



# Mesh 5.0

## Universal Mesh Generator

**Field Precision**

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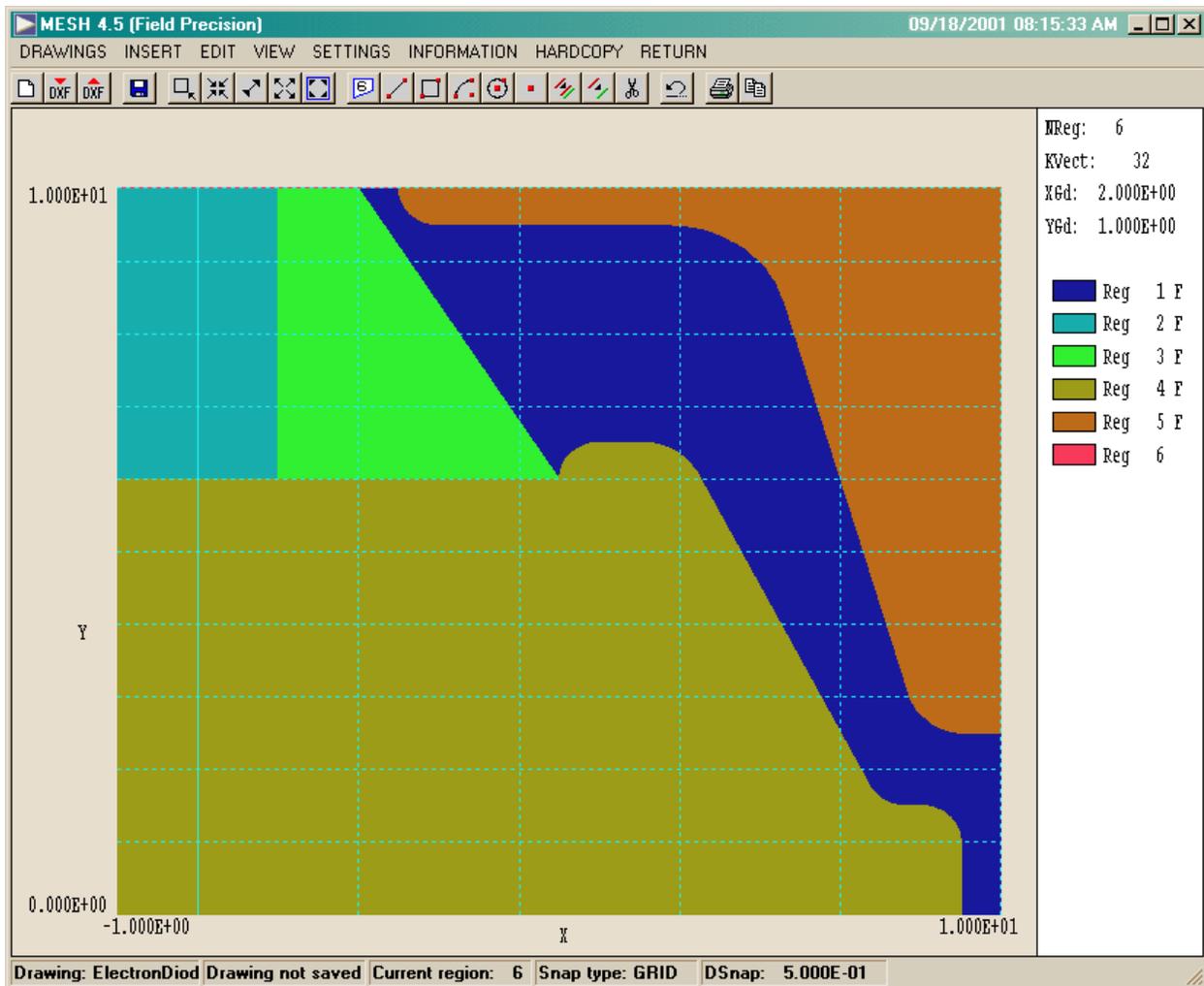


