

# Working with coordinates

For accuracy in a drawing, you can locate specific points by entering coordinates as you draw or modify entities. When you create two-dimensional entities, you enter two-dimensional coordinates; for three-dimensional entities, you specify three-dimensional coordinates.

You can also specify coordinates in relation to other known locations or entities in a drawing. In particular, when you work in three-dimensional drawings, it is often easier to specify coordinates in relation to a two-dimensional working plane, called a user coordinate system (UCS).

This section explains how to work with coordinates, including how to:

- Use two-dimensional and three-dimensional coordinate systems.
- Specify absolute and relative coordinates.
- Specify polar, spherical, and cylindrical coordinates.
- Define and manipulate user coordinate systems.

## ***Topics in this chapter***

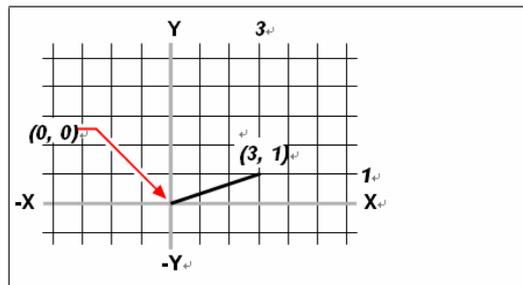
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## Using Cartesian coordinates

Many commands in BtoCAD require that you specify points as you draw or modify entities. You can do so by selecting points with the mouse or by typing coordinate values in the command bar. The program locates points in a drawing using a Cartesian coordinate system.

### Understanding how coordinate systems work

The Cartesian coordinate system uses three perpendicular axes—x, y, and z—to specify points in three-dimensional space. Every location in a drawing can be represented as a point relative to a 0,0,0 coordinate point, referred to as the origin. To draw a two-dimensional entity, you specify horizontal coordinate positions along the x-axis and vertical coordinate positions along the y-axis. Thus, every point on a plane can be represented as a coordinate pair composed of an x-coordinate and a y-coordinate. Positive coordinates are located above and to the right of the origin; negative coordinates are located to the left and below the origin.



The three perpendicular axes of the Cartesian coordinate system.

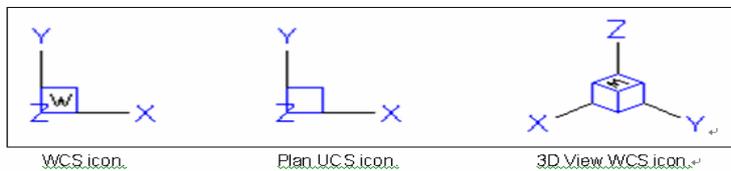
When you work in two dimensions, you need enter only the x- and y-coordinates; the program assumes that the z-axis value is always the current elevation. When you work in three dimensions, however, you must also specify the z-axis value. When you look at a plan view of your drawing (a view from above, looking down), the z-axis extends straight up out of the screen at a 90-degree angle to the xy plane. Positive coordinates are located above the xy plane, and negative coordinates are below the plane.

All BtoCAD drawings use a fixed coordinate system, called the World Coordinate System (WCS), and every point in a drawing has a specific x,y,z-coordinate in the WCS. You can also define arbitrary coordinate systems located anywhere in three-dimensional space. These are called user coordinate systems and can be located anywhere in the WCS and oriented in any direction.

You can create as many user coordinate systems as you want, saving or redefining them to help you construct three-dimensional entities. By defining a UCS within the WCS, you can simplify the creation of most three-dimensional entities into combinations of two-dimensional entities.

To help you keep your bearings in the current coordinate system, the program displays a coordinate system icon. When you begin a new drawing, you are automatically in the WCS, indicated by the letter *W* in the icon. When you display a drawing in plan view, you see the coordinate system icon from the top, with the z-axis directed straight toward you. When you display a three-dimensional drawing in a view other than plan view, the coordinate system icon changes to reflect your new viewpoint.

