsets.

Provides details of all the standard road staked deltas plus a list of the horizontal and vertical distances to each of the cross-section positions from the staked offset position. The reported horizontal and vertical distances include the applied horizontal and vertical construction offsets.

Road – Stake markup

Provides a simplified stakeout display that presents the vertical distance (cut/fill) to the road design position. Appropriate station and offset values and cross-section details (in the case of catch point staking) are reported, based on the road stakeout method.

Road – XS details

Provides all the standard road staked deltas details as well as a list of the cross-section elements (left and right) that define the design cross-section at the selected station.

To generate a report

1. Open the job that contains the data to export.
2. Tap ≡ and select **Report**.
3. In the **File format** field, specify the type of file to create.

4. Tap 📁 to select an existing folder or create a new one.

5. Enter a filename.

   By default, the **File name** field shows the name of the current job. The filename extension is defined in the XSLT style sheet. Change the file name and extension as required.

6. If more fields are displayed, complete them.

   You can use the XSLT style sheets to generate files and reports based on parameters that you define. For example, when generating a Stakeout report, the **Stakeout horizontal tolerance** and the **Stakeout vertical tolerance** fields define acceptable stakeout tolerances. When generating the report you can stipulate the tolerances, then any stakeout delta greater than the defined tolerances appears in color in the generated report.

7. To automatically view the file after you create it, select the **View created file** check box.

8. To create the file, tap **Accept**.

Alternatively, export the job as a JobXML file and then use the ASCII File Generator utility to create the report from the exported JobXML file, using the required XSLT style sheet as the output format. To download the utility, go to https://geospatial.trimble.com/product-and-solutions/access and click **Downloads**.