Figure 5.1. Drawing editor screen shot, display of filled regions

## 5.1. Functions of the drawing editor

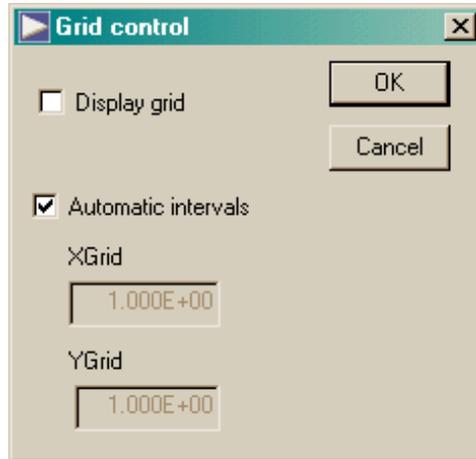
Version 5.0 of **Mesh** contains a useful drawing editor with many of the functions of advanced CAD programs. The editor enables graphical preparation of boundary input specifications which can be converted directly to a **Mesh** input script. The drawing editor offers the convenience of graphical mesh specification while preserving the portability and transparency of scripts. The drawing editor gives you several capabilities:

- You can create drawings from scratch and then automatically generate **Mesh** script files from the vector information.
- You can export DXF drawing files that can be read by most CAD

programs or sent to colleagues by E mail.

- You can import existing drawings from TurboCAD, AutoCAD and other CAD programs into a special layout region. You can then quickly trace and organize entities for incorporation into a **Mesh** script.
- You can prepare drawings with CAD programs following a few simple rules so that they can be directly translated to a **Mesh** script.

The following section describes a walkthrough example illustrating many of the features of the Drawing Editor. Sections 5.3 through 5.5 cover commands and capabilities of the Drawing Editor menu. Section 5.3 command discusses commands of the *Drawings* menu. Here you can start new drawings, import information from existing DXF files and create **Mesh** scripts (MIN). The commands of the *Insert* menu (Section 5.4) add entities (line, arc, rectangle,...) to new or existing drawings. Entities are organized by numbered layers. The layer number of an entity is used as the region number when it is written to a **Mesh** script. Therefore the terms *region* and *layer* are synonymous. The *Insert* menu also contains useful commands to trace or to move vectors from existing drawings to an ordered set of region boundaries. The *Edit* menu (Section 5.5) contains a comprehensive set of commands to modify drawing vectors (delete, copy, move, fillet, ...). You can also reorder regions so that they are written in the proper order to **Mesh** script files. For example, you can change the region number of a dielectric region so that it appears earlier in the script than a neighboring electrode region. Section 5.6 describes commands of the *Settings* and *Information* menus. Commands in the other menus (*View* and *Hardcopy*) are similar to those described in Sects. 4.5 and 4.9. Finally, Section 5.7 covers methods to prepare drawings in other CAD programs and to import them into **Mesh**.

