



kicad



kicad

Pcbnew

2 marzo 2016

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Manuale di riferimento

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Feedback

Si prega di inviare qualsiasi rapporto bug, suggerimento o nuova versione a:

- Documentazione di KiCad: <https://github.com/KiCad/kicad-doc/issues>
- Software KiCad: <https://bugs.launchpad.net/kicad>
- Traduzione di KiCad: <https://github.com/KiCad/kicad-i18n/issues>

Data di pubblicazione e versione del software

17 marzo 2014.

Capitolo 1

Introduzione a Pcbnew

1.1 Descrizione

Pcbnew è un potente strumento software per lo sviluppo di circuiti stampati disponibile per i sistemi operativi Linux, Microsoft Windows e Apple OS X. Pcbnew viene usato assieme al programma di disegno schemi elettrici Eeschema per la creazione di circuiti stampati.

Pcbnew gestisce le librerie di impronte. Ogni impronta è un disegno del componente fisico - la disposizione delle piazzole che forniscono le connessioni al componente. Le impronte richieste vengono automaticamente caricate durante la lettura della Netlist. Qualsiasi cambiamento nella selezione delle impronte o annotazione può essere cambiato nello schema e aggiornato in pcbnew rigenerando la netlist e ricaricandola nuovamente in pcbnew.

Pcbnew provides a design rules check (DRC) tool which prevents track and pad clearance issues as well as preventing nets from being connected that aren't connected in the netlist/schematic. When using the interactive router it continuously runs the design rules check and will help automatically route individual traces.

Pcbnew fornisce una visualizzazione a ratnest, una ragnatela delle connessioni delle piazzole delle impronte connesse sullo schema elettrico. Queste connessioni si spostano dinamicamente seguendo gli spostamenti effettuati di tracce e impronte.

Pcbnew possiede un semplice ma efficace sbrogliatore per assistere nella produzione del circuito. Una funzione di esportazione/importazione in formato dsn SPECCTRA permette inoltre l'uso di sbrogliatori più avanzati.

Pcbnew fornisce opzioni specifiche per la produzione di circuiti ad ultra alta frequenza (come piazzole trapezoidali e di forme complesse, disposizione automatica di bobine sul circuito stampato, ecc.).

1.2 Caratteristiche principali di progettazione

The smallest unit in pcbnew is 1 nanometer. All dimensions are stored as integer nanometers.

Pcbnew può generare fino a 32 strati rame, 14 strati tecnici (serigrafia, maschera di saldatura, adesivo componenti, pasta salda, bordi di taglio) più 4 ausiliari (disegni e commenti) e gestisce in tempo reale l'indicazione della ragnatela di connessioni (rats nest) delle tracce mancanti.

La visualizzazione degli elementi del circuito stampato (tracce, piazzole, testo, disegni...) è personalizzabile:

- in modalità piena o solo contorno;
- con o senza isolamento delle tracce.

Per i circuiti complessi, la visualizzazione degli strati, zone, componenti può essere nascosta in maniera selettiva per una migliore chiarezza sullo schermo. I collegamenti delle piste possono essere evidenziati per migliorarne il contrasto.

Le impronte possono essere ruotate di qualsiasi angolo, con una risoluzione di 0.1 grado.

Pcbnew includes a Footprint Editor that allows editing of individual footprints that have been on a pcb or editing a footprint in a library.

The Footprint Editor provides many time saving tools such as:

- Fast pad numbering by simply dragging the mouse over pads in the order you want them numbered.
- Easy generation of rectangular and circular arrays of pads for LGA/BGA or circular footprints.
- Semi-automatic aligning of rows or columns of pads.

Footprint pads have a variety of properties that can be adjusted. The pads can be round, rectangular, oval or trapezoidal. For through-hole parts drills can be offset inside the pad and be round or a slot. Individual pads can also be rotated and have unique soldermask, net, or paste clearance. Pads can also have a solid connection or a thermal relief connection for easier manufacturing. Any combination of unique pads can be placed within a footprint.

Pcbnew genera facilmente tutti i documenti necessari per la produzione:

- Prodotti per la fabbricazione:
 - File per fotoplotter in formato GERBER RS274X.
 - File per la foratura in formato EXCELLON.
- Stampa di file in formato HPGL, SVG o DXF.
- Mappe di disegno e forature in formato Postscript.
- Stampe locali.

1.3 Osservazioni generali

Due to the degree of control necessary it is highly suggested to use a 3-button mouse with pcbnew. Many features such as panning and zooming require a 3-button mouse.

In the new release of KiCad, pcbnew has seen wide sweeping changes from developers at CERN. This includes features such as a new renderer (OpenGL and Cairo view modes), an interactive push and shove router, differential and meander trace routing and tuning, a reworked Footprint Editor, and many other features. Please note that most of these new features **only** exist in the new OpenGL and Cairo view modes.

Capitolo 2

Installazione

2.1 Installazione del software

La procedura di installazione è descritta nella documentazione di KiCad.

2.2 Modifica della configurazione predefinita

A default configuration file `kicad.pro` is provided in `kicad/share/template`. This file is used as the initial configuration for all new projects.

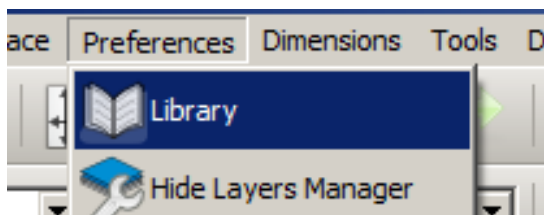
This configuration file can be modified to change the libraries to be loaded.

To do this:

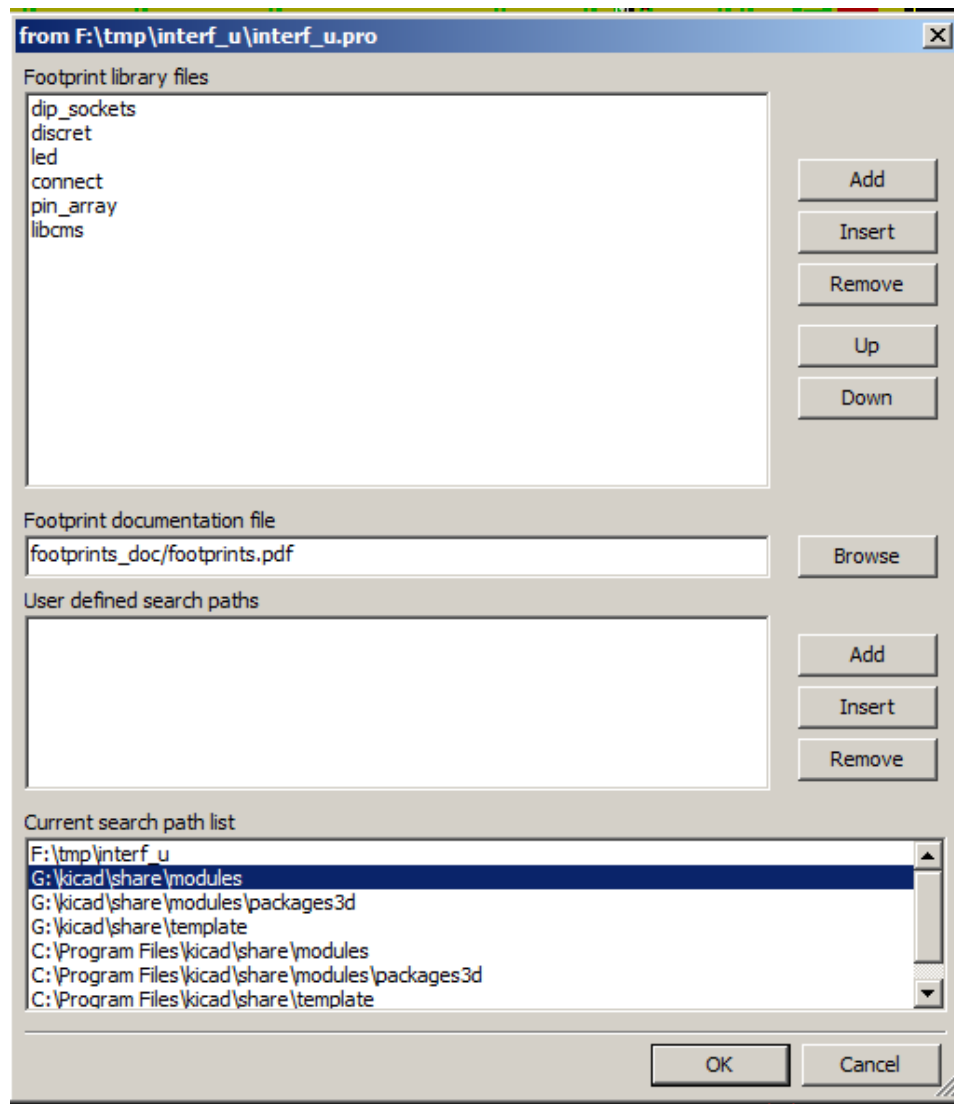
- Launch Pcbnew using `kicad` or directly. On Windows is in `C:\kicad\bin\pcbnew.exe` and on Linux you can run `/usr/local/kicad/bin/kicad` or `/usr/local/kicad/bin/pcbnew` if the binaries are located in `/usr/local/kicad/bin`.
- Select Preferences - Libs and Dir.
- Edit as required.
- Save the modified configuration (Save Cfg) to `kicad/share/template/kicad.pro`.

2.3 Managing Footprint Libraries: legacy versions

You can have access to the library list initialization from the Preferences menu:



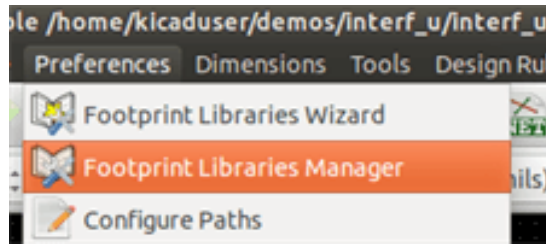
The image below shows the dialog which allows you to set the footprint library list:



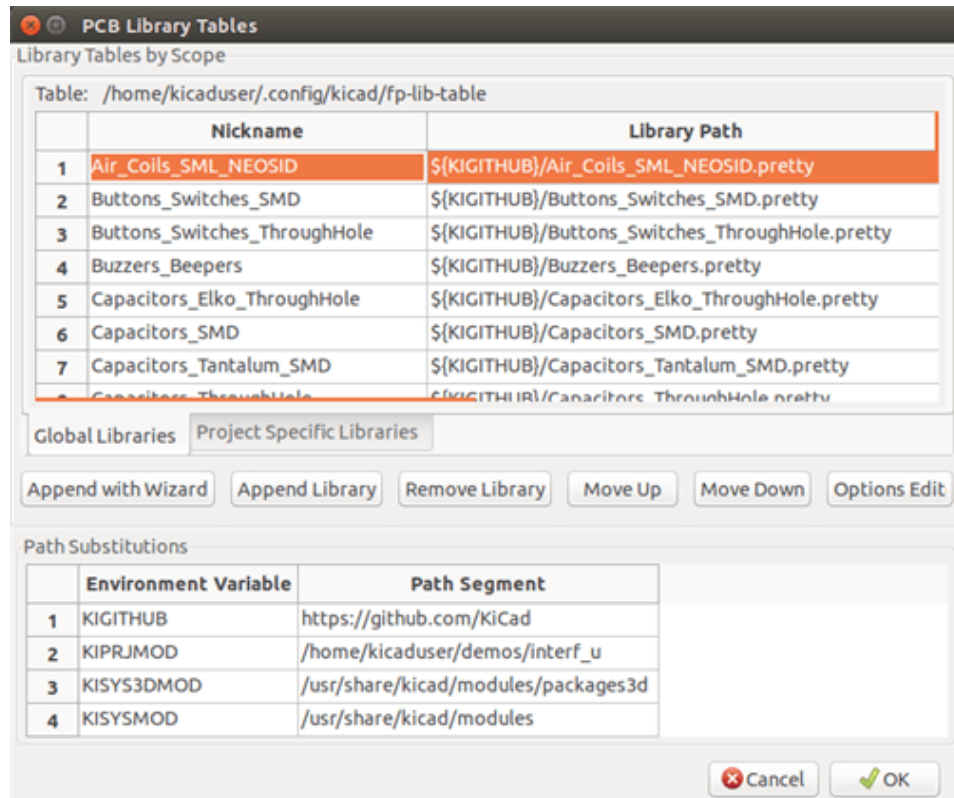
You can use this to add all the libraries that contain the footprints required for your project. You should also remove unused libraries from new projects to prevent footprint name clashes. Please note, there is an issue with the footprint library list when duplicate footprint names exist in more than one library. When this occurs, the footprint will be loaded from the first library found in the list. If this is an issue (you cannot load the footprint you want), either change the library list order using the Up and Down buttons in the dialog above or give the footprint a unique name using the footprint editor.

2.4 Managing Footprint Libraries: .pretty repositories

As of release 4.0, Pcbnew uses the new footprint library table implementation to manage footprint libraries. The information in the previous section is no longer valid. The library table manager is accessible by:



The image below shows the footprint library table editing dialog which can be opened by invoking the Footprint Libraries Manager entry from the Preferences menu.



The footprint library table is used to map a footprint library of any supported library type to a library nickname. This nickname is used to look up footprints instead of the previous method which depended on library search path ordering. This allows Pcbnew to access footprints with the same name in different libraries by ensuring that the correct footprint is loaded from the appropriate library. It also allows Pcbnew to support loading libraries from different PCB editors such as Eagle and gEDA.

2.4.1 Global Footprint Library Table

The global footprint library table contains the list of libraries that are always available regardless of the currently loaded project file. The table is saved in the file `fp-lib-table` in the user's home folder. The location of this folder is dependent on the operating system.

2.4.2 Project Specific Footprint Library Table

The project specific footprint library table contains the list of libraries that are available specifically for the currently loaded project file. The project specific footprint library table can only be edited when it is loaded along with the project board file. If no project file is loaded or there is no footprint library table file in the project path, an empty table is created which can be edited and later saved along with the board file.

2.4.3 Initial Configuration

The first time CvPcb or Pcbnew is run and the global footprint table file **fp-lib-table** is not found in the user's home folder, Pcbnew will attempt to copy the default footprint table file `fp_global_table` stored in the system's KiCad template folder to the file **fp-lib-table** in the user's home folder. If `fp_global_table` cannot be found, an empty footprint library table will be created in the user's home folder. If this happens, the user can either copy `fp_global_table` manually or configure the table by hand. The default footprint library table includes all of the standard footprint libraries that are installed as part of KiCad.

2.4.4 Adding Table Entries

In order to use a footprint library, it must first be added to either the global table or the project specific table. The project specific table is only applicable when a board file is open. Each library entry must have a unique nickname. This does not have to be related in any way to the actual library file name or path. The colon `:` character cannot be used anywhere in the nickname. Each library entry must have a valid path and/or file name depending on the type of library. Paths can be defined as absolute, relative, or by environment variable substitution. The appropriate plug in type must be selected in order for the library to be properly read. Pcbnew currently supports reading KiCad legacy, KiCad Pretty, Eagle, and gEDA footprint libraries. There is also a description field to add a description of the library entry. The option field is not used at this time so adding options will have no effect when loading libraries. Please note that you cannot have duplicate library nicknames in the same table. However, you can have duplicate library nicknames in both the global and project specific footprint library table. The project specific table entry will take precedence over the global table entry when duplicated names occur. When entries are defined in the project specific table, an `fp-lib-table` file containing the entries will be written into the folder of the currently open netlist.

2.4.5 Environment Variable Substitution

One of the most powerful features of the footprint library table is environment variable substitution. This allows you to define custom paths to where your libraries are stored in environment variables. Environment variable substitution is supported by using the syntax `${ENV_VAR_NAME}` in the footprint library path. By default, at run time Pcbnew defines the `$KISYSMOD` environment variable. This points to where the default footprint libraries that were installed with KiCad are located. You can override `$KISYSMOD` by defining it yourself which allows you to substitute your own libraries in place of the default KiCad footprint libraries. When a board file is loaded, Pcbnew also defines the `$KPRJMOD` using the board file path. This allows you to create libraries in the project path without having to define the absolute path to the library in the project specific footprint library table.

2.4.6 Using the GitHub Plugin

The GitHub plugin is a special plugin that provides an interface for read-only access to a remote GitHub repository consisting of pretty (Pretty is name of the KiCad footprint file format) footprints and optionally provides Copy-On-Write (COW) support for editing footprints read from the GitHub repo and saving them locally. Therefore the GitHub plugin is for **read-only for accessing remote pretty footprint libraries** at <https://github.com>. To add a GitHub entry to the footprint library table the Library Path in the footprint library table entry must be set to a valid GitHub URL.

For example:

```
https://github.com/liftoff-sr/pretty_footprints
```

Typically GitHub URLs take the form:

```
https://github.com/user_name/repo_name
```

The Plugin Type must be set to Github. To enable the Copy-On-Write feature the option `allow_pretty_writing_to_this_dir` must be added to the Options setting of the footprint library table entry. This option is the Library Path for local storage of modified copies of footprints read from the GitHub repo. The footprints saved to this path are combined with the read-only part of the GitHub repository to create the footprint library. If this option is missing, then the GitHub library is read-only. If the option is present for a GitHub library, then any writes to this hybrid library will go to the local `*.pretty` directory. Note that the github.com resident portion of this hybrid COW library is always read-only, meaning you cannot delete anything or modify any footprint in the specified GitHub repository directly. The aggregate library type remains Github in all further discussions, but it consists of both the local read/write portion and the remote read-only portion.

The table below shows a footprint library table entry without the option `allow_pretty_writing_to_this_dir`:

Nickname	Library Path	Plugin Type	Options	Description
github	https://github.com/liftoff-sr/pretty_footprints	Github		Liftoff' s GH footprints

The table below shows a footprint library table entry with the COW option given. Note the use of the environment variable `${HOME}` as an example only. The github.pretty directory is located in `${HOME}/pretty/path`. Anytime you use the option `allow_pretty_writing_to_this_dir`, you will need to create that directory manually in advance and it must end with the extension `.pretty`.

Nickname	Library Path	Plugin Type	Options	Description
github	https://github.com/liftoff-sr/pretty_footprints	Github		Liftoff' s GH footprints

Footprint loads will always give precedence to the local footprints found in the path given by the option `allow_pretty_writing_to_this_dir`. Once you have saved a footprint to the COW library's local directory by doing a footprint save in the Footprint Editor, no GitHub updates will be seen when loading a footprint with the same name as one for which you've saved locally.

Always keep a separate local `*.pretty` directory for each GitHub library, never combine them by referring to the same directory more than once. Also, do not use the same COW (`*.pretty`) directory in a footprint library table entry. This would likely create a mess. The value of the option `allow_pretty_writing_to_this_dir` will expand any environment variable using the `${}` notation to create the path in the same way as the Library Path setting.