**TIP** *The visible portions of the axes are the positive directions.*



The BtoCAD UCS icon looks different from the UCS icon in AutoCAD, because it presents more information. Three colors represent the three axes, making it easier for you to recognize the orientation in three-dimensional space:

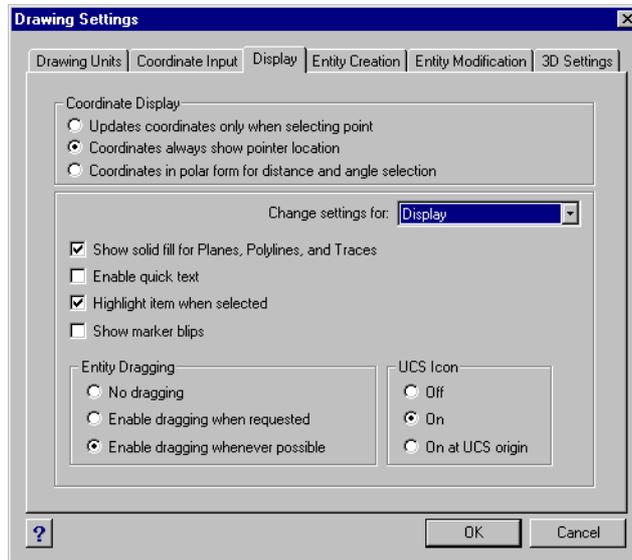
- x-axis: red
- y-axis: green
- z-axis: blue

If you prefer a single color for the cursor and UCS icon, you can make that change with the *config* or *options* command.

## Understanding how coordinates are displayed

The current position of the cursor is displayed as x,y,z-coordinates in the status bar and, by default, updates dynamically as you move the cursor. You can toggle the coordinate display to static mode by pressing F6, so that it updates only when you select a point in the drawing.

You can also change the coordinate display to a different dynamic mode that shows the distance and angle (rather than x,y,z-coordinates) when the program displays a rubber-band line. To do this, choose Settings > Drawing Settings and select the Display tab. Under Coordinate Display, select the option for Coordinates In Polar Form For Distance And Angle Selection.



You can control the coordinate display from the Drawing Settings dialog box.

## Finding the coordinates of a point

To find the x,y,z-coordinates for a point on an entity, such as the endpoint of a line, select an appropriate entity snap (such as Endpoint) before selecting the entity. If you have no entity snaps set, the x,y-coordinates of the point you specified is displayed, with the z-coordinate equal to the current elevation.

### To find the coordinate of a point in the drawing

1 Do one of the following:

- Choose Tools > Inquiry > ID Coordinates.
- On the Inquiry toolbar, click the ID Coordinates tool ().
- Type *idpoint* and then press Enter.

2 Select the point for which you want to find the coordinates. If the command bar is activated, the x,y,z-coordinates for the point you selected display in the command bar.

If the command bar is not activated, the Prompt History window displays, showing the x,y,z-coordinates for the point you selected.

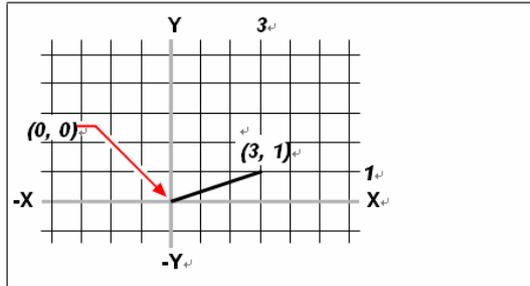
## Using two-dimensional coordinates

When working in two dimensions, you specify points on the xy plane. You can specify any point as an absolute coordinate (or Cartesian coordinate), using the exact x- coordinate and y-coordinate locations in relation to the origin (the 0,0 coordinate point at which the two axes intersect), or as a relative coordinate in relation to the previous point. You can also specify points using relative or absolute polar coordinates, which locate a point using a distance and an angle.