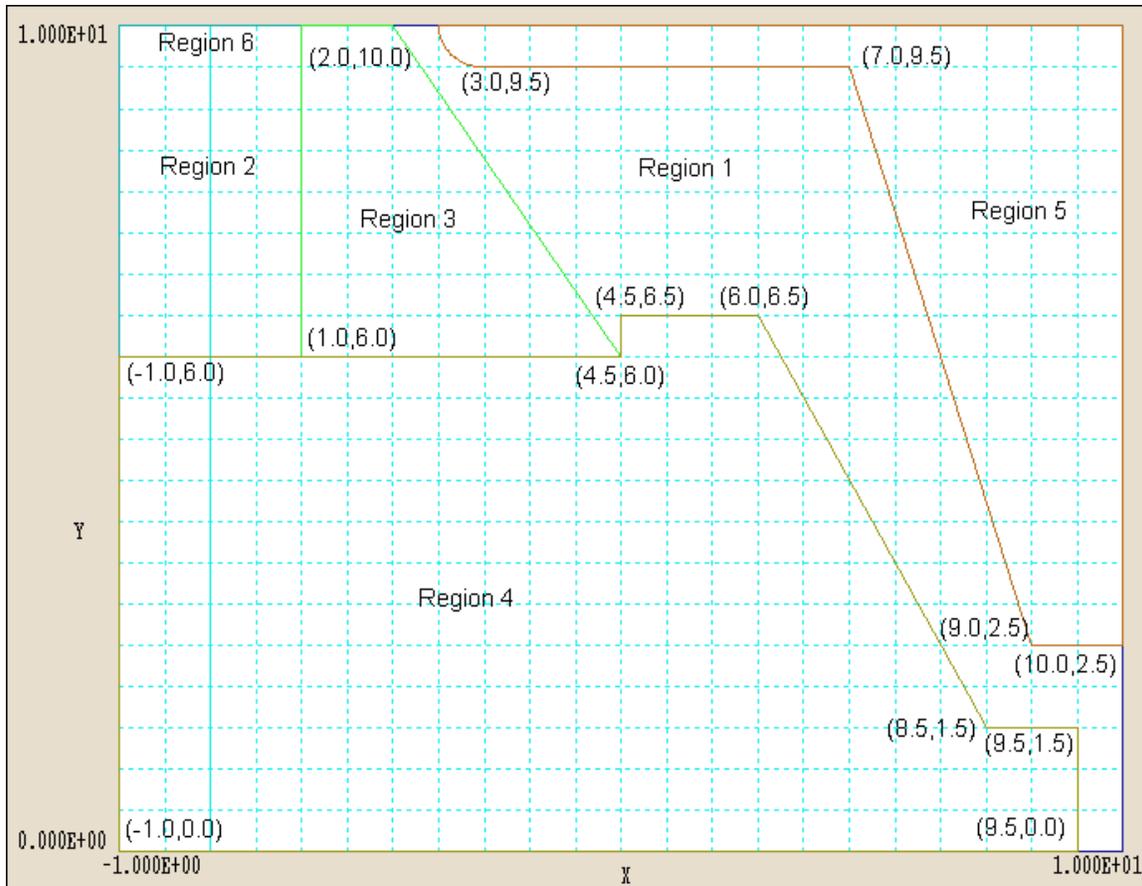


**Figure 5.2.** Grid control dialog

## 5.2. Walkthrough example

This section gives a step-by-step description of the preparation of a mesh to simulate a high-power electron-beam injector. Figure 5.1 shows the geometry, a cylindrical system with azimuthal symmetry about the  $z$ -axis (bottom). The ordinate is the radial distance from the axis. The area shown as *Region 1* is vacuum and *Region 2* is a purified-water dielectric at the end of a high-power coaxial transmission line. *Region 3* is a vacuum insulator, *Region 4* is the high-voltage center conductor, and *Regions 5* and *6* correspond to the grounded vacuum chamber wall.

Run **Mesh** and go to the *Drawing* menu. Click on the *New drawing* tool or the *New drawing* command in the *Drawings* menu to bring up a dialog. Type `ElectronDiode` in the title box and set the following limits:  $z_{\min} = -1.0$ ,  $z_{\max} = 10.0$ ,  $r_{\min} = 0.0$  and  $r_{\max} = 10.0$ . After you click *OK*, the program displays the drawing area with default grid intervals. The information area and status bar show that no vectors are currently defined and that the program is ready to insert vectors into *Region 1*. Furthermore, the mouse snap mode is set to *Grid* with a snap distance of 0.50. The latter figure means that whenever you pick a coordinate by pressing the left mouse button the program chooses the closest snap point, such as  $(-0.5, 1.5)$ ,  $(0.0, 5.0)$ , .... We next set display grid intervals that will be convenient for the drawing. Click on *Grid control* in the *Settings* menu to display the dialog shown in Fig. 5.2. Uncheck the *Automatic intervals* box and change the  $z$  and  $r$  grid intervals to 0.5. After you click *OK*, the program displays a new grid with dashed blue lines (Fig. 5.3). Note that the line at  $z = 0.0$  is solid.