What's the point of COW? It is to turbo-charge the sharing of footprints. If you periodically email your COW pretty footprint modifications to the GitHub repository maintainer, you can help update the GitHub copy. Simply email the individual `*.kicad_mod` files you find in your COW directories to the maintainer of the GitHub repository. After you've received confirmation that your changes have been committed, you can safely delete your COW file(s) and the updated footprint from the read-only part of GitHub library will flow down. Your goal should be to keep the COW file set as small as possible by contributing frequently to the shared master copies at <https://github.com>.

Finally, Nginx can be used as a cache to the github server to speed up the loading of footprints. It can be installed locally or on a network server. There is an example configuration in KiCad sources at `pcbnew/github/nginx.conf`. The most straightforward way to get this working is to overwrite the default `nginx.conf` with this one and `export KIGITHUB=http://my_server:54321/KiCad`, where `my_server` is the IP or domain name of the machine running nginx.

2.4.7 Usage Patterns

Footprint libraries can be defined either globally or specifically to the currently loaded project. Footprint libraries defined in the user's global table are always available and are stored in the `fp-lib-table` file in the user's home folder. Global footprint libraries can always be accessed even when there is no project net list file opened. The project specific footprint table is active only for the currently open net list file. The project specific footprint library table is saved in the file `fp-lib-table` in the path of the currently open board file. You are free to define libraries in either table.

There are advantages and disadvantages to each method:

- You can define all of your libraries in the global table which means they will always be available when you need them.
 - The disadvantage of this is that you may have to search through a lot of libraries to find the footprint you are looking for.
- You can define all your libraries on a project specific basis.
 - The advantage of this is that you only need to define the libraries you actually need for the project which cuts down on searching.
 - The disadvantage is that you always have to remember to add each footprint library that you need for every project.
- You can also define footprint libraries both globally and project specifically.

One usage pattern would be to define your most commonly used libraries globally and the library only require for the project in the project specific library table. There is no restriction on how you define your libraries.

Capitolo 3

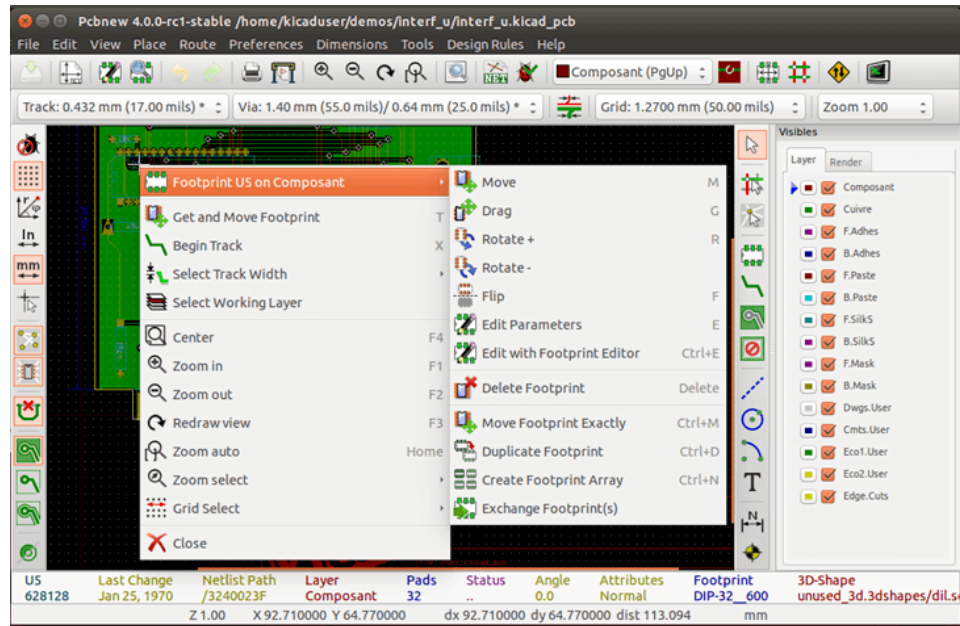
General operations

3.1 Toolbars and commands

In Pcbnew it is possible to execute commands using various means:

- Text-based menu at the top of the main window.
- Top toolbar menu.
- Right toolbar menu.
- Left toolbar menu.
- Mouse buttons (menu options). Specifically:
 - The right mouse button reveals a pop-up menu the content of which depends on the element under the mouse arrow.
- Keyboard (Function keys **F1**, **F2**, **F3**, **F4**, **Shift**, **Delete**, **+**, **-**, **Page Up**, **Page Down** and **Space bar**). The **Escape** key generally cancels an operation in progress.

The screenshot below illustrates some of the possible accesses to these operations:



3.2 Mouse commands

3.2.1 Basic commands

- Left button
 - Single-click displays the characteristics of the footprint or text under the cursor in the lower status bar.
 - Double-click displays the editor (if the element is editable) of the element under the cursor.
- Centre button/wheel
 - Rapid zoom and some commands in layer manager.
 - Hold down the centre button and draw a rectangle to zoom to the described area. Rotation of the mouse wheel will allow you to zoom in and zoom out.
- Right button
 - Displays a pop-up menu

3.2.2 Operations on blocks

Operations to move, invert (mirror), copy, rotate and delete a block are all available via the pop-up menu. In addition, the view can zoom to the area described by the block.

The framework of the block is traced by moving the mouse while holding down the left mouse button. The operation is executed when the button is released.

By holding down one of the hotkeys **Shift** or **Ctrl**, or both keys **Shift** and **Ctrl** together, while the block is drawn the operation invert, rotate or delete is automatically selected as shown in the table below:

Action	Effect
Left mouse button held down	Trace framework to move block
Shift + Left mouse button held down	Trace framework for invert block
Ctrl + Left mouse button held down	Trace framework for rotating block 90°
Shift + Ctrl + Left mouse button held down	Trace framework to delete the block
Centre mouse button held down	Trace framework to zoom to block

When moving a block:

- Move block to new position and operate left mouse button to place the elements.
- To cancel the operation use the right mouse button and select Cancel Block from the menu (or press the **Esc** key).

Alternatively if no key is pressed when drawing the block use the right mouse button to display the pop-up menu and select the required operation.

For each block operation a selection window enables the action to be limited to only some elements.

3.3 Selection of grid size

During element layout the cursor moves on a grid. The grid can be turned on or off using the icon on the left toolbar.

Any of the pre-defined grid sizes, or a User Defined grid, can be chosen using the pop-up window, or the drop-down selector on the toolbar at the top of the screen. The size of the User Defined grid is set using the menu bar option Dimensions → User Grid Size.

3.4 Adjustment of the zoom level

The zoom level can be changed using any of the following methods:

- Open the pop-up window (using the right mouse button) and then select the desired zoom.
- Use the following function keys:
 - F1: Enlarge (zoom in)
 - F2: Reduce (zoom out)
 - F3: Redraw the display
 - F4: Centre view at the current cursor position
- Rotate the mouse wheel.
- Hold down the middle mouse button and draw a rectangle to zoom to the described area.

3.5 Displaying cursor coordinates

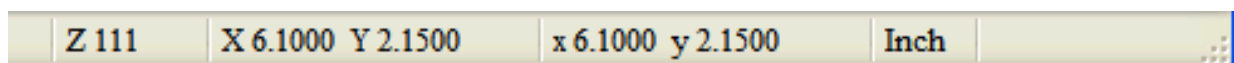
The cursor coordinates are displayed in inches or millimetres as selected using the *In* or *mm* icons on the left hand side toolbar.

Whichever unit is selected Pcbnew always works to a precision of 1/10,000 of inch.

The status bar at the bottom of the screen gives:

- The current zoom setting.
- The absolute position of the cursor.
- The relative position of the cursor. Note the relative coordinates (x,y) can be set to (0,0) at any position by pressing the space bar. The cursor position is then displayed relative to this new datum.

In addition the relative position of the cursor can be displayed using its polar co-ordinates (ray + angle). This can be turned on and off using the icon in the left hand side toolbar.



3.6 Keyboard commands - hotkeys

Many commands are accessible directly with the keyboard. Selection can be either upper or lower case. Most hot keys are shown in menus. Some hot keys that do not appear are:

- **Delete**: deletes a footprint or a track. (*Available only if the Footprint mode or the Track mode is active*)
- **V**: if the track tool is active switches working layer or place via, if a track is in progress.
- **+** and **-**: select next or previous layer.
- **?**: display the list off all hot keys.
- **Space**: reset relative coordinates.

3.7 Operation on blocks

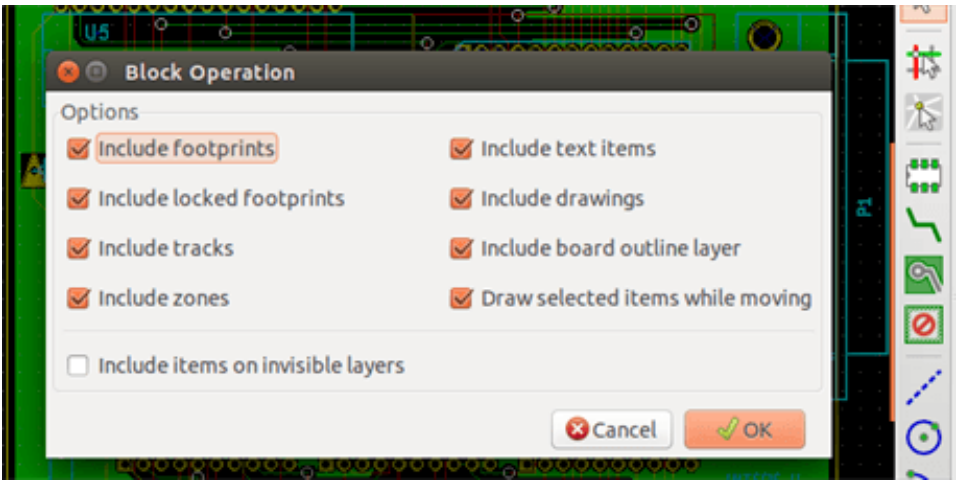
Operations to move, invert (mirror), copy, rotate and delete a block are all available from the pop-up menu. In addition, the view can zoom to that described by the block.

The framework of the block is traced by moving the mouse while holding down the left mouse button. The operation is executed when the button is released.


By holding down one of the keys **Shift** or **Ctrl**, both **Shift** and **Ctrl** together, or **Alt**, while the block is drawn the operation invert, rotate, delete or copy is automatically selected as shown in the table below:

Action	Effect
Left mouse button held down	Move block
Shift + Left mouse button held down	Invert (mirror) block
Ctrl + Left mouse button held down	Rotate block 90°
Shift + Ctrl + Left mouse button held down	Delete the block
Alt + Left mouse button held down	Copy the block

When a block command is made, a dialog window is displayed, and items involved in this command can be chosen. Any of the commands above can be cancelled via the same pop-up menu or by pressing the Escape key (Esc).



3.8 Units used in dialogs

Units used to display dimensions values are inch and mm. The desired unit can be selected by pressing the icon located in left toolbar:  However one can enter the unit used to define a value, when entering a new value.

Accepted units are:

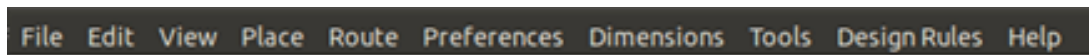
1 in	1 inch
1	1 inch
25 th	25 thou
25 mi	25 mils, same as thou
6 mm	6 mm

The rules are:

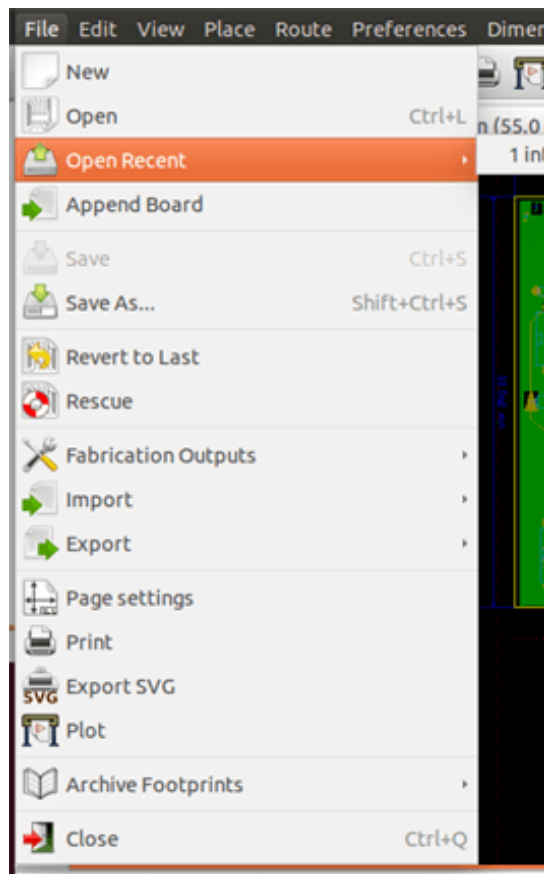
- Spaces between the number and the unit are accepted.
- Only the first two letters are significant.
- In countries using an alternative decimal separator than the period, the period (.) can be used as well. Therefore 1,5 and 1.5 are the same in French.

3.9 Top menu bar

The top menu bar provides access to the files (loading and saving), configuration options, printing, plotting and the help files.



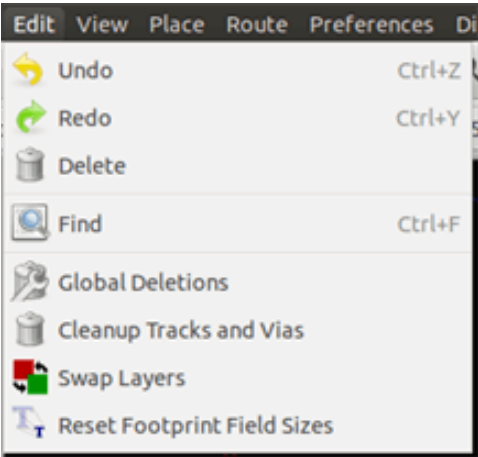
3.9.1 The File menu



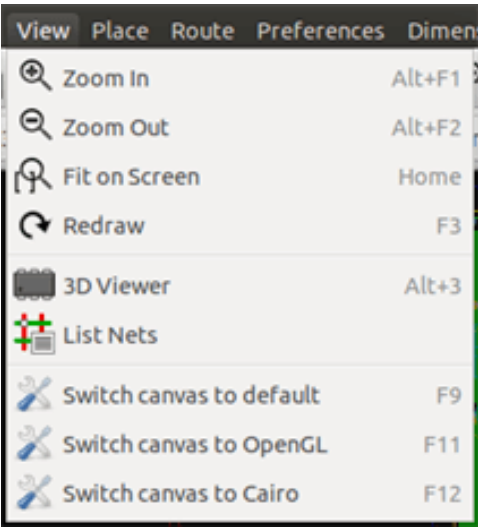
The File menu allows the loading and saving of printed circuits files, as well as printing and plotting the circuit board. It enables the export (with the format GenCAD 1.4) of the circuit for use with automatic testers.

3.9.2 Edit menu

Allows some global edit actions:



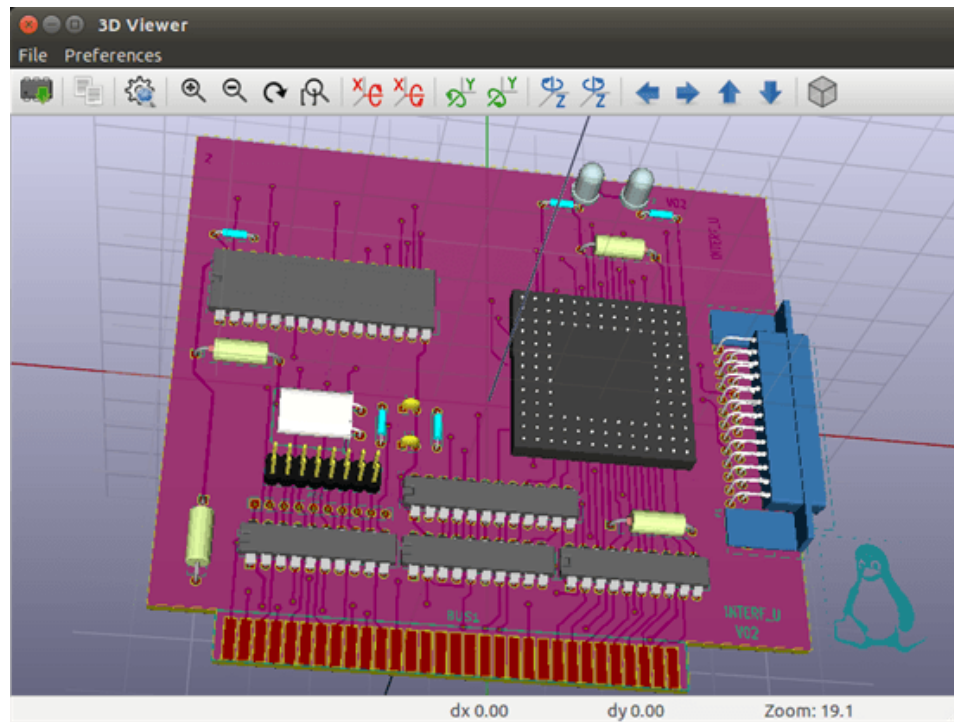
3.9.3 View menu



Zoom functions and 3D board display.

3.9.3.1 3D Viewer

Opens the 3D Viewer. Here is a sample:



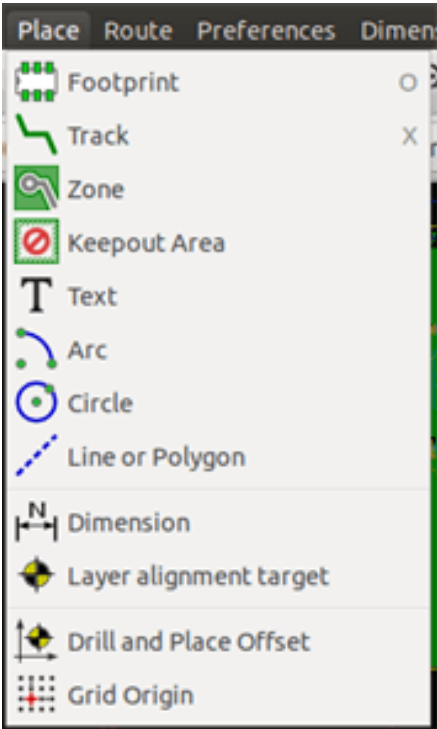
3.9.3.2 Switch canvas

Allows switching canvas.

- default
- OpenGL
- Cairo

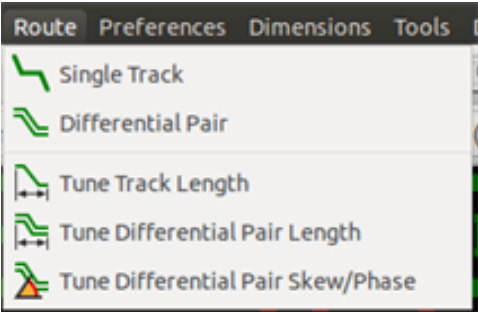
3.9.4 Place menu

Same function as the right-hand toolbar.