## Entering absolute Cartesian coordinates

To enter absolute Cartesian coordinates, type the coordinate location of the point in the command bar. For example, to use absolute Cartesian coordinates to draw a line from the origin (0,0) to a point 3 units to the right and 1 unit above the origin, start the Line command and respond to the prompts as follows:

```
Start of line: 0,0  
Angle • Length • <Endpoint>: 3,1
```



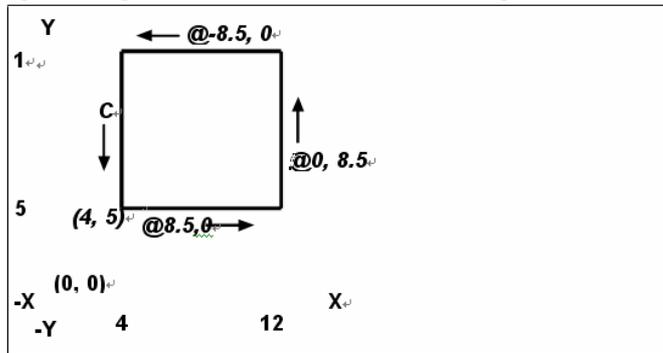
Drawing a line using the absolute Cartesian coordinate method.

When using absolute Cartesian coordinates, you need to know the exact point locations for anything you draw. For instance, to use absolute Cartesian coordinates to draw an 8.5-unit square with its lower left corner at 4,5, you must determine that the upper left corner is at coordinate 4,13.5, the upper right corner at 12.5,13.5, and the lower right corner at 12.5,5.

## Entering relative Cartesian coordinates

Another, simpler method is to use relative Cartesian coordinates: you specify a location in the drawing by determining its position relative to the last coordinate you specified. To use relative Cartesian coordinates, type the coordinate values in the command bar, preceded by the *at* symbol (@). The coordinate pair following the @ symbol represents the distance along the x-axis and the y-axis to the next point. For example, to draw an 8.5-unit square with its lower left corner at 4,5 using relative Cartesian coordinates, start the Line command, and then respond to the prompts as follows:

```
Start of line: 4,5
Angle • Length • <Endpoint>: @8.5,0
Angle • Length • Follow • Undo • <Endpoint>: @0,8.5
Angle • Length • Follow • Close • Undo • <Endpoint>: @-8.5,0
Angle • Length • Follow • Close • Undo • <Endpoint>: C
```



Drawing a square using the relative Cartesian coordinates method; enter C to close.

The first relative coordinate (@8.5,0) locates the new point 8.5 units to the right (along the x-axis) from the previous point of 4,5; the second relative coordinate (@0,8.5) locates the next point 8.5 units above (along the y-axis) the previous point, and so on. Entering C (for Close) draws the final line segment back to the first point specified when you started the Line command.

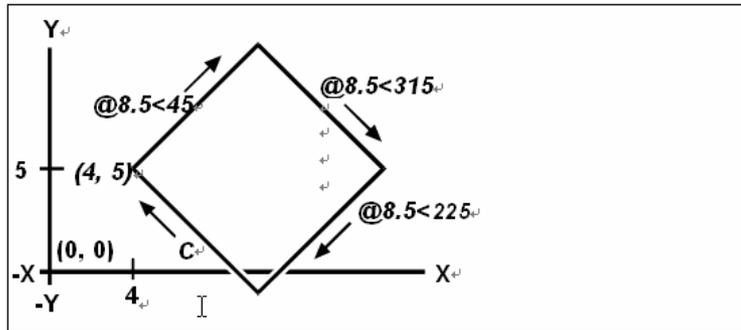
## Entering polar coordinates

Using relative polar coordinates makes drawing a square tilted at a 45-degree angle a simple task. Polar coordinates base the location of a point on a distance and angle from either the origin (absolute coordinate) or from the previous point (relative coordinate).

To specify polar coordinates, type a distance and an angle, separated by the open angle bracket (<). For example, to use relative polar coordinates to specify a point 1 unit away from the previous point and at an angle of 45 degrees, type @1<45.