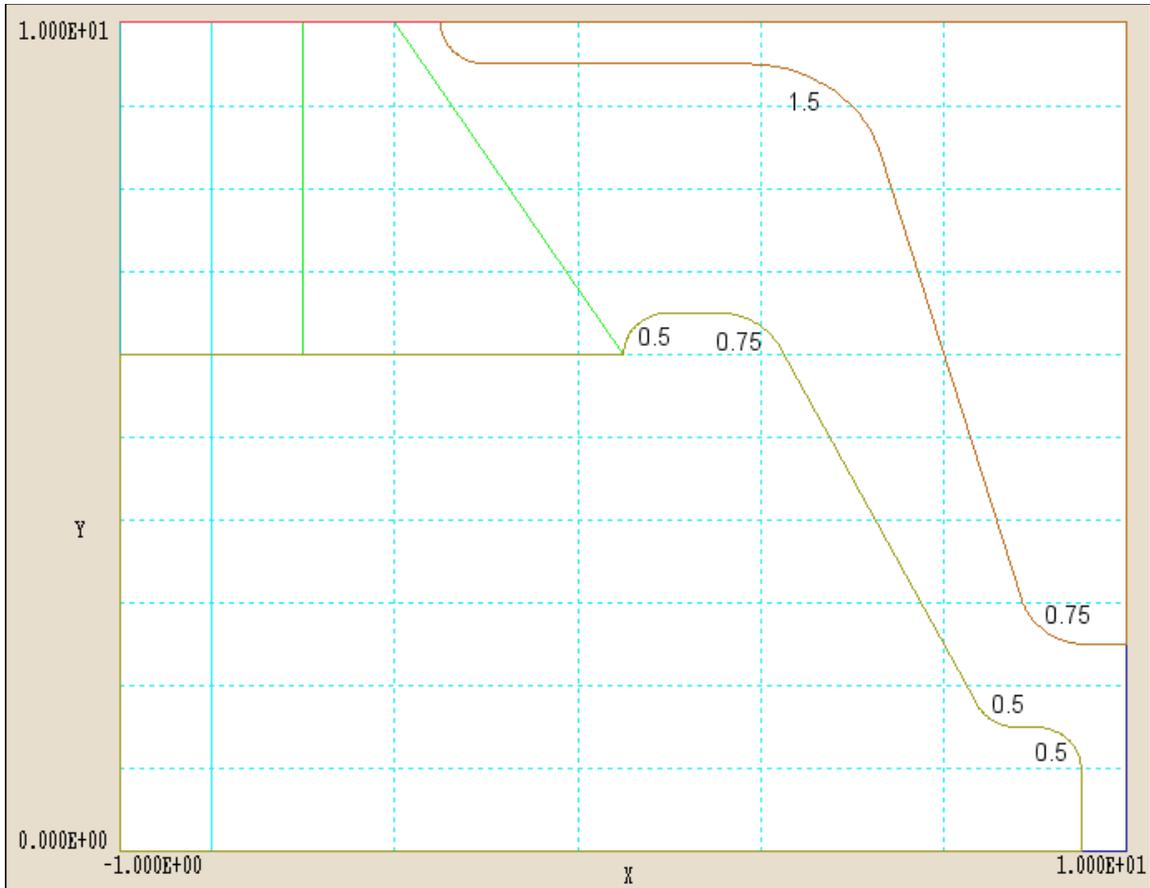
**Figure 5.3.** Rough drawing for the example *ElectronDiode* showing coordinates and region assignments

*Region 1* (vacuum) will cover the full solution area. Later, we will over-write portions of the region to represent electrodes and dielectrics. Pick the *Rectangle* command in the *Insert* menu and move the mouse pointer into the plot area. Once inside the plot, the mouse becomes active and the cursor changes to a cross-hair pattern. The status bar at the bottom of the display shifts to coordinate-input mode. It shows brief instructions, the present location of the cursor and the snap status. Move the cursor close to the bottom-left corner and click the left button. Then move the cursor to the top-right corner and click the left button a second time. The information area now shows that the drawing contains four vectors. The set of vectors (plotted in dark blue) outlines the drawing region. The drawing may not be correct if the pointer was not close enough to snap to the corners. In this case, pick the *Undo last operation* command in the *Edit* menu or click the *Undo* tool.