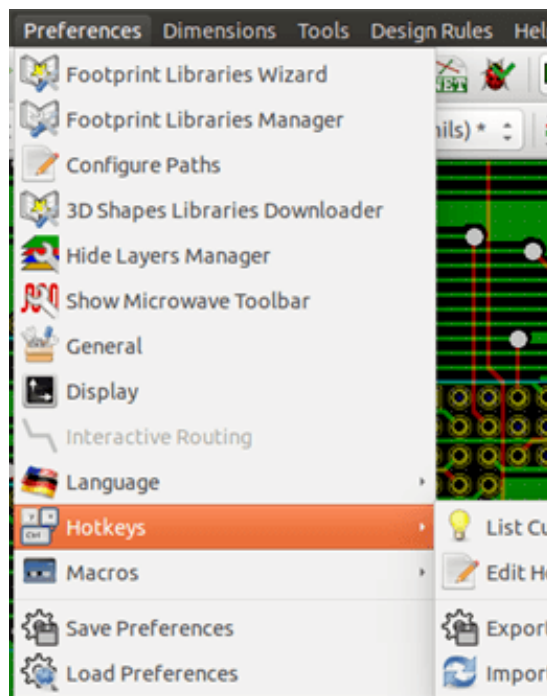


3.9.5 Route menu

Routing function.



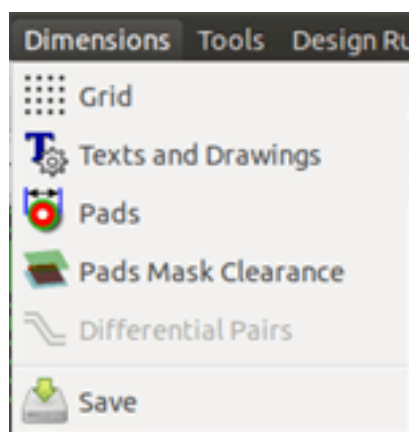
3.9.6 Il menu delle preferenze



Allows:

- Selection of the footprint libraries.
- Hide/Show the Layers manager (colors selection for displaying layers and other elements. Also enables the display of elements to be turned on and off).
- Management of general options (units, etc.).
- The management of other display options.
- Creation, editing (and re-read) of the hot keys file.

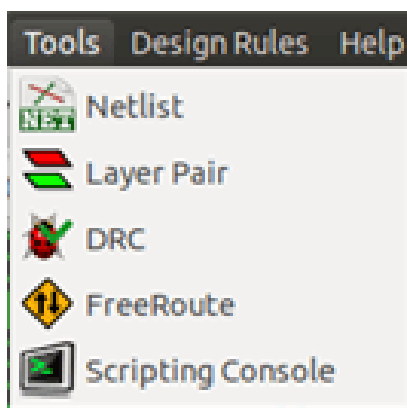
3.9.7 Menu dimensioni



An important menu. Allows adjustment of:

- User grid size.
- Size of texts and the line width for drawings.
- Dimensions and characteristic of pads.
- Setting the global values for solder mask and solder paste layers

3.9.8 Tools menu



3.9.9 The Design Rules menu



Provides access to 2 dialogs:

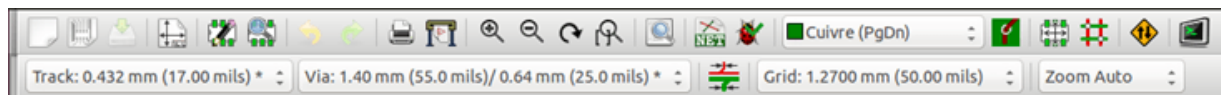
- Impostazione regole di progettazione (dimensioni piste e via, isolamenti).
- Setting Layers (number, enabled and layers names)



3.9.10 Il menu di aiuto

Provides access to the user manuals and to the version information menu (Pcbnew About).




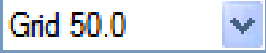
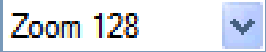
3.10 Uso delle icone nella barra in cima

This toolbar gives access to the principal functions of Pcbnew.

































	Creation of a new printed circuit.
	Opening of an old printed circuit.
	Save printed circuit.
	Selection of the page size and modification of the file properties.
	Opens Footprint Editor to edit library or pcb footprint.
	Opens Footprint Viewer to display library or pcb footprint.
	Undo/Redo last commands (10 levels)
	Display print menu.
	Display plot menu.
	Zoom in and Zoom out (relative to the centre of screen).
	Redraw the screen
	Fit to page
	Find footprint or text.
	Netlist operations (selection, reading, testing and compiling).
	DRC (Design Rule Check): Automatic check of the tracks.
 Soudure (PgDn) ▾	Selection of the working layer.
	Selection of layer pair (for vias)
	Footprint mode: when active this enables footprint options in the pop-up window.
	Routing mode: when active this enables routing options in the pop-up window
	Direct access to the router Freerouter
	Show / Hide the Python scripting console

3.10.1 Auxiliary toolbar

	Selection of thickness of track already in use.
	Selection of a dimension of via already in use.
	Automatic track width: if enabled when creating a new track, when starting on an existing track, the width of the new track is set to the width of the existing track.
	Selection of the grid size.
	Selection of the zoom.

3.11 Right-hand side toolbar

This toolbar gives access to the editing tool to change the PCB shown in Pcbnew.

		Select the standard mouse mode.
		Highlight net selected by clicking on a track or pad.
		Display local ratsnest (Pad or Footprint).
		Add a footprint from a library.
		Placement of tracks and vias.
		Placement of zones (copper planes).
		Placement of keepout areas (on copper layers).
		Draw Lines on technical layers (i.e. not a copper layer).
		Draw Circles on technical layers (i.e. not a copper layer).
		Draw Arcs on technical layers (i.e. not a copper layer).
		Placement of text.
		Draw Dimensions on technical layers (i.e. not the copper layer).
		Draw Alignment Marks (appearing on all layers).
		Delete element pointed to by the cursor Note: When Deleting, if several superimposed elements are pointed to, priority is given to the smallest (in the decreasing set of priorities tracks, text, footprint). The function Undelete of the upper toolbar allows the cancellation of the last item deleted.
		Offset adjust for drilling and place files.






Grid origin. (grid offset). Useful mainly for editing and placement of footprints. Can also be set in Dimensions/Grid menu.

- Placement of footprints, tracks, zones of copper, texts, etc.
- Net Highlighting.
- Creating notes, graphic elements, etc.
- Deleting elements.

3.12 Left-hand side toolbar

The left hand-side toolbar provides display and control options that affect Pcbnew's interface.

		Turns DRC (Design Rule Checking) on/off. Caution: when DRC is off incorrect connections can be made.
		Turn grid display on/off Note: a small grid may not be displayed unless zoomed in far enough
		Polar display of the relative co-ordinates on the status bar on/off.
		Display/entry of coordinates or dimensions in inches or millimeters.
		Change cursor display shape.
		Display general rats nest (incomplete connections between footprints).
		Display footprint rats nest dynamically as it is moved.
		Enable/Disable automatic deletion of a track when it is redrawn.
		Show filled areas in zones
		Do not show filled areas in zones
		Show only outlines of filled areas in zones
		Display of pads in outline mode on/off.
		Display of vias in outline mode on/off.
		Display of tracks in outline mode on/off.

	High contrast display mode on/off. In this mode the active layer is displayed normally, all the other layers are displayed in gray. Useful for working on multi-layer circuits.
	Hide/Show the Layers manager
	Access to microwaves tools. Under development

3.13 Pop-up windows and fast editing

A right-click of the mouse opens a pop-up window. Its contents depends on the element pointed at by the cursor.





This gives immediate access to:

- Changing the display (centre display on cursor, zoom in or out or selecting the zoom).
- Setting the grid size.
- Additionally a right-click on an element enables editing of the most commonly modified element parameters.

The screenshots below show what the pop-up windows looks like.

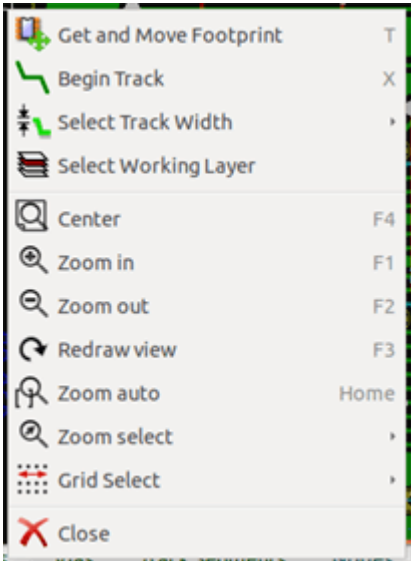
3.14 Available modes

There are 3 modes when using pop-up menus. In the pop-up menus, these modes add or remove some specific commands.

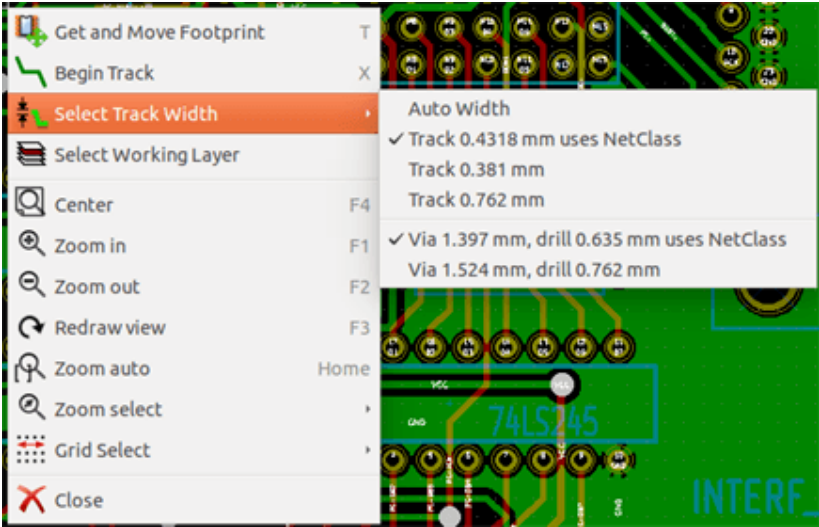
 and  disabled	Normal mode
 enabled	Footprint mode
 enabled	Tracks mode

3.14.1 Normal mode

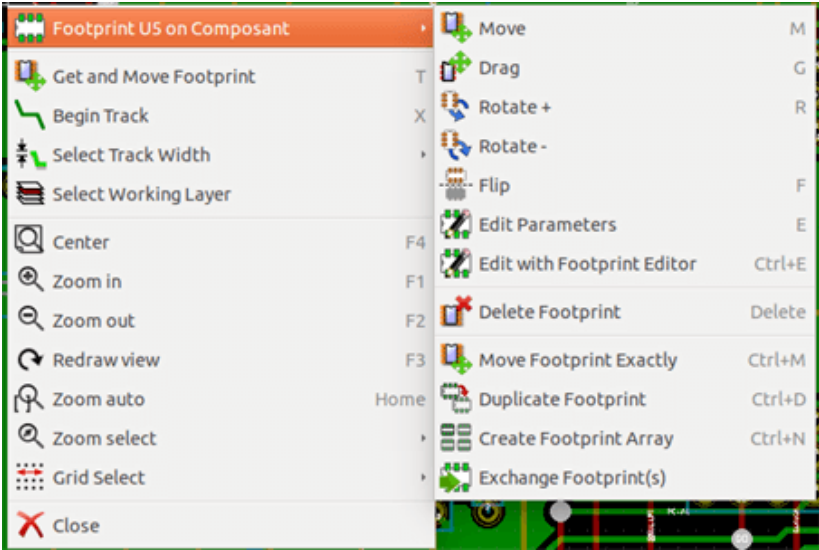
- Pop-up menu with no selection:



- Pop-up menu with track selected:



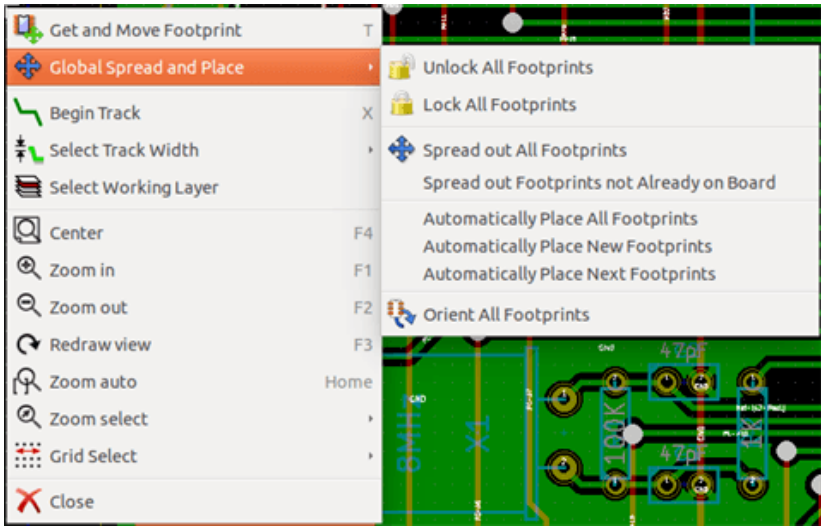
- Pop-up menu with footprint selected:



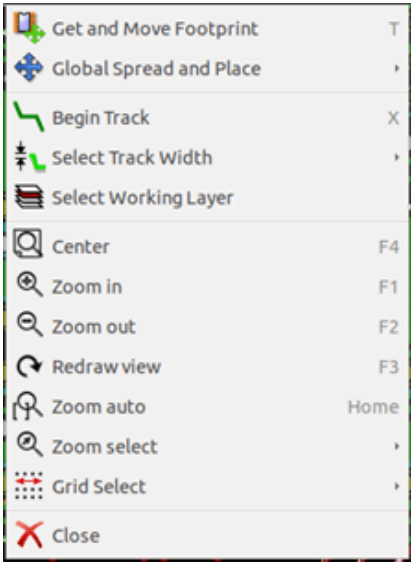
3.14.2 Footprint mode

Same cases in Footprint Mode ( enabled)

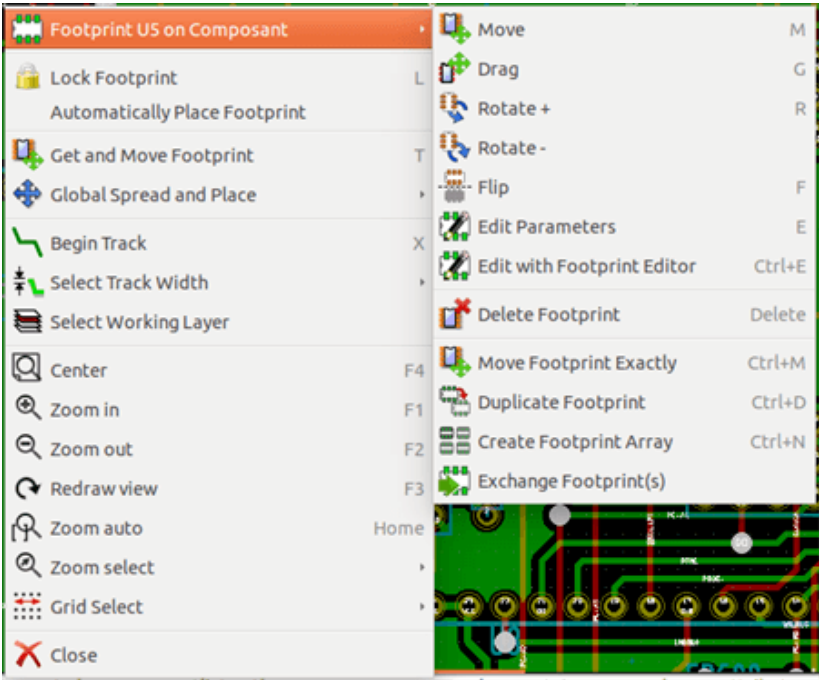
- Pop-up menu with no selection:



- Pop-up menu with track selected:



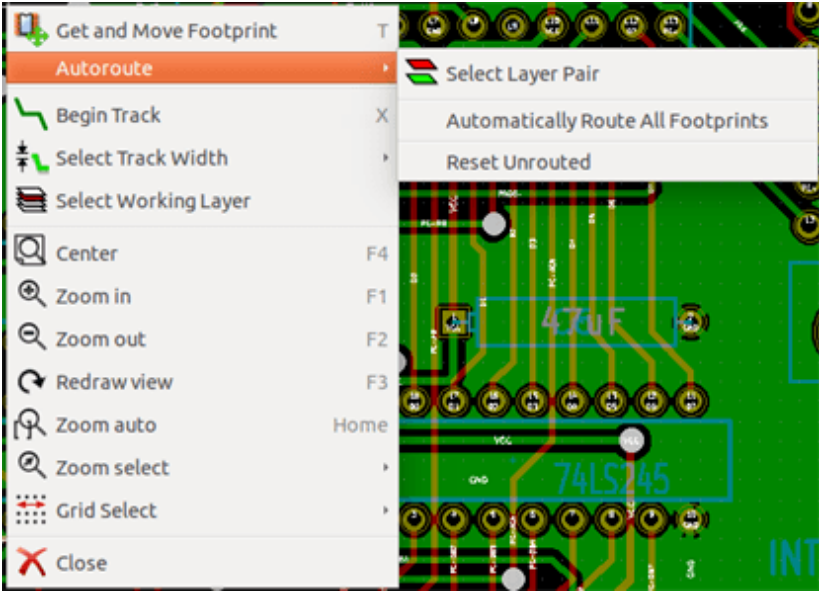
- Pop-up menu with footprint selected:



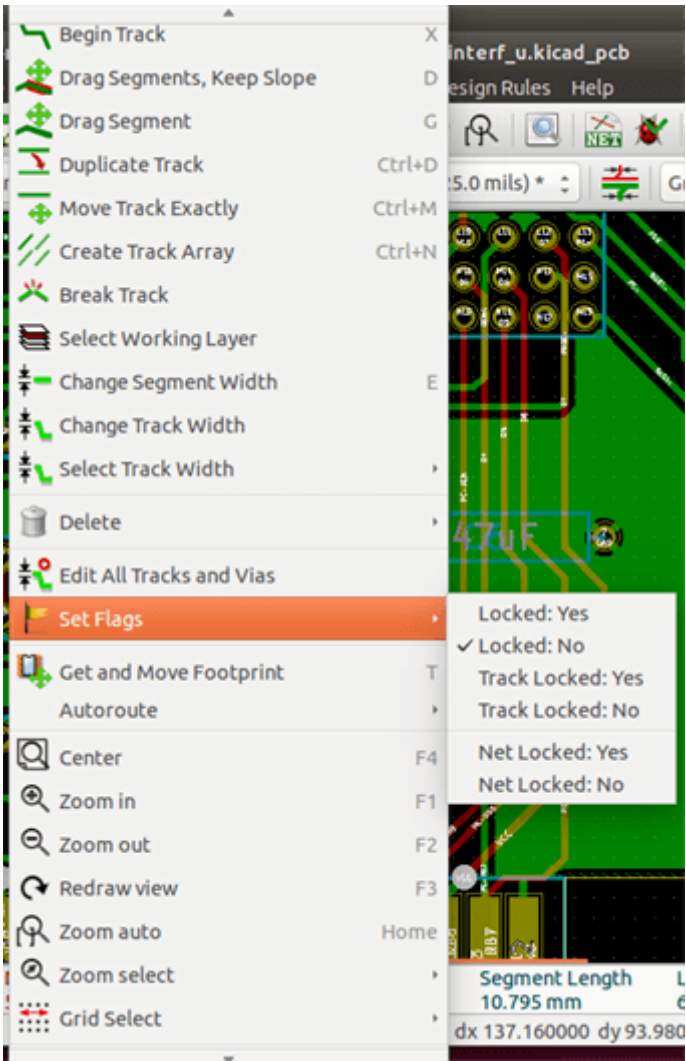
3.14.3 Tracks mode

Same cases in Track Mode ( enabled)

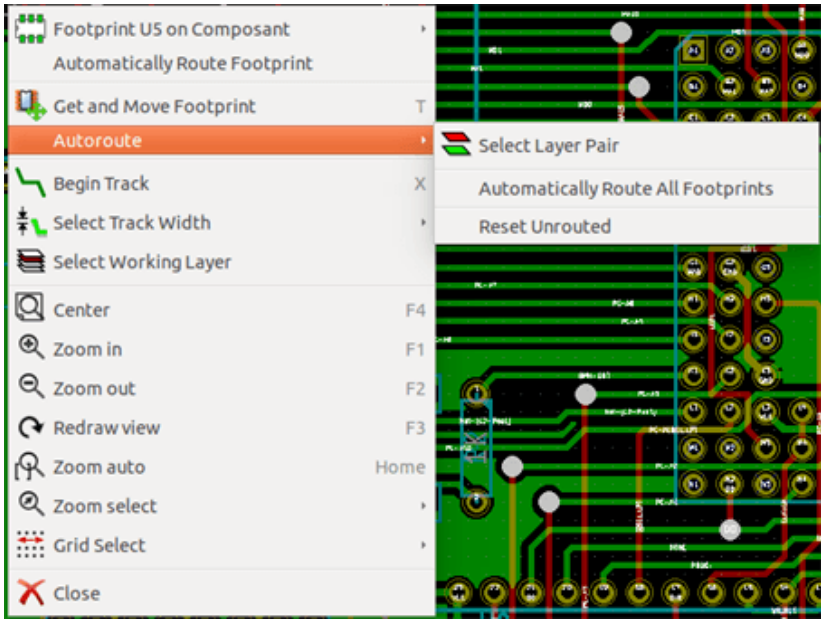
- Pop-up menu with no selection:



- Pop-up menu with track selected:



- Pop-up menu with footprint selected:



Capitolo 4

Schematic Implementation

4.1 Linking a schematic to a printed circuit board

Generally speaking, a schematic sheet is linked to its printed circuit board by means of the netlist file, which is normally generated by the schematic editor used to make the schematic. Pcbnew accepts netlist files made with Eeschema or Orcad PCB 2. The netlist file, generated from the schematic is usually missing the footprints that correspond to the various components. Consequently an intermediate stage is necessary. During this intermediate process the association of components with footprints is performed. In KiCad, CvPcb is used to create this association and a file named *.cmp is produced. CvPcb also updates the netlist file using this information.

CvPcb can also output a stuff file *.stf which can be back annotated into the schematic file as the F2 field for each component, saving the task of re-assigning footprints in each schematic edit pass. In Eeschema copying a component will also copy the footprint assignment and set the reference designator as unassigned for later auto-incremental annotation.

Pcbnew reads the modified netlist file .net and, if it exists, the .cmp file. In the event of a footprint being changed directly in Pcbnew the .cmp file is automatically updated avoiding the requirement to run CvPcb again.

Refer to the figure of Getting Started in KiCad manual in the section *KiCad Workflow* that illustrates the work-flow of KiCad and how intermediate files are obtained and used by the different software tools that comprise KiCad.

4.2 Procedure for creating a printed circuit board

After having created your schematic in Eeschema:

- Generate the netlist using Eeschema.
- Assign each component in your netlist file to the corresponding footprint (often called footprint) used on the printed circuit using Cvpcb.
- Launch Pcbnew and read the modified Netlist. This will also read the file with the footprint selections.

Pcbnew will then load automatically all the necessary footprints. Footprints can now be placed manually or automatically on the board and tracks can be routed.

4.3 Procedure for updating a printed circuit board


If the schematic is modified (after a printed circuit board has been generated), the following steps must be repeated:

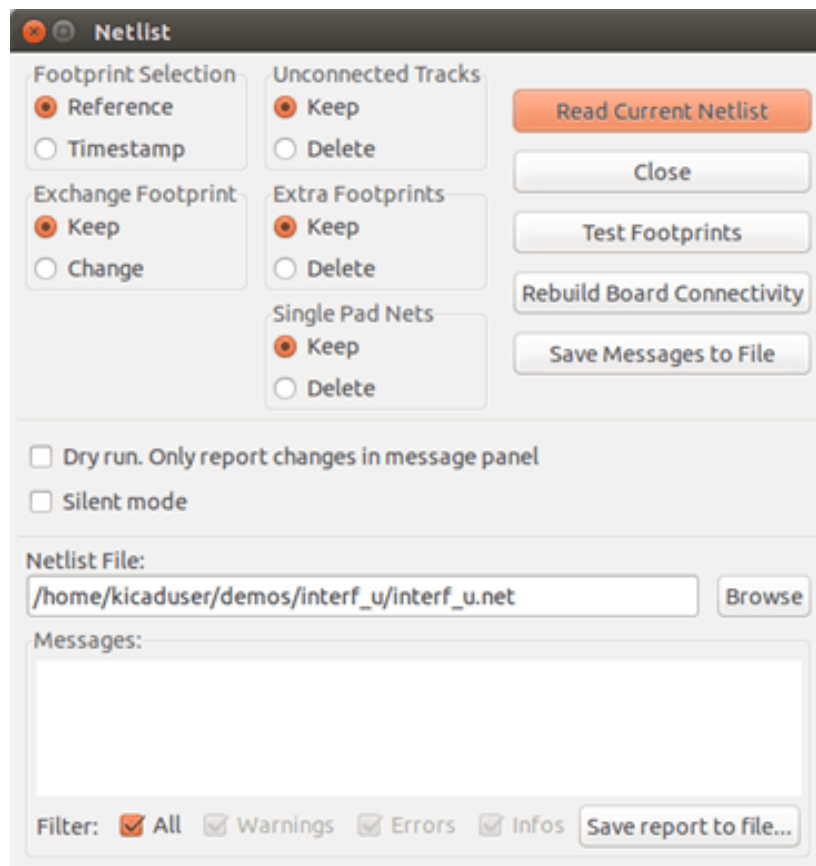
- Generate a new netlist file using Eeschema.
- If the changes to the schematic involve new components, the corresponding footprints must be assigned using Cypcb.
- Launch Pcbnew and re-read the modified netlist (this will also re-read the file with the footprint selections).

Pcbnew will then load automatically any new footprints, add the new connections and remove redundant connections. This process is called forward annotation and is a very common procedure when a PCB is made and updated.

4.4 Reading netlist file - loading footprints

4.4.1 Dialog box

Accessible from the icon 

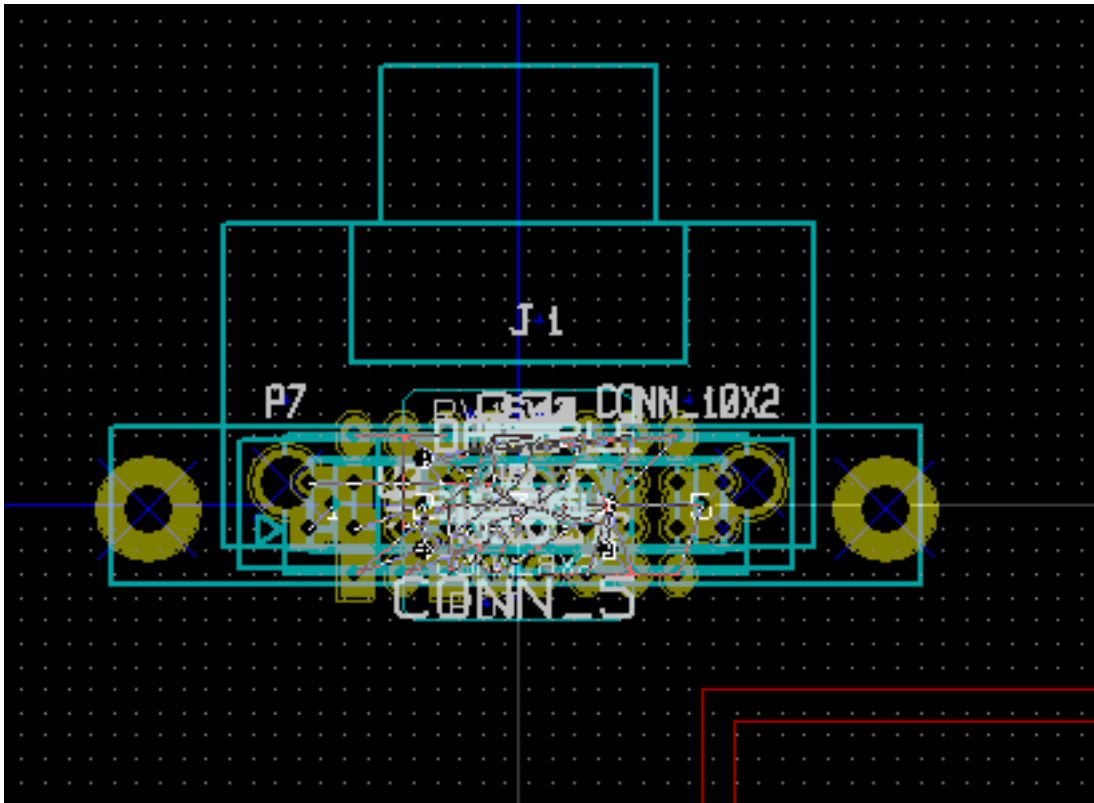


4.4.2 Available options


Footprint Selection	Components and corresponding footprints on board link: normal link is Reference (normal option Timestamp can be used after reannotation of schematic, if the previous annotation was destroyed (special option)
Exchange Footprint:	If a footprint has changed in the netlist: keep old footprint or change to the new one.
Unconnected Tracks	Keep all existing tracks, or delete erroneous tracks
Extra Footprints	Remove footprints which are on board but not in the netlist. Footprint with attribute Locked will not be removed.
Single Pad Nets	Remove single pad nets.

4.4.3 Loading new footprints

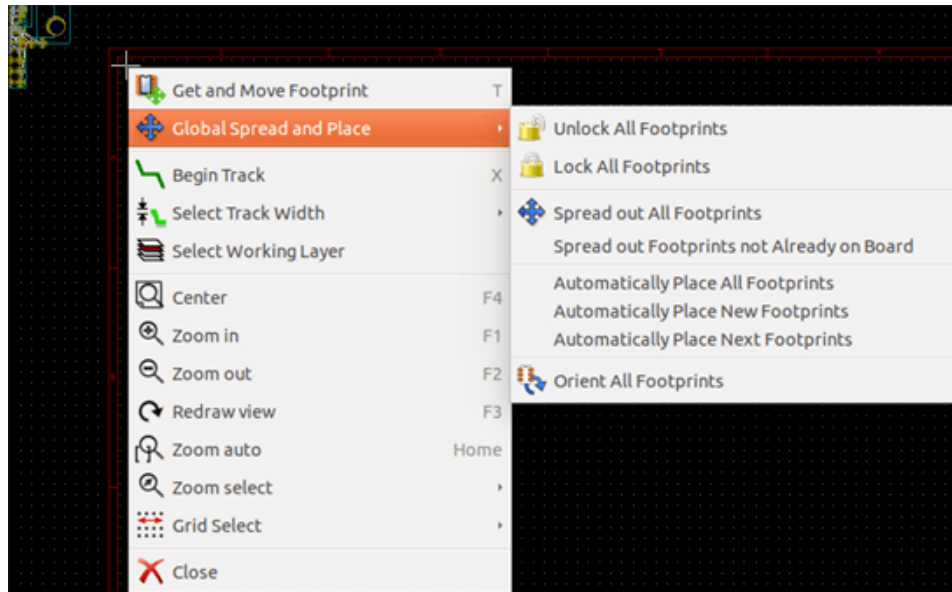
When new footprints are found in the netlist file, they will be automatically loaded and placed at coordinate (0,0).



New footprints can be moved and arranged one by one. A better way is to automatically move (unstack) them:

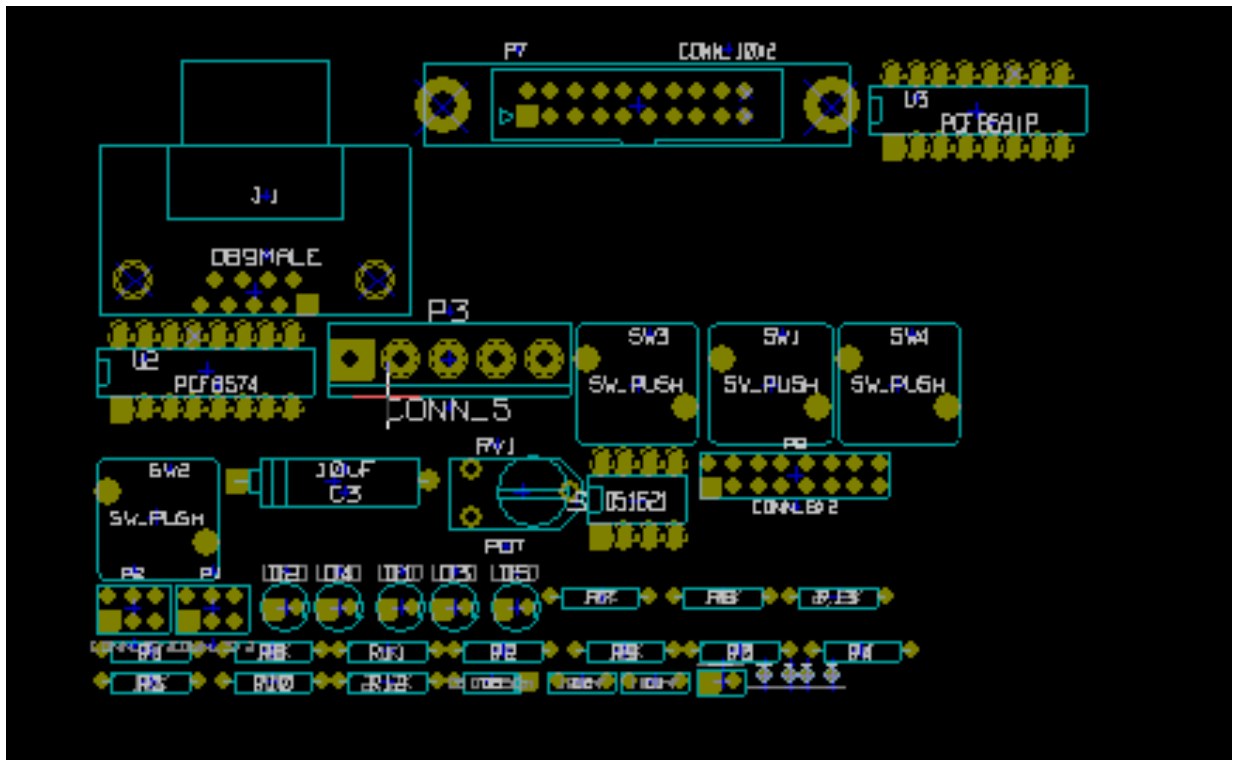
Activate footprint mode ()

Move the mouse cursor to a suitable (free of component) area, and click on the right button:



- Automatically Place New Footprints, if there is already a board with existing footprints.
- Automatically Place All Footprints, for the first time (when creating a board).

The following screenshot shows the results.



Capitolo 5

Impostazione degli strati di lavoro

Pcbnew può lavorare con 50 strati diversi:

- 32 strati rame (o per lo sbroglio piste).
- 14 strati tecnici (incluso 1 strato di bordi scheda).
- 4 strati ausiliari.

Il numero di strati rame e, se necessario, i loro nomi ed attributi dovrebbe essere impostato. Gli strati tecnici non usati possono essere disabilitati.

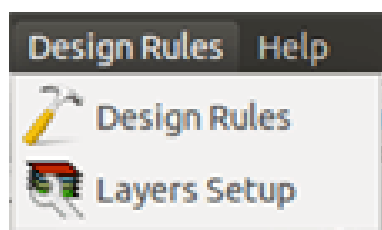
5.1 Selezione degli strati rame

5.1.1 Introduzione

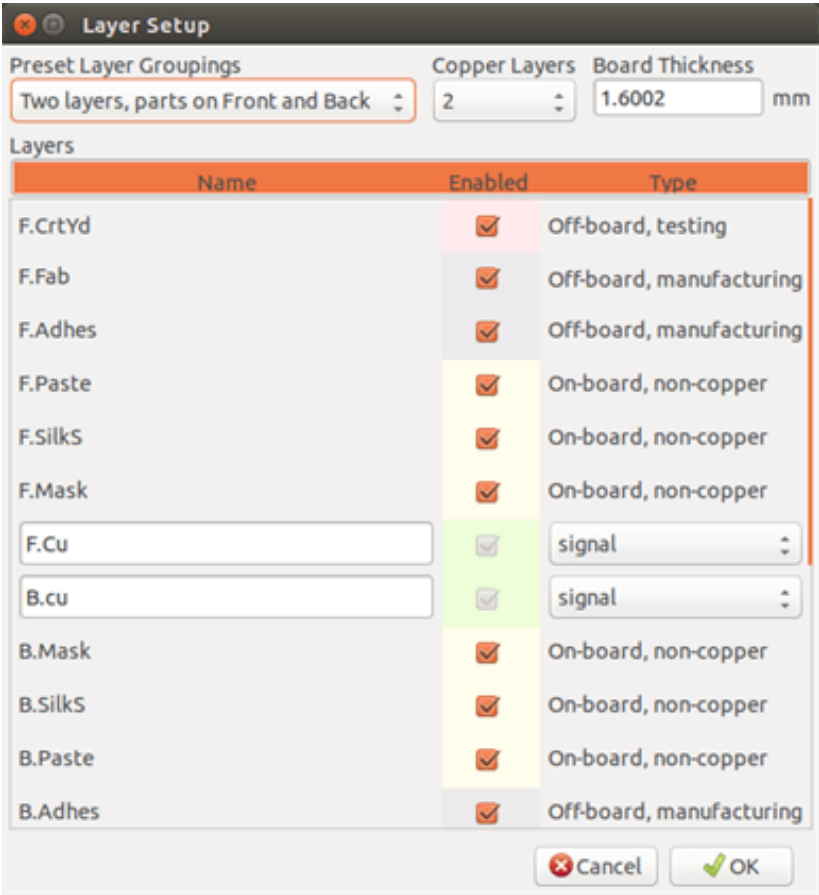
Copper layers are the usual working layers used by the automatic router to place and re-arrange tracks. Layer 0 is the copper (solder) layer. Layer 31 is the component layer. Other layers are the inner layers, from In1 to In30.