To draw the square from the example in the previous section, “Entering relative Cartesian coordinates,” this time tilted at a 45-degree angle, start the Line command, and then respond to the prompts as follows:

```
Start of line: 4,5
Angle • Length • <Endpoint>: @8.5<45
Angle • Length • Follow • Undo • <Endpoint>: @8.5<315
Angle • Length • Follow • Close • Undo • <Endpoint>: @8.5<225
Angle • Length • Follow • Close • Undo • <Endpoint>: C
```



Drawing a tilted square using the relative polar coordinates method; enter C to close.

**NOTE** This example, like all examples in this guide, assumes the program's default settings: Angles increase counterclockwise and decrease clockwise. Thus, an angle of 315 degrees is the same as -45 degrees.

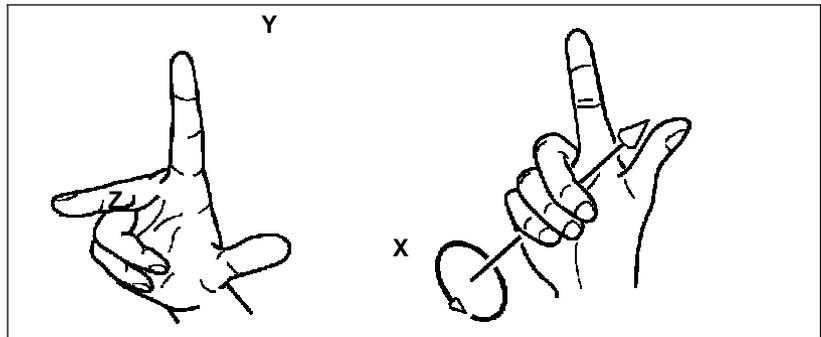
## Using three-dimensional coordinates

Specifying coordinates in three-dimensional space is similar to working in two dimensions, except that you also use the z-axis to locate coordinates. Three-dimensional coordinates are represented in the format  $x,y,z$  (for example, 2,3,6).

### Using the right-hand rule

To visualize how BtoCAD works with three-dimensional space, use a technique known as the right-hand rule. Hold up your right hand in a loose fist with your palm facing you. Extend your thumb in the direction of the positive x-axis and your index finger upward in the direction of the positive y-axis. Then extend your middle finger straight toward you in the direction of the z-axis. These three fingers are now pointing in the positive x, y, and z directions, respectively.

You can also use the right-hand rule to determine the positive rotation direction. Point your thumb in the positive direction of the axis about which you want to rotate, and then curl the rest of your fingers toward your palm. These fingers are curling in the positive rotation direction.



The right-hand rule helps you determine the positive direction of the x-, y-, and z-axes and the positive rotation direction.

### Entering x,y,z-coordinates

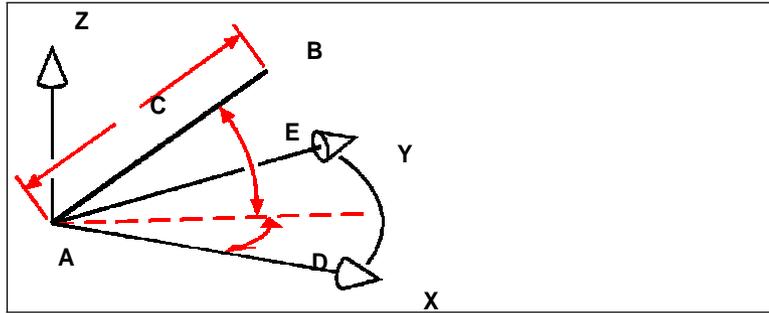
When working in three dimensions, you can specify  $x,y,z$ -coordinates as absolute distances in relation to the origin (the 0,0,0 coordinate point at which the three axes intersect) or as relative coordinates based on the last point selected. For example, to specify a point 3 units along the positive x-axis, 4 units along the positive y-axis, and 2 units along the positive z-axis, specify the coordinate 3,4,2.