To ensure proper assignment of boundary conditions in **EStat**, we want to define dielectric regions first and then to enter constant potential regions (electrodes). *Region 2* represents purified water at the end of a low-impedance coaxial transmission line. In the *Insert* menu click on *Set current region* and enter the number 2. Use the *Rectangle* command to define the region illustrated in Fig. 5.3. The corner points are at  $z$ - $r$  coordinates of (-1.0,6.0) and (1.0,10.0). *Region 3* represents a vacuum insulator. Set the current region to 3 with the *Change current region* command. Click the *Line* tool or the *Line* command in the *Insert* menu. The program enters *repeat mode* where you can enter multiple lines. Note that the menus and tools are deactivated. Click the left mouse button to set a line start point at (1.0,6.0), then move to (4.5,6.0) and click the left button again. The program inserts the vector, plots it in green and awaits input for the next line. Click the left mouse button to set the start point at (4.5,6.0) and the end point at (2.0,10.0). To draw the top line, set the start point at (2.0,10.0). Before setting the end point, press the  $F2$  key. This brings up a dialog where you can change the snap mode for the next coordinate entry. Section 5.6 discusses snap modes in detail. Grid snap is sufficient for the present drawing, so click *CANCEL* to exit the dialog with no changes. Continue by setting the end point of the line at (1.0,10.0). Finally, draw a line from (1.0,10.0) to (1.0,6.0) to complete the outline of the insulator. Press  $ESC$  or click the right mouse button to exit repeat mode. (Note that the right mouse button is active only when the pointer is in the plot area.)

To complete the rough drawing, we need to enter three more regions: Region 4 (inner high-voltage electrode), Region 5 (grounded shaped vacuum chamber in the diode region) and Region 6 (grounded outer wall of the transmission line). Use the *Change current region* and *Line* commands to outline Region 4 (Fig. 5.3) with the following coordinates: (-1.0,0.0)  $\Rightarrow$  (9.5,0.0)  $\Rightarrow$  (9.5,1.5)  $\Rightarrow$  (8.5,1.5)  $\Rightarrow$  (6.0,6.5)  $\Rightarrow$  (4.5,6.5)  $\Rightarrow$  (4.5,6.0)  $\Rightarrow$  (-1.0,6.0)  $\Rightarrow$  (-1.0,0.0). Be sure to enter all segments. It does not matter if you enter the segments in order. **Mesh** automatically sorts the vectors and arranges closed regions as they are entered.

The outline of Region 5 involves five lines and one arc. Change the current region to 5 and enter lines between the following coordinates: (2.5,10.0)  $\Rightarrow$  (10.0,10.0)  $\Rightarrow$  (10.0,2.5)  $\Rightarrow$  (9.0,2.5)  $\Rightarrow$  (7.0,9.5)  $\Rightarrow$  (3.0,9.5). Exit repeat mode and click on the *Arc* tool or the *Arc/Start-end-center* command in the *Insert* menu. Set the start point at (3.0,9.5), the end point at (2.5,10.0) and the center point at (3.0,10.0).