5.1.2 Selezione numero strati

To enable navigation between layers, it is necessary to select the number of working layers. To do this you can use the menu bar and select Design Rules → Layers Setup.

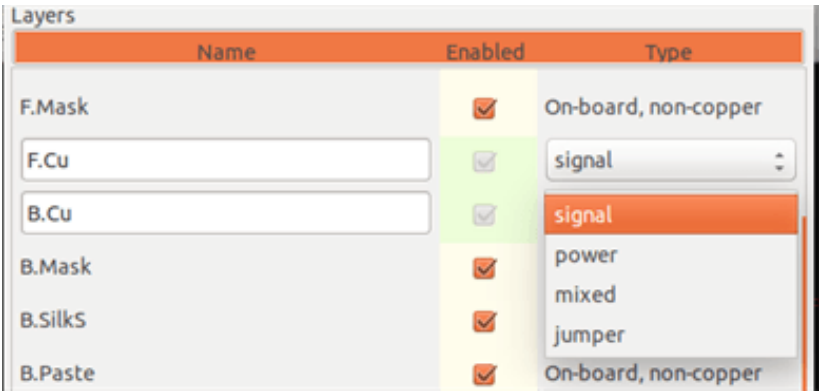


Then select the number of layers wanted, from 2 to 32.



5.1.3 Copper layers

The name of any copper layer is editable. Copper layers have attributes useful when using the external router *Freerouter*.



5.2 Auxiliary technical layers

Some are associated in pairs, others not. When they appear as a pair this affects the behaviour of footprints. The elements making up a footprint (pads, drawing and text) appearing on a layer (solder or component), appear on the other complementary layer when the footprint is inverted (mirrored).

The technical layers are:

5.2.1 Paired layers

- The **Adhesives** layers (Copper and Component):
 - These are used in the application of adhesive to stick SMD components to the circuit board, generally before wave soldering.
- The **Solder Paste** layers paste SMD (Copper and Component):
 - Used to produce a mask to allow solder paste to be placed on the pads of surface mount components, generally before reflow soldering. Usually only surface mount pads occupy these layers.
- The **Silk Screen** layers (Copper and Component):
 - They are the layers where the drawings of the components appear.
- The **Solder Mask** layers (Copper and Component):
 - These define the solder masks. Normally all pads appear on one or the other of these layers (or both for through pads) to prevent the varnish covering the pads.

5.2.2 Layers for general use

- Comments
- E.C.O. 1
- E.C.O. 2
- Drawings

These layers are for any use. They can be used for text such as instructions for assembly or wiring, or construction drawings, to be used to create a file for assembly or machining.

5.2.3 Special layer

- **Edge Cuts** layer:
 - This layer is reserved for the drawing of circuit board outline. Any element (graphic, texts...) placed on this layer appears on all the other layers. Use this layer only to draw board outlines.

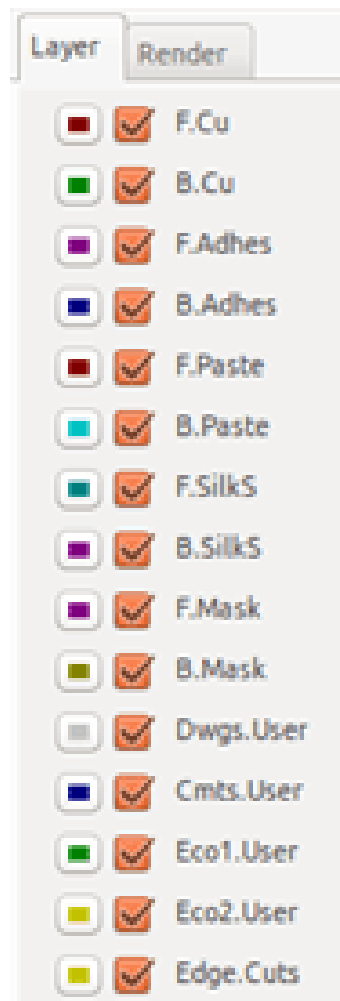
5.3 Selection of the active layer

The selection of the active working layer can be done in several ways:

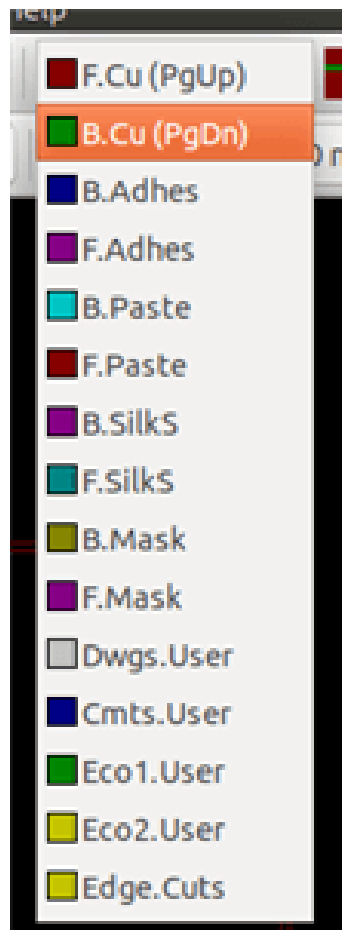
- Using the right toolbar (Layer manager).
 - Using the upper toolbar.
-

- With the pop-up window (activated with the right mouse button).
- Using the + and - keys (works on copper layers only).
- By hot keys.

5.3.1 Selection using the layer manager



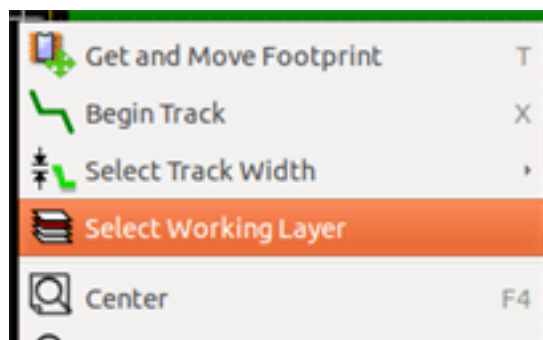
5.3.2 Selection using the upper toolbar



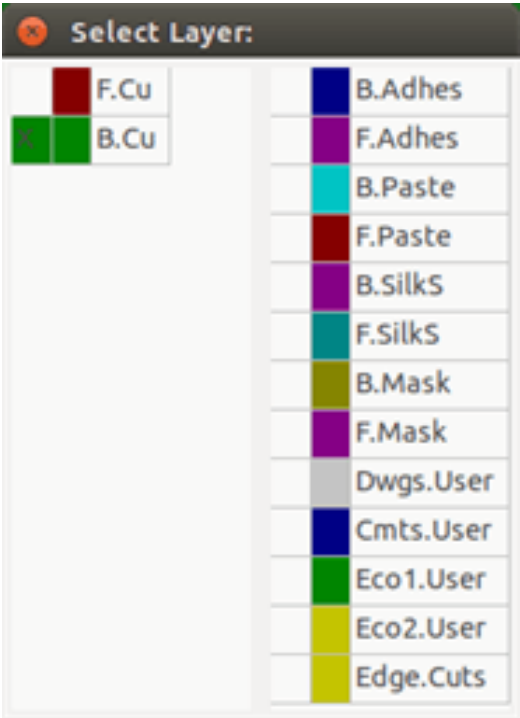
This directly selects the working layer.

Hot keys to select the working layer are displayed.

5.3.3 Selection using the pop-up window

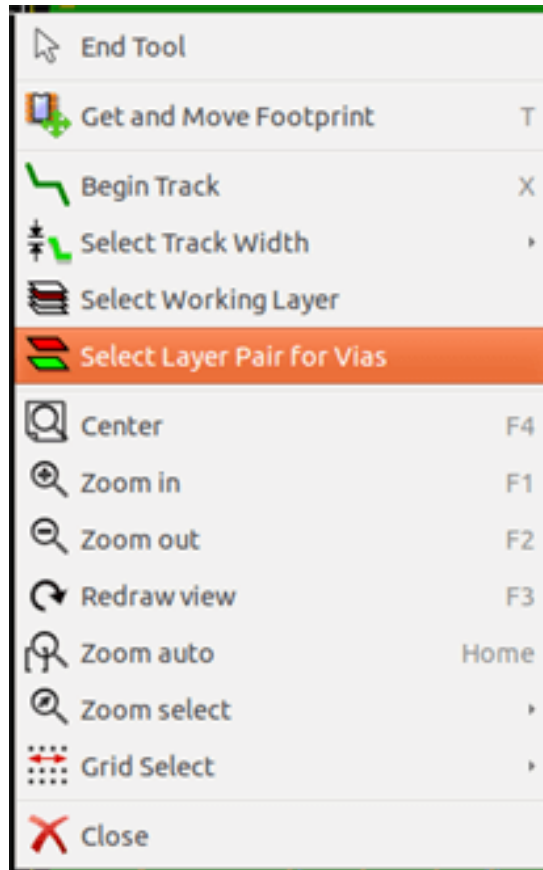


The Pop-up window opens a menu window which provides a choice for the working layer.

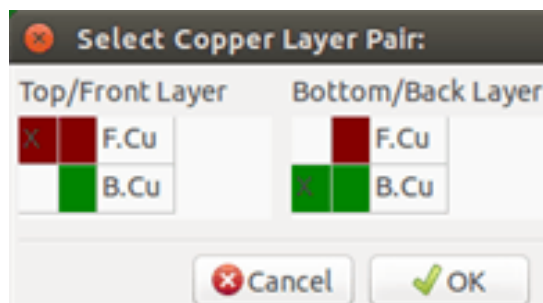


5.4 Selection of the Layers for Vias

If the **Add Tracks and Vias** icon is selected on the right hand toolbar, the Pop-Up window provides the option to change the layer pair used for vias:




This selection opens a menu window which provides choice of the layers used for vias.



When a via is placed the working (active) layer is automatically switched to the alternate layer of the layer pair used for the vias.

One can also switch to an other active layer by hot keys, and if a track is in progress, a via will be inserted.

5.5 Using the high-contrast mode

This mode is entered when the tool (in the left toolbar) is activated: 

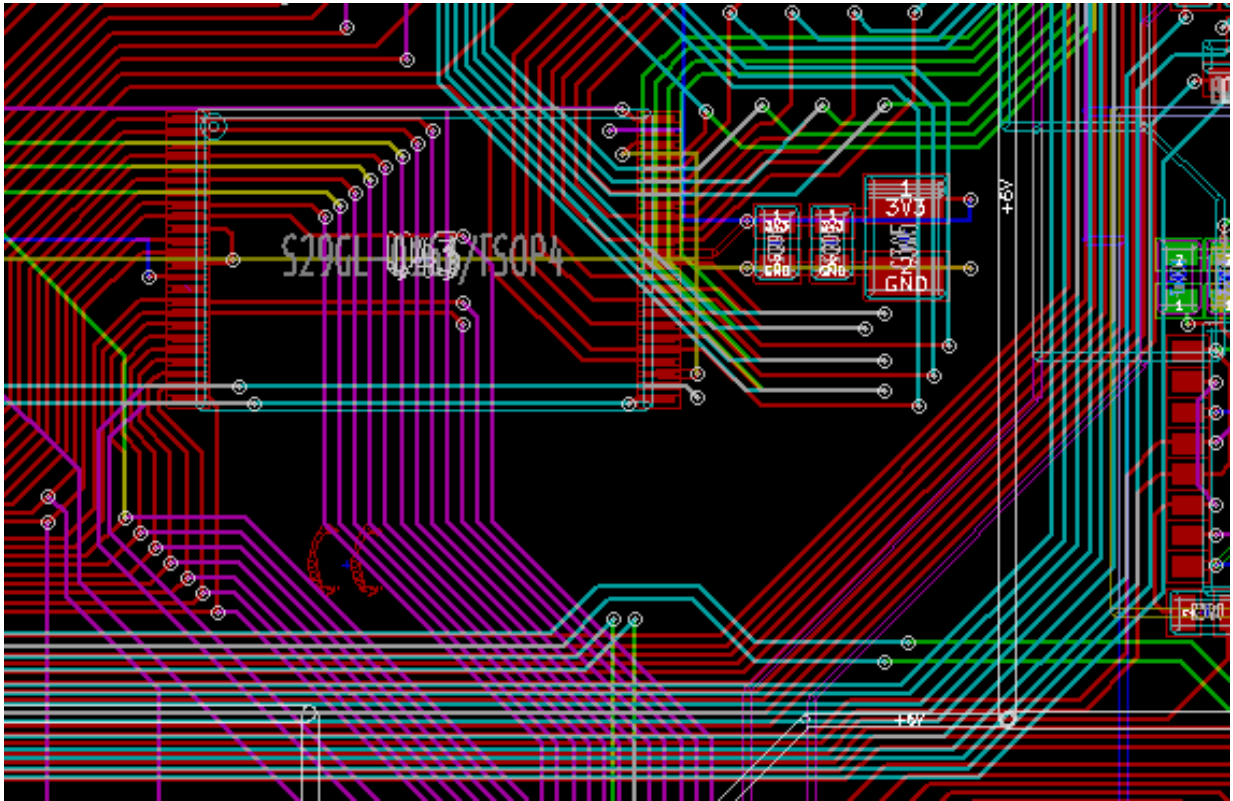
When using this mode, the active layer is displayed like in the normal mode, but all others layers are displayed in gray color.

There are two useful cases:

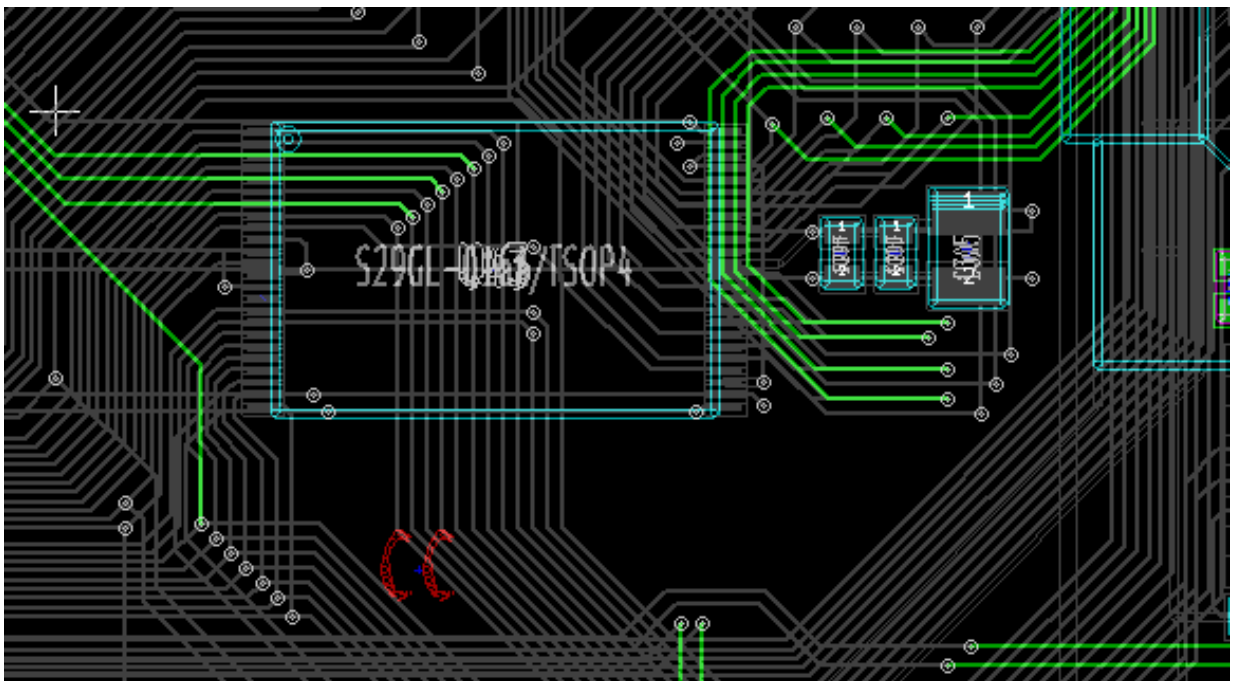
5.5.1 Copper layers in high-contrast mode

When a board uses more than four layers, this option allows the active copper layer to be seen more easily:

Normal mode (back side copper layer active):



High-contrast mode (back side copper layer active):