## Entering spherical coordinates

When working in three-dimensional space, you can use spherical coordinates to specify a three-dimensional point by entering its distance from either the origin (absolute distance) or the last point (relative distance), along with its angle in the xy plane and its angle up from the xy plane. In spherical format, you separate each angle with the open angle bracket (<).

Thus, to draw a line from the origin to a point 10.2500 drawing units away, at an angle of 45 degrees from the x-axis and 35 degrees from the xy plane, start the Line command, and then respond to the prompts as follows:

```
Start of line: 0,0,0  
Angle • Length • <Endpoint>: 10.2500<45<35
```



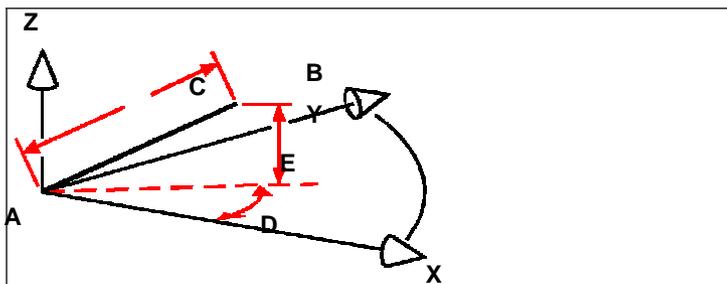
When you draw a line from a start point (A) to an endpoint (B) using spherical coordinates, you specify its length (C, in this case 10.2500 units), the angle in the xy plane (D, in this case 45 degrees), and the angle from the xy plane (E, in this case 35 degrees).

## Entering cylindrical coordinates

When working in three-dimensional space, you can also use cylindrical coordinates to specify a three-dimensional point. You specify a point by entering its distance from either the origin (absolute distance) or the last point (relative distance), its angle in the xy plane, and its z-coordinate value.

In cylindrical format, you separate the distance and angle with the open angle bracket (<) and separate the angle and z value with a comma. For example, to draw a line from the last point to a point 7.4750 units away, at an angle of 27 degrees from the x-axis in the xy plane and 3 units up in the z direction, start the Line command, and then respond to the prompts as follows:

```
Start of line: (select point A)
Angle • Length • <Endpoint>: @7.4750<27,3
```



When you draw a line from a start point (A) to an endpoint (B) using cylindrical coordinates, you specify its length (C, in this case 7.4750), the angle in the xy plane (D, in this case 27degrees), and the distance in the z direction (E, in this case 3 units).

## Using xyz point filters

Point filters provide a method of locating a point in a drawing relative to another point without specifying the entire coordinate. Using a point filter, you can enter partial coordinates, and then the program prompts you for the remaining coordinate information. To use xyz point filters, respond to the prompt for a coordinate with a filter in the following form:

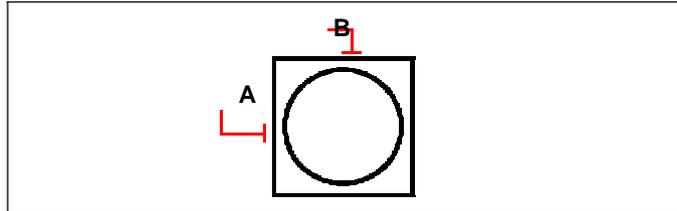
*.coordinate*

where *coordinate* is one or more of the letters x, y, and z. The program then prompts you for the filtered coordinate(s). For example, if you type *.xy*, the program prompts you to select a point whose xy-coordinate you want, and then prompts you for the z-coordinate. The filters *.x*, *.y*, *.z*, *.xy*, *.xz*, and *.yz* are all valid filters.

## Using point filters in two dimensions

You can use point filters when you work in two dimensions to locate points in relation to existing entities. For example, to draw a circle centered in a rectangle, start the Circle command, and then respond to the prompts as follows:

```
2Point • 3Point • RadTanTan • Arc • Multiple • <Center of circle>: .y
Select Y of: mid
Snap to midpoint of: (select the left side of the rectangle) Still
need XZ of: mid
Snap to midpoint of: (select top of the rectangle)
Diameter • <Radius>: (specify radius of circle)
```



You can use point filters to center the circle by separately selecting the midpoints of two sides of the rectangle (**A** and **B**) and then specifying its radius.