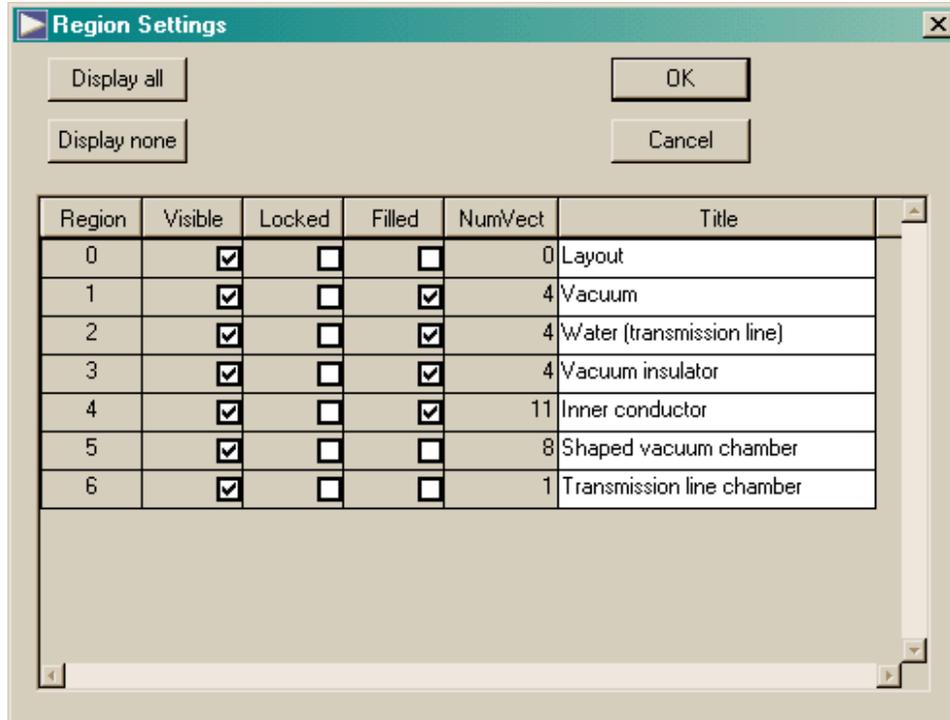


**Figure 5.4.** Finished drawing with fillet radii, *ElectronDiode* example

At this point the drawing should resemble Fig. 5.3. (Coordinates and labels have been added for clarity.) Finally, the outer wall of the vacuum chamber (Region 6) is a single line from  $(-1.0, 10.0)$  to  $(2.5, 10.0)$ .

Save the rough drawing by choosing the *Export DXF file* tool or the *Export DXF file* command in the *File* menu. Type in the file prefix *ElectronDiodeRough* and click *OK*. The program makes the DXF file *ElectronDiodeRough.DXF* in the current directory. You can reload this file or open it in another CAD program.

Now we will use the *Fillet* command in the *Edit* menu to make the finished drawing. Click on the *Fillet/chamfer width* command in the *Edit* menu and change the fillet radius to 0.5. Choose the *Fillet* command and pick the two vectors on the right-hand side of the high-voltage electrode (*Region 4*). Figure 5.4 shows the locations and



**Figure 5.5.** Region properties dialog

radii of fillets. If all is well, your drawing should look like the drawing of Fig. 5.4 after you complete the fillet operations. If not, use the *Undo* command or reload the file `ElectroDiodeRough.DXF`.

To complete the drawing we will set parameters for the regions. Choose the *Region properties* command in the *Settings* menu to call up the dialog shown in Fig. 5.5. Click check boxes to set *Regions* 1,2,3,4 and 5 to the *Filled* condition and type in descriptive names for the regions. To type in a name, click the mouse inside the desired title box. The *TAB* key cannot be used to move between title boxes. Click *OK* when you are finished. Note that the fill status of regions has been updated in the information area. To check if the filled regions have been defined correctly, choose the *Display region fill* command in the *Settings* menu. You should see the display of Fig. 5.1. The fill display give invalid results if a region with an unconnected boundary is set *Filled*. To turn off the fill display, click the *Display region fill* command again. Use the *Export DXF file* command to make a copy of the final drawing. The fill status of the regions and the titles are recorded in the DXF file in a form that is recognized by **Mesh** but not by other CAD programs. The settings are restored if you reload the

drawing. The final operation within the drawing editor is to make a **Mesh** script file. Choose the *Create MIN file* tool or the command in the *File* menu. Accept the default prefix and click *OK*. The program makes the file `ElectronDiode.MIN` and opens it in the text editor. Note that the region titles have been added as comment lines in the script. At this point you could make changes in the *XMesh* and *YMesh* statements to fine-tune the variable resolution. For this exercise, simply exit the text editor and click *Return* in the drawing editor menu. You can now load and process the file `ElectronDiode.MIN` with the commands discussed in the previous section.