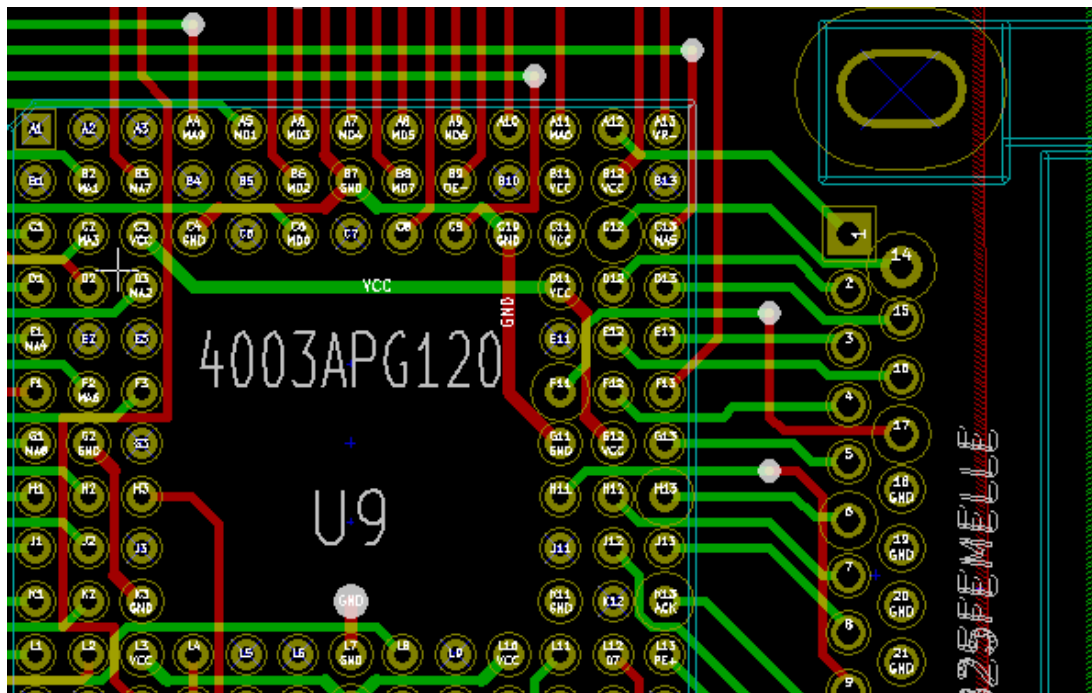


5.5.2 Technical layers

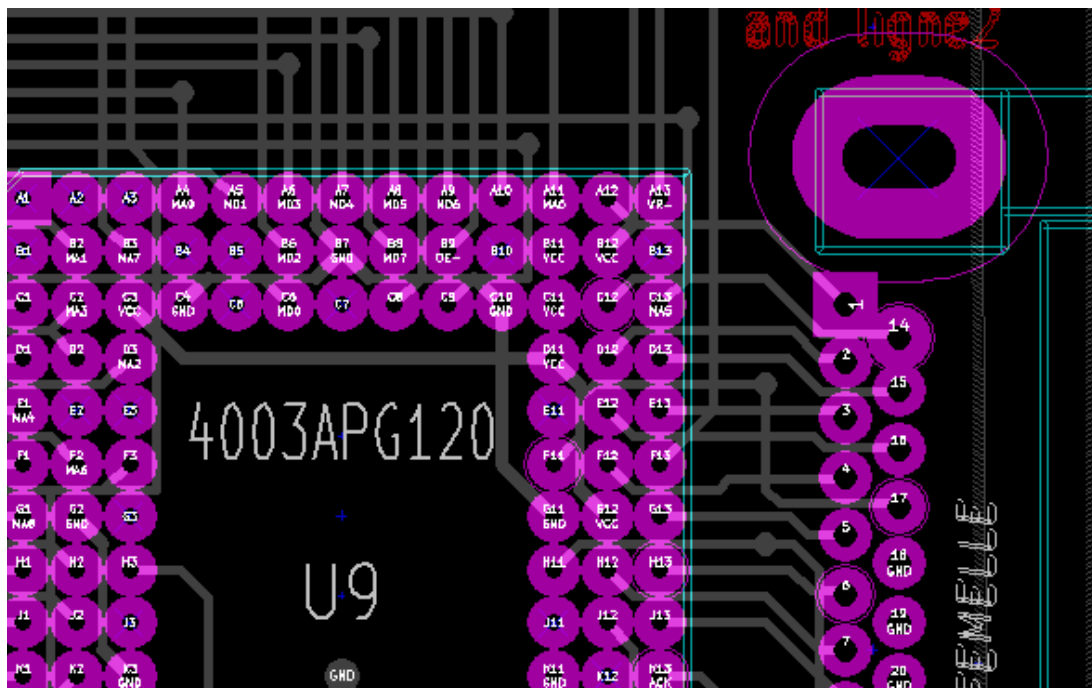
The other case is when it is necessary to examine solder paste layers and solder mask layers which are usually not displayed.

Masks on pads are displayed if this mode is active.

Normal mode (front side solder mask layer active):



High-contrast mode (front side solder mask layer active):



Capitolo 6

Crea e modifica una scheda

6.1 Creazione di una scheda

6.1.1 Disegno dei contorni della scheda

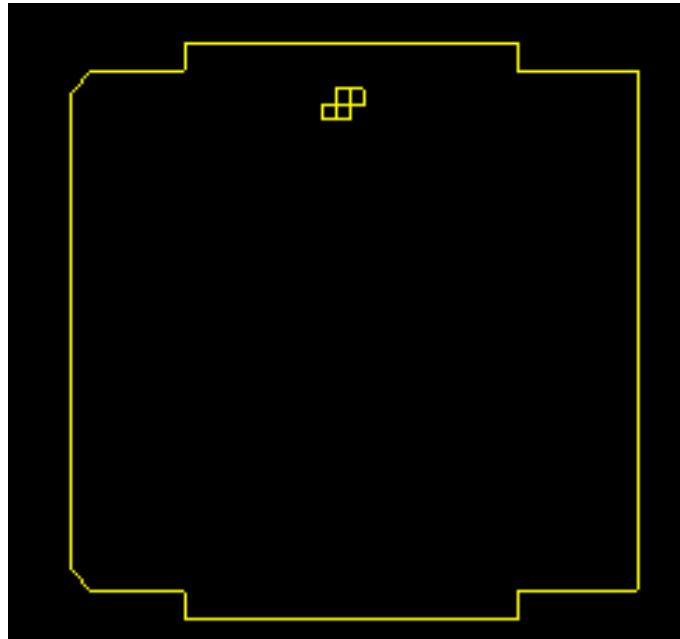
Solitamente è considerata una buona idea definire per prima cosa i bordi della scheda. I bordi si disegnano con una sequenza di segmenti di linea. Selezionare *Edge.Cuts* come strato attivo e usare lo strumento “Aggiungi linea o poligono grafico” per tracciare il bordo, facendo clic alla posizione di ogni vertice e facendo doppio clic per finire. Le schede di solito hanno dimensioni molto precise, perciò potrebbe essere necessario usare le coordinate mostrate del puntatore durante la tracciatura del contorno. Tenere a mente che le coordinate relative possono essere azzerate in qualsiasi momento usando la barra spaziatrice, e che le unità di misura mostrate possono essere abilitate/disabilitate usando la combinazione “Ctrl-U”. Le coordinate relative consentono disegni di dimensioni molto precise. È possibile disegnare un contorno circolare (o arcuato):

1. Selezionare lo strumento “Aggiungi cerchio grafico” o “Aggiungi arco grafico”
2. Fare clic per fissare il centro del cerchio
3. Regolare il raggio muovendo il mouse
4. Terminare facendo nuovamente clic.

Nota

La larghezza del bordo può essere regolata, nel menu Parametri (larghezza raccomandata = 150 in decimi di mils) o attraverso le Opzioni, ma questa non sarà visibile a meno che la grafica non sia mostrata in una modalità diversa da contorni.

Il bordo risultante dovrebbe somigliare a questo:



6.1.2 Uso di disegno DXF per il contorno scheda

In alternativa a disegnare il contorno scheda direttamente in Pcbnew, questo può essere importato da un disegno DXF.

Usando questa funzione si possono creare forme di schede più complesse di quelle che si otterrebbe sfruttando solamente le capacità di disegno interne di Pcbnew.

Per esempio un pacchetto CAD meccanico può essere usato per definire la forma della scheda giusta per un contenitore particolare.

6.1.2.1 Preparazione di un disegno DXF per contorno scheda

Le capacità di importazione **DXF** di KiCad non includono il supporto a caratteristiche DXF come **POLYLINE** e **ELLISSI** e i file DXF che usano queste caratteristiche richiedono alcuni passi aggiuntivi di conversione per prepararli all' importazione.

Per questa conversione si può usare un pacchetto software come LibreCAD.

Come primo passo, tutte le **POLILINEE** devono essere divise (esplose) nelle loro originali forme più semplici. In LibreCAD usare i passi seguenti:

1. Aprire una copia del file DXF.
2. Selezionare la forma della scheda (le forme selezionate sono mostrate con linee tratteggiate).
3. Nel menu **Modifica**, selezionare **Esplodi**.
4. Premere INVIO.

Come prossimo passo, curve complesse come le **ELLISSI** vanno spezzate in segmenti di linea più piccoli che *approssimano* la forma desiderata. Questo accade automaticamente quando il file DXF viene esportato o salvato nel vecchio formato file **DXF R12** (dato che il formato R12 non supporta forme dalle curve complesse, le applicazioni CAD

convertono queste forme in segmenti di linea. Alcune applicazioni CAD permettono la configurazione del numero o della lunghezza dei segmenti di linea usati). In LibreCAD la lunghezza dei segmenti è generalmente abbastanza piccola da poter essere usata per le forme dei circuiti stampati.

In LibreCAD, usare i passi seguenti per esportare nel formato file **DXF R12**:

1. Nel menu **File**, usare **Salva con nome...**
2. Nella finestra di dialogo **Salva disegno come**, c'è un selettore **Salva come:** in fondo a destra della finestra di dialogo. Selezionare l'opzione **Drawing Exchange DXF R12**.
3. Opzionalmente inserire un nome file nel campo **Nome file:**.
4. Fare clic su **Salva**

Il file DXF è ora pronto per l'importazione in KiCad.

6.1.2.2 Importare il file DXF in KiCad

I passi seguenti descrivono l'importazione del file DXF preparato come forma di circuito stampato in KiCad. Si noti che il comportamento di importazione è leggermente differente a seconda della modalità *schermo* usata.

Uso nella modalità schermo "predefinita" :

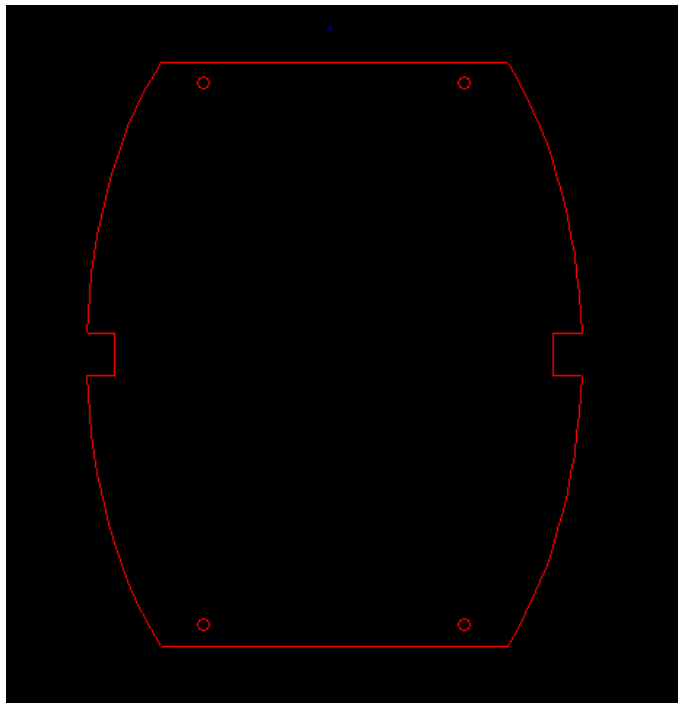
1. Nel menu **File**, selezionare **Importa** e poi l'opzione **File DXF**.
2. Nella finestra di dialogo **Importa file DXF** usare *Esplora* per selezionare il file DXF preparato per essere importato.
3. Nell'opzione *Posiziona punto origine DXF (0,0):*, impostare il punto dell'origine DXF relativa alle coordinate della scheda (la scheda KiCad ha (0,0) nell'angolo in alto a sinistra). Per *Posizione personalizzata* inserire le coordinate nei campi *Posizione X:* e *Posizione Y:*.
4. Nella selezione *Strati*, selezionare lo strato della scheda da importare. Per i contorni scheda serve **Edge.Cuts**.
5. Fare clic su *OK*.

Uso nelle modalità schermo "OpenGL" o "Cairo" :

1. Nel menu **File**, selezionare **Importa** e poi l'opzione **File DXF**.
 2. Nella finestra di dialogo **Importa file DXF** usare *Esplora* per selezionare il file DXF preparato per essere importato.
 3. L'impostazione dell'opzione *Posiziona punto origine DXF (0,0):* viene ignorata in questa modalità.
 4. Nella selezione *Strati*, selezionare lo strato della scheda da importare. Per i contorni scheda serve **Edge.Cuts**.
 5. Fare clic su *OK*.
 6. La forma è ora attaccata al proprio cursore e può essere spostata sull'area della scheda.
 7. Fare clic per *depositare* la forma sulla scheda.
-

6.1.2.3 Esempio di forma DXF importata

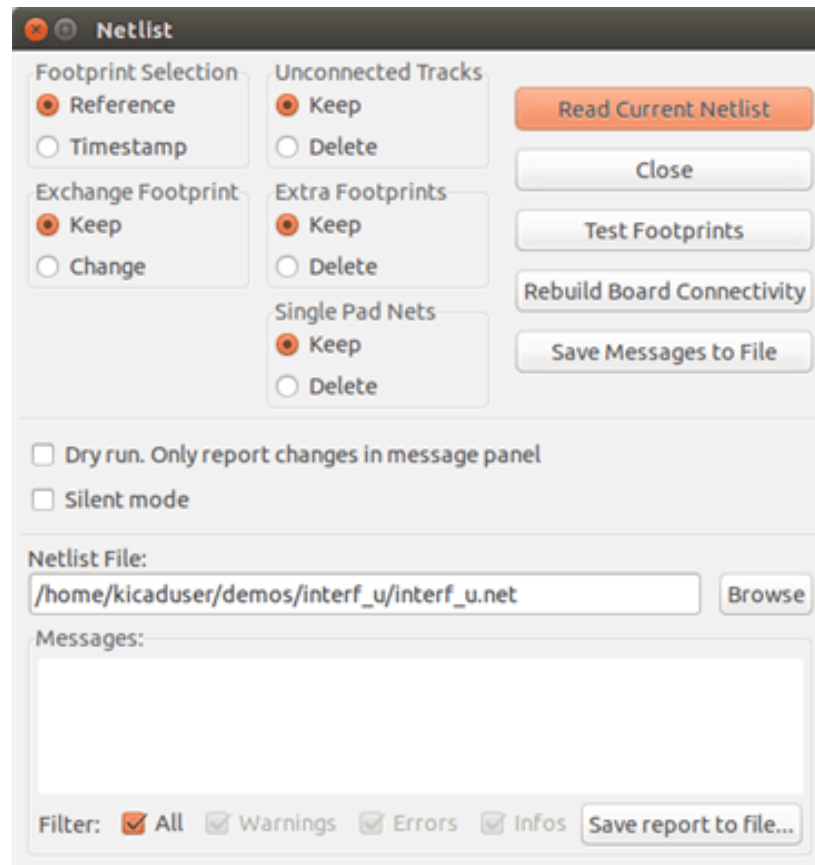
Ecco un esempio di importazione DXF con una scheda che ha diversi segmenti ellittici approssimati da una serie di corti segmenti di linea:



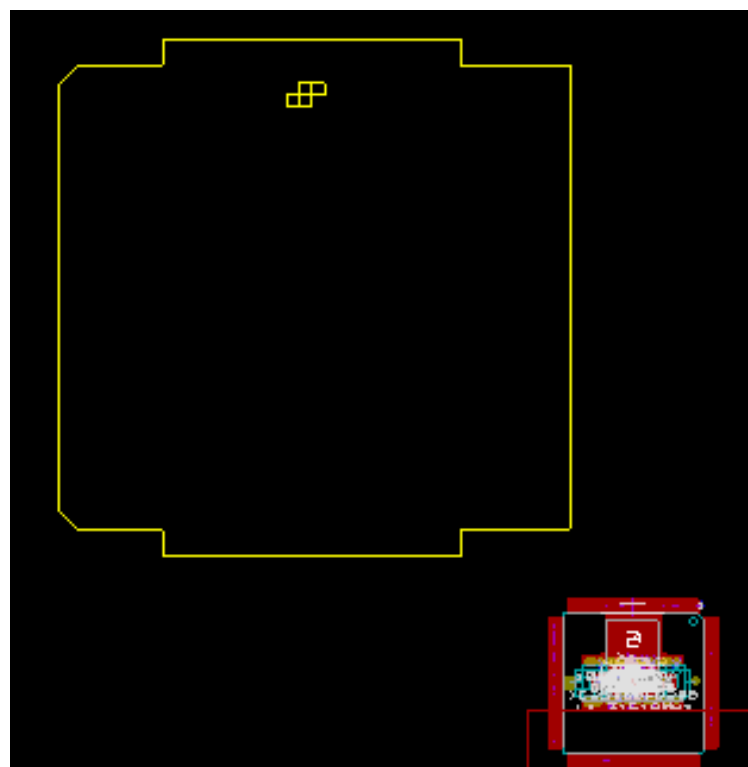
6.1.3 Lettura della netlist generata dallo schema elettrico



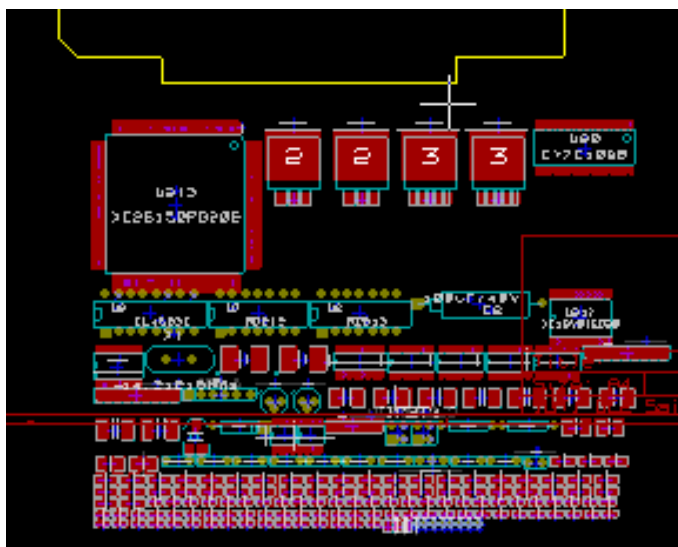
Attivare l' icona  per mostrare la finestra di dialogo della netlist:



Se il nome (percorso) della netlist nel titolo della finestra è sbagliato, usare il pulsante *Seleziona* per sfogliare e selezionare la netlist desiderata. Poi *Leggere* la netlist. Ogni modulo non ancora caricato apparirà, sovrapposto uno sull' altro (vedremo poi come spostarli automaticamente).



Se nessuna delle impronte è stata piazzata, tutte le impronte appariranno sulla scheda nello stesso punto, rendendole difficili da riconoscere. È possibile disporle automaticamente (usando il comando *Disposizione globale* tramite il pulsante destro del mouse). Ecco il risultato di tale riorganizzazione:



Nota

Se una scheda viene modificata sostituendo un' impronta esistente con una nuova (per esempio cambiando una resistenza da 1/8W con una da 1/2W) in CvPcb, sarà necessario cancellare il componente esistente prima che Pcbnew carichi l' impronta di rimpiazzo. Comunque, se un' impronta deve essere sostituita da una esistente, è più facile usare la finestra di dialogo impronte, accessibile tramite clic sul tasto destro del mouse sopra l' impronta in questione.

6.2 Correggere una scheda

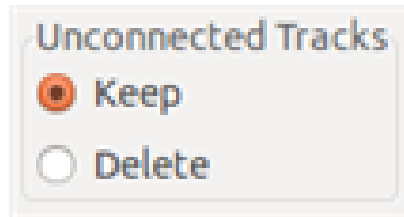
È molto spesso necessario correggere una scheda seguendo un corrispondente cambiamento nello schema elettrico.

6.2.1 Passi da seguire

1. Creare una nuova dallo schema elettrico modificato. Se sono stati aggiunti nuovi componenti, collegarli alle impronte corrispondenti in CvPcb.
2. Leggere la nuova netlist in Pcbnew.