## Using point filters in three dimensions

You can use point filters when you work in three-dimensional space to locate points in two dimensions and then specify the z-coordinate as the elevation above the xy plane. For example, to begin drawing a line from a point with a z-coordinate 3 units above the center of a circle, insert the circle, and then start the Line command and respond to the prompts as follows:

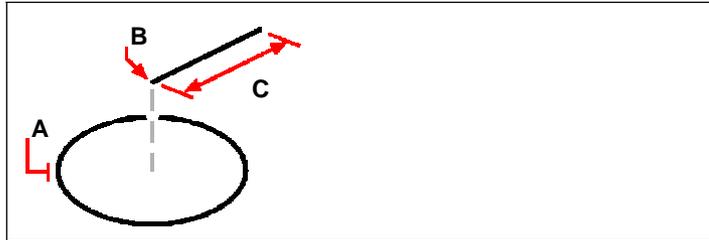
ENTER to use last point • Follow • <Start of line>: .xy

Select XY of: cen

Snap to centerpoint of: (select a point on the circle)

Still need Z of: 3 (locates the starting point 3 units above the center of the circle)

Length of line: (specify the length of the line)

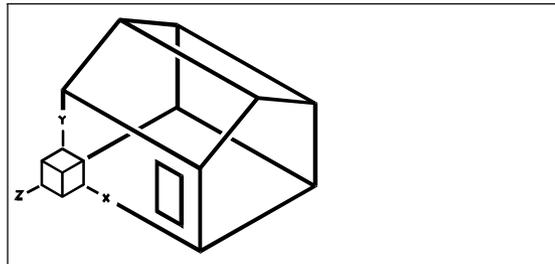


You can use point filters to draw a line by first selecting a point in the xy plane (A), specifying the z-coordinate (B), and then specifying the length of the line (C).

## Defining user coordinate systems

When working in three-dimensional space, you can define a UCS with its own 0,0,0 origin and orientation separate from the WCS. You can create as many user coordinate systems as you want, and then save and recall them as you need them to simplify construction of three-dimensional entities.

For example, you can create a separate UCS for each side of a building. Then, by switching to the UCS for the east side of the building, you can draw the windows on that side by specifying only their x- and y-coordinates. When you create one or more user coordinate systems, the coordinate entry is based on the current UCS.



UCS aligned with the front wall of the house.

### Defining a user coordinate system

To define a UCS, you can use any of the following methods:

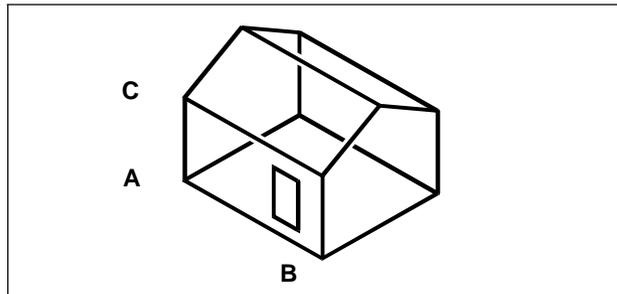
- Specify a new origin and points on the positive x- and y-axes.

- Specify a new origin and point on the positive z-axis.
- Align the UCS with an existing entity.
- Rotate the current UCS around any of its axes.
- Align the UCS with its z-axis parallel to the current viewing direction.
- Align the UCS xy plane perpendicular to the current view.

When you define a new UCS, the UCS icon changes to indicate the origin and orientation of the new UCS.

### To define a UCS by specifying a new origin and points on the positive x- and y-axes

- 1 Do one of the following:
  - Choose Settings > User Coordinate Systems.
  - On the Settings toolbar, click the User Coordinate Systems tool ().
  - Type *setucs* and then press Enter.
- 2 In the User Coordinate Systems dialog box, click Explore UCSs.
- 3 In the prompt box, choose 3 Point.
- 4 Select the new origin.
- 5 Select a point on the positive x-axis.
- 6 Select a point in the positive y direction.



Define the new UCS by selecting the origin (A), a point on the positive x-axis (B), and a point in the positive y direction (C).

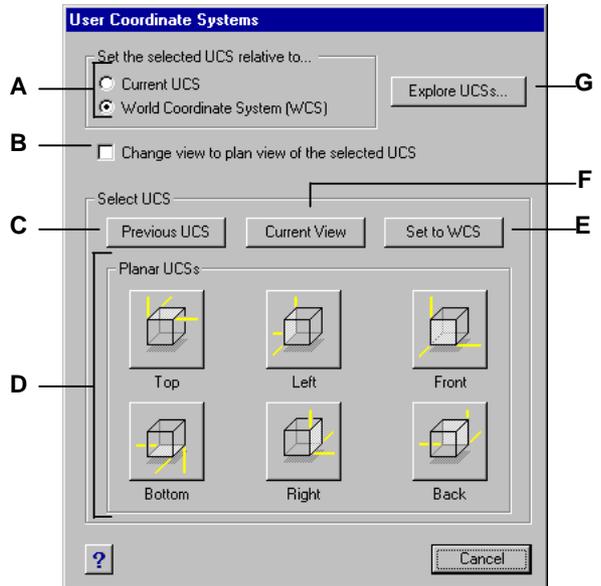
### Using a preset user coordinate system

BtoCAD lets you select a preset UCS. The six planes defined by looking along the x,y,z-axes align the UCS with the top, left, front, bottom, right, or back, based on either the WCS or the current UCS in effect when you select the tool. You can also select the previous UCS, align the UCS to the current view, or select the WCS.

When you select a UCS, the cursor orientation and UCS icon change to reflect the new UCS. The display does not change, however, unless you select the Change View To Plan View Of The Selected UCS check box.

### To select a preset UCS

- 1 Do one of the following:
  - Choose Settings > User Coordinate Systems.
  - On the Settings toolbar, click the User Coordinate Systems tool ()
  - Type *setucs* and then press Enter.
- 2 Under Set The Selected UCS Relative To, select either Current UCS to change to the new UCS by reorienting relative to the current UCS or World Coordinate System (WCS) to base the new UCS orientation on the WCS.
- 3 Under Select UCS, click the button corresponding to the UCS you want as the new current UCS.



- A Specify whether to define the new UCS relative to the current UCS or to the World Coordinate System (WCS).
- B Select to change the display to the plan view of the new UCS.
- C Click to select the previous UCS.
- D Click one of these buttons to select the view you want of a preset UCS.
- E Click to select the WCS.
- F Click to align the UCS with the current view.
- G Click to display the IntelliCAD Explorer.

## Polar

Function key: F10

### 1. Command Function

After activating the “Polar”, the working window will show the temporary aligning path of the appointed polar angle.

### 2. Parameters:

Click F10 function key, or click “Polar” in the status bar, system informs “Polar on”, click again for “Polar off”

### 3. Tips:

Right click “Polar” on the status bar, select “settings”, system will pop up a dialog box. In the “polar angle settings”, you can set “increment angle” and “additional angles” for polar tracking.

## Object snap trace

Function Key: F11

### 1. Command Function

Using the Object snap tracking function, one can track the align path of the snapped object. There will be a + symbol nearby the tracked point. When we move the mouse along the drawing path, the system will show you the horizontal, vertical or parallel path.

### 2. Parameters:

Click F11 function key, or click “Otrack” on the status bar, system will inform “Object snap tracking on”, click again for “Object snap tracking off”

### 3. Tips:

- a. Right click “Otrack” on the status bar, select “settings”, system will pop up a dialog box that you can set the “Object snap tracking”
- b. Use this function together with “Perpendicular”, “Endpoint” and “Midpoint” to drawing points perpendicular to the endpoint or midpoint of the object.