6.2.2 Cancellare le piste errate

Pcbnew è in grado di cancellare automaticamente piste che sono divenute errate per delle modifiche. Per far ciò, controllare l' opzione *Cancella* nel riquadro *Piste non collegate* nella finestra di dialogo della netlist:

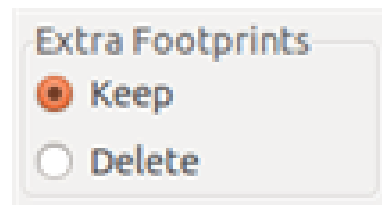


Comunque, si fa spesso più velocemente a modificare tali piste a mano (la funzione DRC ne permette l'identificazione).

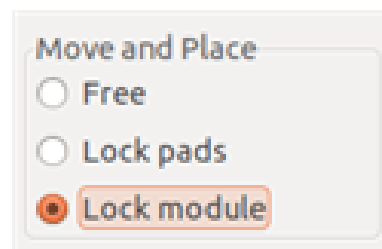
6.2.3 Componenti cancellati

Pcbnew può cancellare impronte corrispondenti a componenti che sono stati rimossi dallo schema. Opzionale.

Ciò è necessario perché ci sono spesso impronte (fori di fissaggio viti, per esempio) aggiunte al circuito stampato che non appariranno mai sullo schema elettrico.

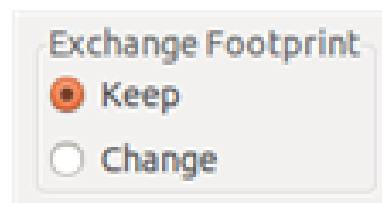


Se l'opzione Impronte extra è selezionata, un'impronta corrispondente ad un componente non trovato nella netlist, verrà cancellata, a meno che questa non abbia l'opzione Bloccata attiva. È una buona idea attivare quest'opzione per le impronte meccaniche:



6.2.4 Impronte modificate

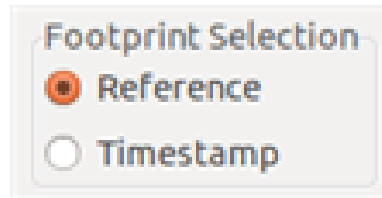
Se un'impronta viene modificata nella netlist (usando CvPcb), ma l'impronta è stata già posizionata, essa non verrà modificata da Pcbnew, a meno che la corrispondente opzione del riquadro *Scambio impronte* della finestra di dialogo netlist dialog sia stata abilitata:



Cambiare un'impronta (sostituendo una resistenza con un'altra di dimensione diversa, per esempio) può essere effettuata direttamente modificando l'impronta.

6.2.5 Opzioni avanzate - selezioni usando le marche temporali

Sometimes the notation of the schematic is changed, without any material changes in the circuit (this would concern the references - like R5, U4...). The PCB is therefore unchanged (except possibly for the silkscreen markings). Nevertheless, internally, components and footprints are represented by their reference. In this situation, the *Timestamp* option of the netlist dialog may be selected before re-reading the netlist:



With this option, Pcbnew no longer identifies footprints by their reference, but by their time stamp instead. The time stamp is automatically generated by Eeschema (it is the time and date when the component was placed in the schematic).

avvertimento

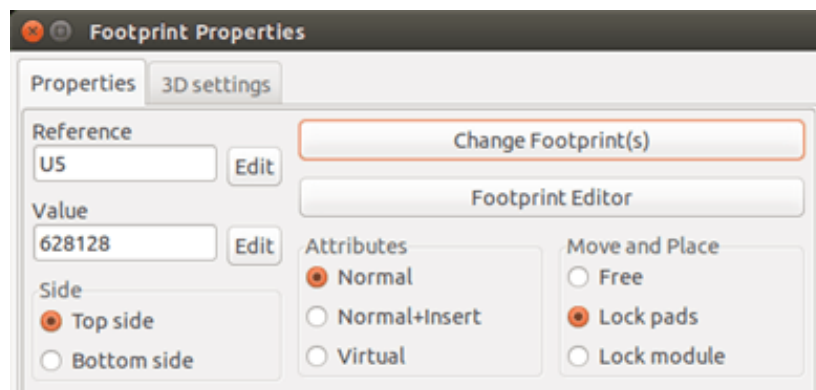


Great care should be exercised when using this option (save the file first!). This is because the technique is complicated in the case of components containing multiple parts (e.g. a 7400 has 4 parts and one case). In this situation, the time stamp is not uniquely defined (for the 7400 there would be up to four - one for each part). Nevertheless, the time stamp option usually resolves re-annotation problems.

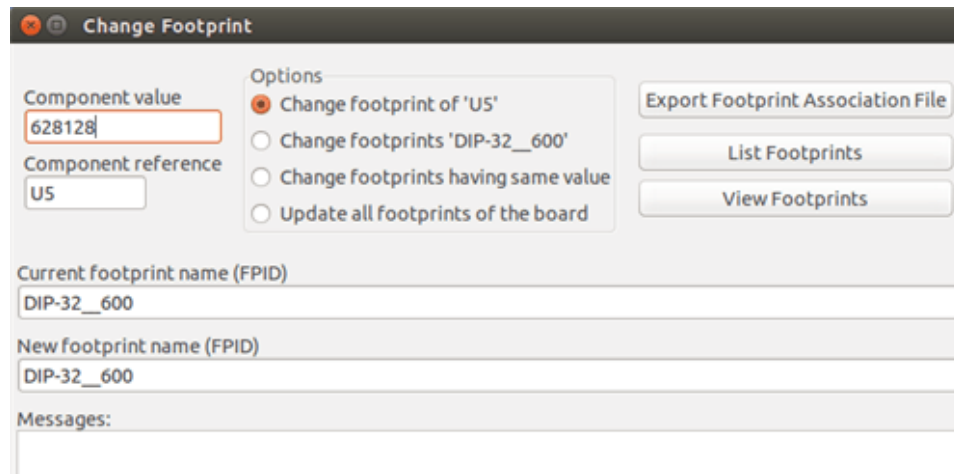
6.3 Direct exchange for footprints already placed on board

Changing a footprint (or some identical footprints) to another footprint is very useful, and is very easy:

1. Click on a footprint to open the Edit dialog box.
2. Activate Change Footprints.



Options for Change Footprint(s):



The screenshot shows the 'Change Footprint' dialog box. It has a title bar with a close button and a maximize button. The dialog is divided into several sections. On the left, there are two text input fields: 'Component value' containing '628128' and 'Component reference' containing 'U5'. To the right of these is a group box labeled 'Options' containing four radio buttons: 'Change footprint of 'U5'', 'Change footprints 'DIP-32__600'', 'Change footprints having same value', and 'Update all footprints of the board'. The first option is selected. To the right of the 'Options' group box are three buttons: 'Export Footprint Association File', 'List Footprints', and 'View Footprints'. Below the 'Options' group box are two text input fields: 'Current footprint name (FPID)' containing 'DIP-32__600' and 'New footprint name (FPID)' containing 'DIP-32__600'. At the bottom is a section labeled 'Messages:' with a text area.

One must choose a new footprint name and use:


- **Change footprint of *xx*** for the current footprint
- **Change footprints *yy*** for all footprints like the current footprint.
- **Change footprints having same value** for all footprints like the current footprint, restricted to components which have the same value.
- **Update all footprints of the board** for reloads all footprints on board.

Capitolo 7

Footprint placement

7.1 Assisted placement

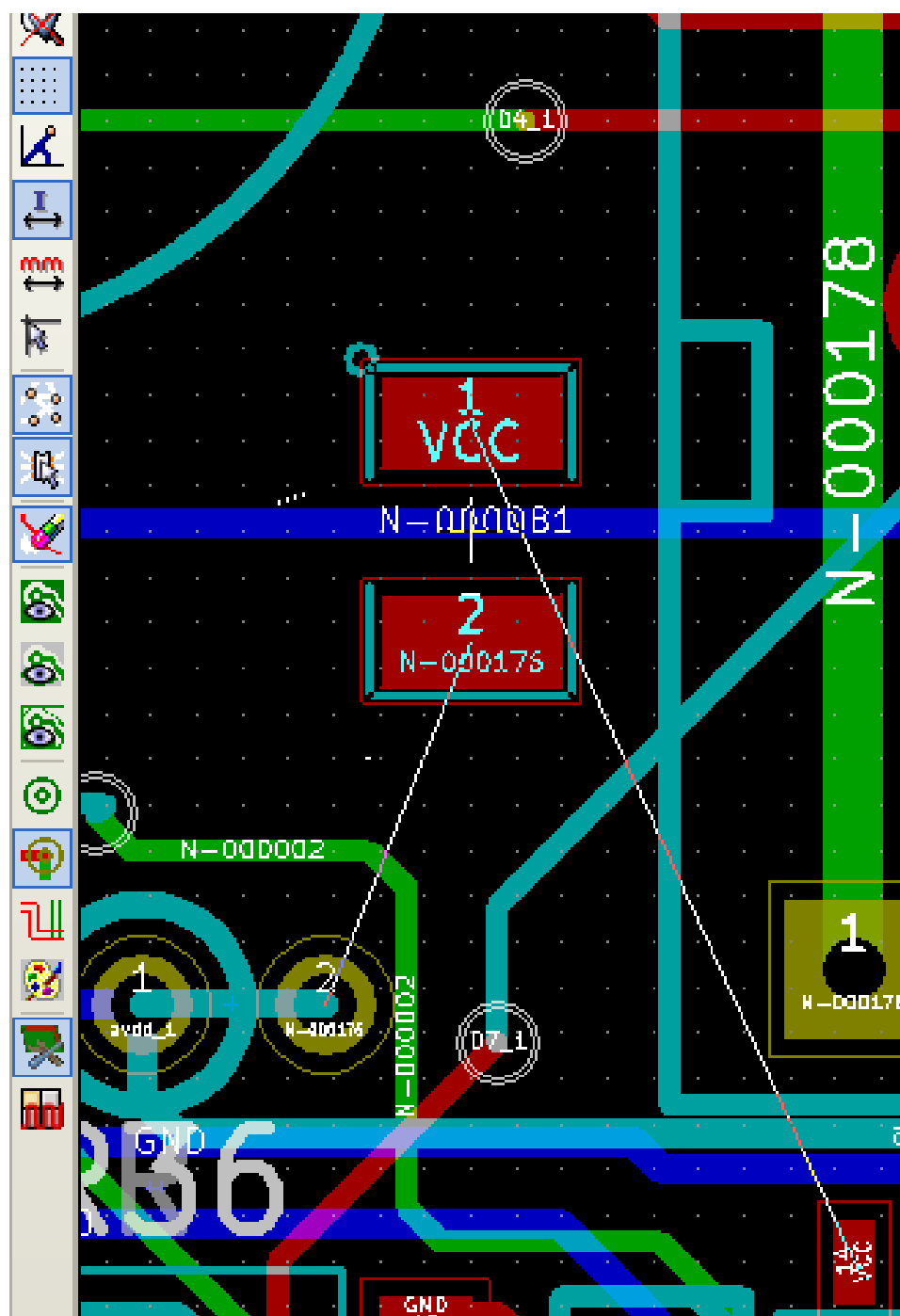
Whilst moving footprints the footprint ratsnest (the net connections) can be displayed to assist the placement. To

enable this the icon  of the left toolbar must be activated.

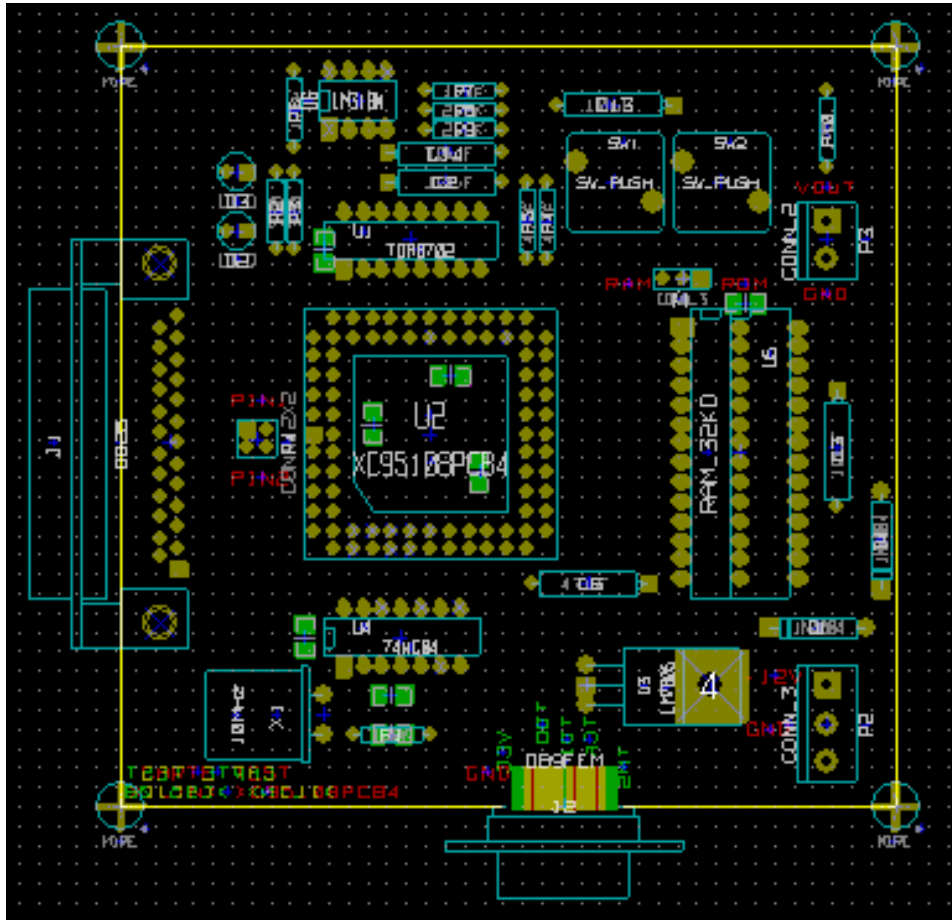
7.2 Manual placement

Select the footprint with the right mouse button then choose the Move command from the menu. Move the footprint to the required position and place it with the left mouse button. If required the selected footprint can also be rotated, inverted or edited. Select Cancel from the menu (or press the Esc key) to abort.

Here you can see the display of the footprint ratsnest during a move:



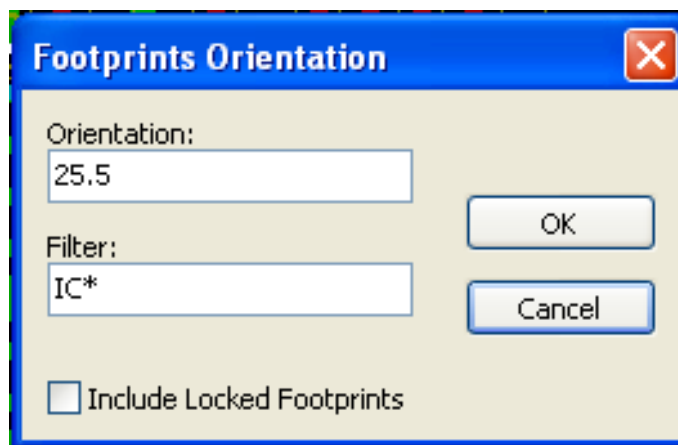
The circuit once all the footprints are placed may be as shown:



7.3 General re-orientation of footprints

Initially all footprints inherit the same orientation that they had in the library (normally 0).

If an alternative orientation is required for an individual footprint, or all footprints (for example all vertical) use the menu option AutoPlace/Orient All Footprints. This orientation can be selective (for example to relate only to the footprints whose reference starts with IC).




7.4 Automatic Footprint Distribution

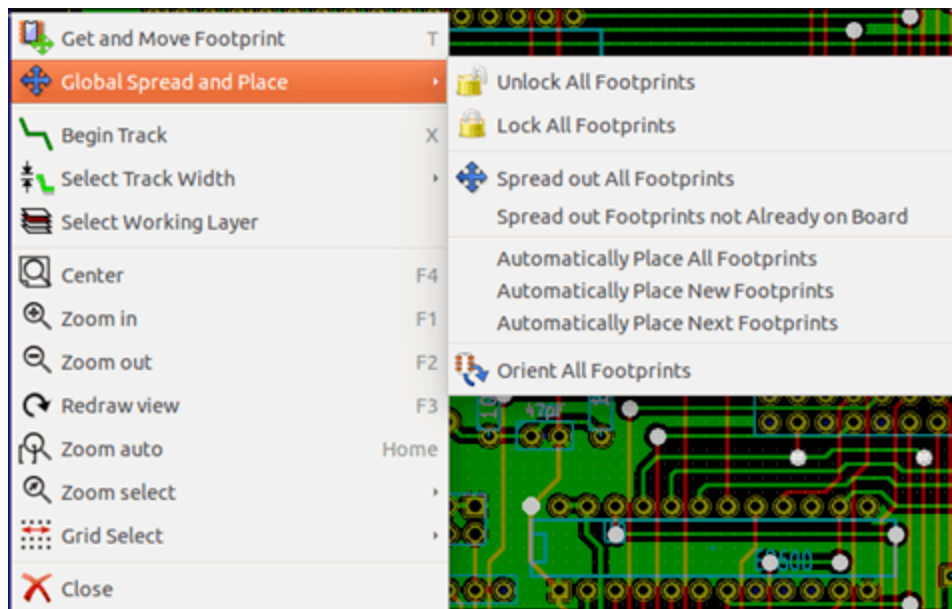
Generally speaking, footprints can only be moved if they have not been Fixed. This attribute can be turned on and off from the pop-up window (click right mouse button over footprint) whilst in Footprint Mode, or through the Edit Footprint Menu.

As stated in the last chapter, new footprints loaded during the reading of the netlist appear piled up at a single location on the board. Pcbnew allows an automatic distribution of the footprints to make manual selection and placement easier.

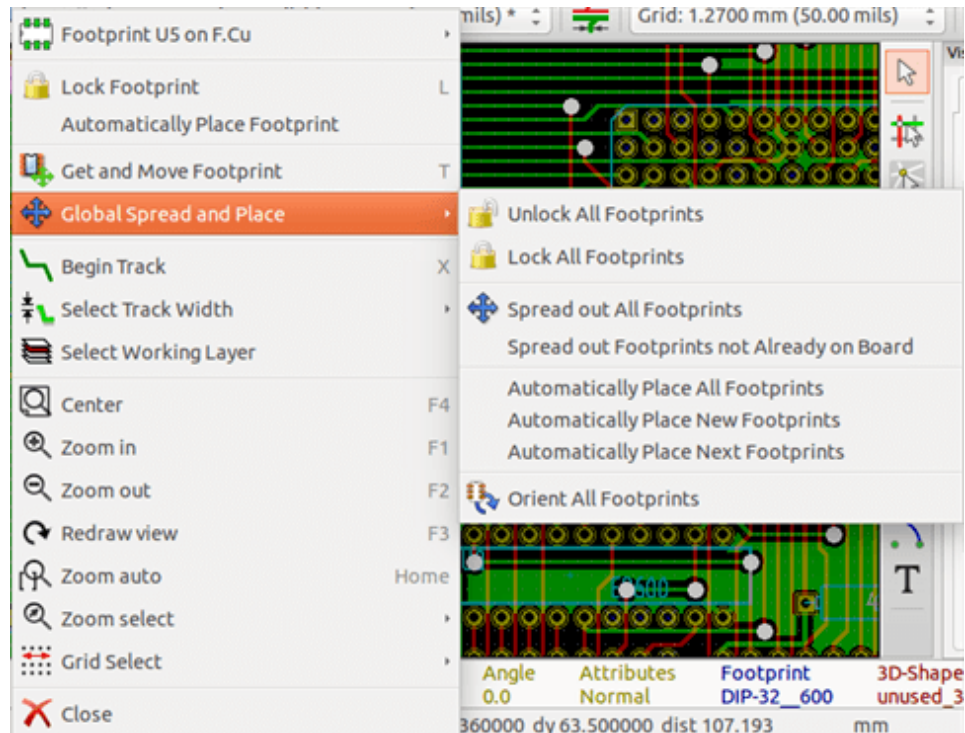


- Select the option Footprint Mode (Icon  on the upper toolbar).
- The pop-up window activated by the right mouse button becomes:

If there is a footprint under the cursor:



If there is nothing under the cursor:



In both cases the following commands are available:

- **Spread out All Footprints** allows the automatic distribution of all the footprints not Fixed. This is generally used after the first reading of a netlist.
- **Spread out Footprints not Already on Board** allows the automatic distribution of the footprints which have not been placed already within the PCB outline. This command requires that an outline of the board has been drawn to determine which footprints can be automatically distributed.

7.5 Automatic placement of footprints

7.5.1 Characteristics of the automatic placer


The automatic placement feature allows the placement of footprints onto the 2 faces of the circuit board (however switching a footprint onto the copper layer is not automatic).

It also seeks the best orientation (0, 90, -90, 180 degrees) of the footprint. The placement is made according to an optimization algorithm, which seeks to minimize the length of the ratsnest, and which seeks to create space between the larger footprints with many pads. The order of placement is optimized to initially place these larger footprints with many pads.

7.5.2 Preparation

Pcbnew can thus place the footprints automatically, however it is necessary to guide this placement, because no software can guess what the user wants to achieve.

Before an automatic placement is carried out one must:

- Create the outline of the board (It can be complex, but it must be closed if the form is not rectangular).
- Manually place the components whose positions are imposed (Connectors, clamp holes, etc).
- Similarly, certain SMD footprints and critical components (large footprints for example) must be on a specific side or position on the board and this must be done manually.
- Having completed any manual placement these footprints must be Fixed to prevent them being moved. With the Footprint Mode icon  selected right click on the footprint and pick Fix Footprint on the Pop-up menu. This can also be done through the Edit/Footprint Pop-up menu.
- Automatic placement can then be carried out. With the Footprint Mode icon selected, right click and select Glob(al) Move and Place - then Autoplace All Footprints.

During automatic placement, if required, Pcbnew can optimize the orientation of the footprints. However rotation will only be attempted if this has been authorized for the footprint (see Edit Footprint Options).

Usually resistors and non-polarized capacitors are authorized for 180 degrees rotation. Some footprints (small transistors for example) can be authorized for +/- 90 and 180 degrees rotation.

For each footprint one slider authorizes 90 degree Rot(ation) and a second slider authorizes 180 degree Rot(ation). A setting of 0 prevents rotation, a setting of 10 authorizes it, and an intermediate value indicates a preference for/against rotation.

The rotation authorization can be done by editing the footprint once it is placed on the board. However it is preferable to set the required options to the footprint in the library as these settings will then be inherited each time the footprint is used.

7.5.3 Interactive auto-placement

It may be necessary during automatic placement to stop (press Esc key) and manually re-position a footprint. Using the command Autoplace Next Footprint will restart the autoplacement from the point at which it was stopped.

The command Autoplace new footprints allows the automatic placement of the footprints which have not been placed already within the PCB outline. It will not move those within the PCB outline even if they are not fixed.

The command Autoplace Footprint makes it possible to re-place the footprint pointed to by the mouse, even if its *fixed* attribute is active.

7.5.4 Additional note

Pcbnew automatically determines the possible zone of placement of the footprints by respecting the shape of the board outline, which is not necessarily rectangular (It can be round, or have cutouts, etc).

If the board is not rectangular, the outline must be closed, so that Pcbnew can determine what is inside and what is outside the outline. In the same way, if there are internal cutouts, their outline will have to be closed.

Pcbnew calculates the possible zone of placement of the footprints using the outline of the board, then passes each footprint in turn over this area in order to determine the optimum position at which to place it.

Capitolo 8

Setting routing parameters

8.1 Current settings

8.1.1 Accessing the main dialog

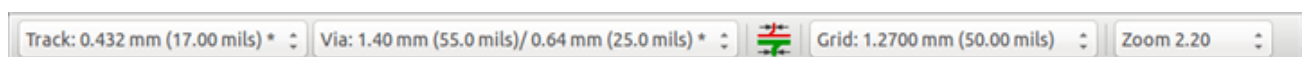
The most important parameters are accessed from the following drop-down menu:



and are set in the Design Rules dialog.

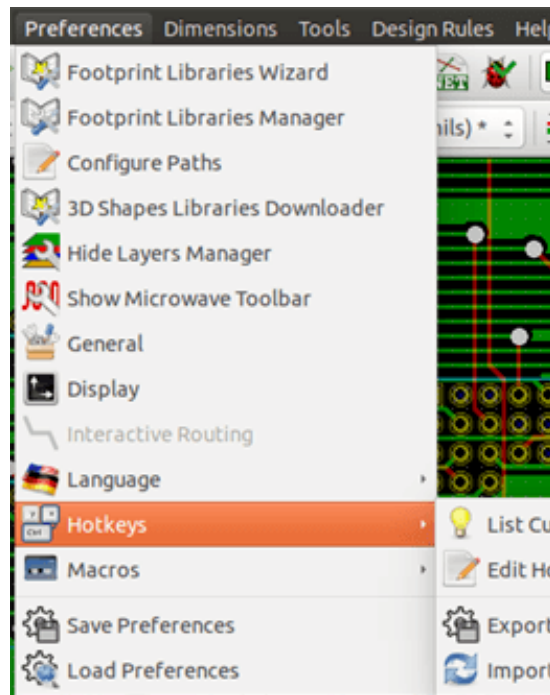
8.1.2 Current settings

Current settings are displayed in the top toolbar.

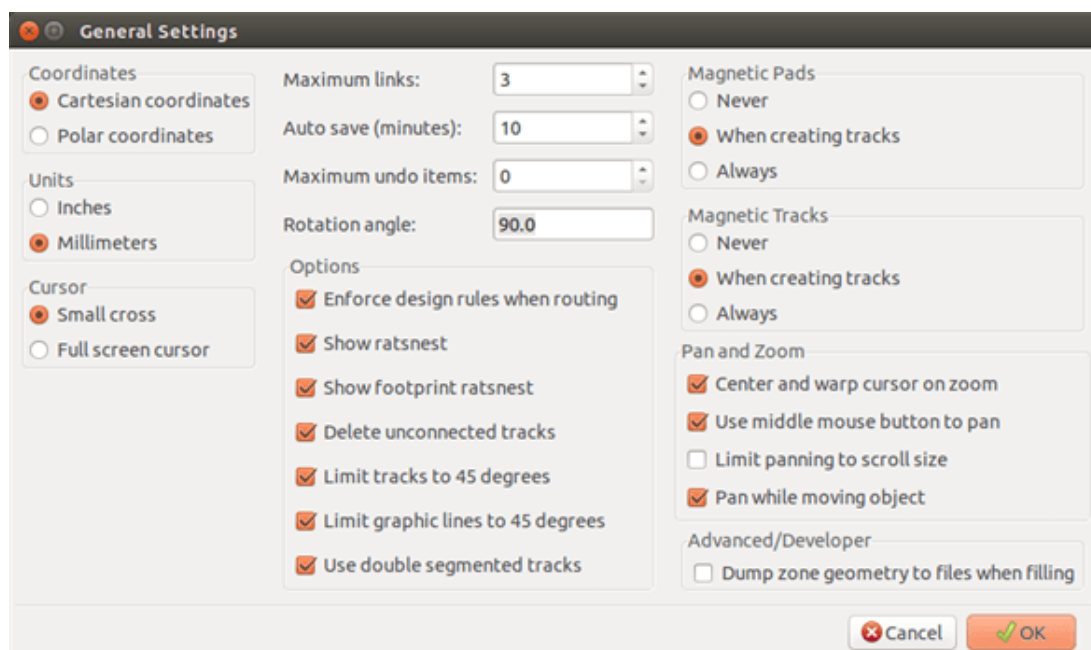


8.2 General options

The General options menu is available via the top toolbar link Preferences → General dialog.



The dialog looks like the following:



For the creation of tracks the necessary parameters are:

- **Tracks 45 Only:** Directions allowed for track segments are 0, 45 or 90 degrees.
- **Double Segm Track:** When creating tracks, 2 segments will be displayed.
- **Tracks Auto Del:** When recreating tracks, the old one will be automatically deleted if considered redundant.
- **Magnetic Pads:** The graphic cursor becomes a pad, centered in the pad area.
- **Magnetic Tracks:** The graphic cursor becomes the track axis.

8.3 Netclasses

Pcbnew allows you to define different routing parameters for each net. Parameters are defined by a group of nets.

- A group of nets is called a Netclass.
- There is always a netclass called default.
- Users can add others Netclasses.

A netclass specifies:

- The width of tracks, via diameters and drills.
- The clearance between pads and tracks (or vias).
- When routing, Pcbnew automatically selects the netclass corresponding to the net of the track to create or edit, and therefore the routing parameters.

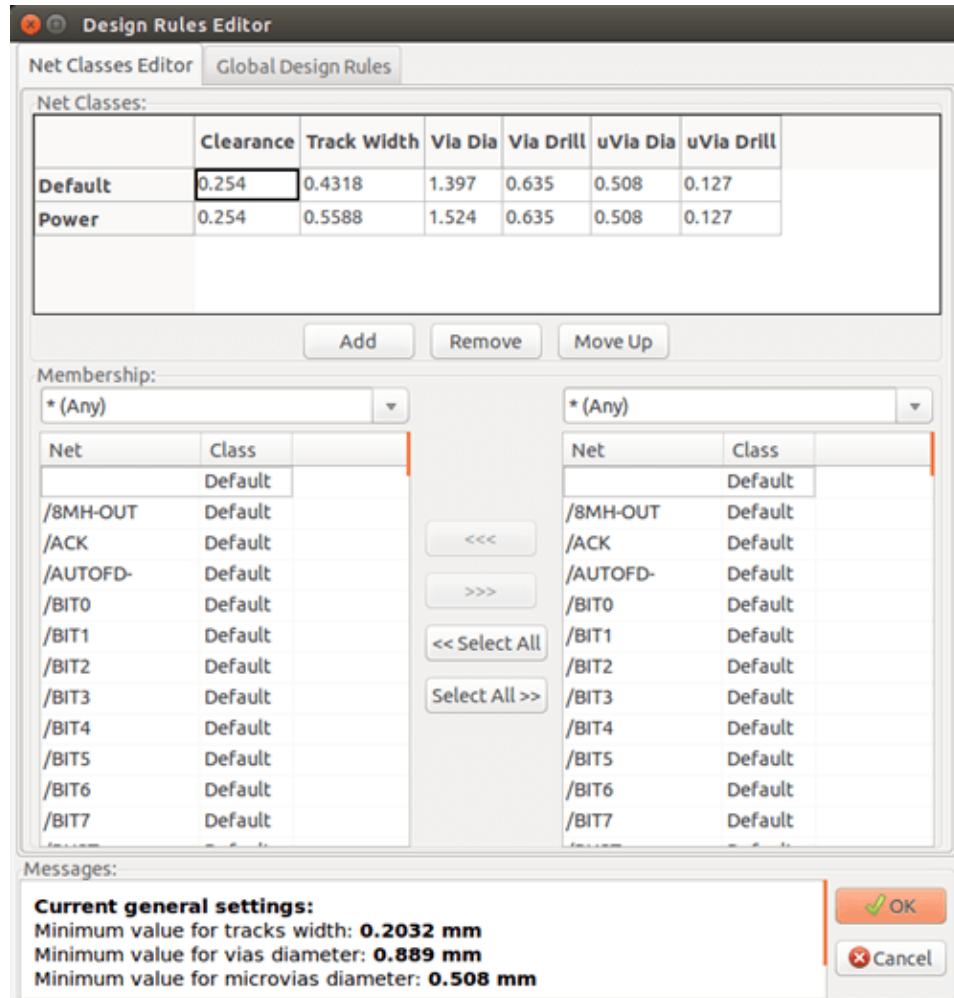
8.3.1 Setting routing parameters

The choice is made in the menu: Design Rules → Design Rules.

8.3.2 Netclass editor

The Netclass editor allows you to:

- Add or delete Netclasses.
 - Set routing parameters values: clearance, track width, via sizes.
 - Group nets in netclasses.
-



8.3.3 Global Design Rules

The global design rules are:

- Enabling/disabling Blind/buried Vias use.
- Enabling/disabling Micro Vias use.
- Minimum Allowed Values for tracks and vias.

A DRC error is raised when a value smaller than the minimum value specified is encountered. The second dialog panel is:

Design Rules Editor

Net Classes Editor | **Global Design Rules**

Via Options:

Blind/buried Vias:
☒ Do not allow blind/buried vias
☐ Allow blind/buried vias

Micro Vias:
☒ Do not allow micro vias
☐ Allow micro vias

Minimum Allowed Values:

Min track width (mm): 0.2032
 Min via diameter (mm): 0.889
 Min via drill dia (mm): 0.508
 Min uvia diameter (mm): 0.508
 Min uvia drill dia (mm): 0.127

Specific via diameters and track widths, which can be used to replace default Netclass values on demand, for arbitrary vias or track segments.

Custom Via Sizes:
 Drill value: a blank or 0 => default Netclass value

	Diameter	Drill
Via 1	1.524	0.762
Via 2		
Via 3		
Via 4		
Via 5		
Via 6		
Via 7		
Via 8		

Custom Track Widths:

	Width
Track 1	0.381
Track 2	0.762
Track 3	
Track 4	
Track 5	
Track 6	
Track 7	
Track 8	

Messages:

Current general settings:
 Minimum value for tracks width: **0.2032 mm**
 Minimum value for vias diameter: **0.889 mm**
 Minimum value for microvias diameter: **0.508 mm**

OK Cancel

This dialog also allows to enter a stock of tracks and vias sizes.

When routing, one can select one of these values to create a track or via, instead of using the netclass' s default value. Useful in critical cases when a small track segment must have a specific size.

8.3.4 Via parameters

Pcbnew handles 3 types of vias:

- Through vias (usual vias).
- Blind or buried vias.
- Micro Vias, like buried vias but restricted to an external layer to its nearest neighbor. They are intended to connect BGA pins to the nearest inner layer. Their diameter is usually very small and they are drilled by laser.

By default, all vias have the same drill value.

This dialog specifies the smallest acceptable values for via parameters. On a board, a via smaller than specified here generates a DRC error.

8.3.5 Track parameters

Specify the minimum acceptable track width. On a board, a track width smaller than specified here generates a DRC error.

8.3.6 Specific sizes

Specific via diameters and track widths, which can be used to replace default Netclass values on demand, for arbitrary vias or track segments.

Custom Via Sizes:

Drill value: a blank or 0 => default Netclass value

	Diameter	Drill
Via 1	1.524	0.762
Via 2		
Via 3		
Via 4		
Via 5		
Via 6		
Via 7		
Via 8		

Custom Track Widths:

	Width
Track 1	0.381
Track 2	0.762
Track 3	
Track 4	
Track 5	
Track 6	
Track 7	
Track 8	

One can enter a set of extra tracks and/or vias sizes. While routing a track, these values can be used on demand instead of the values from the current netclass values.

8.4 Examples and typical dimensions

8.4.1 Track width

Use the largest possible value and conform to the minimum sizes given here.

Units	CLASS 1	CLASS 2	CLASS 3	CLASS 4	CLASS 5
mm	0.8	0.5	0.4	0.25	0.15
mils	31	20	16	10	6

8.4.2 Insulation (clearance)

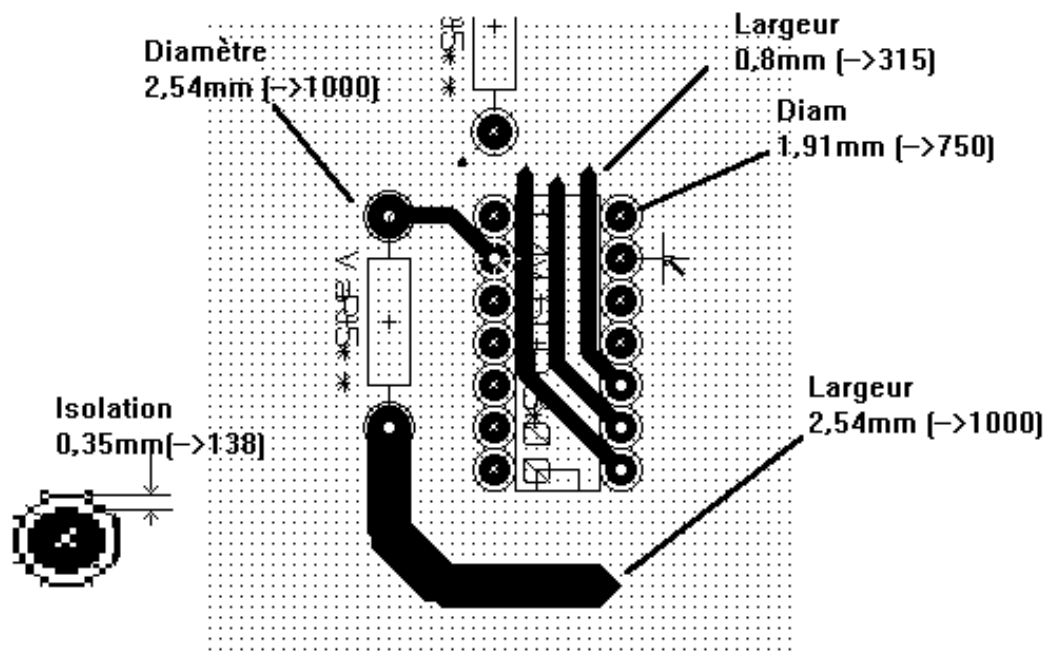
Units	CLASS 1	CLASS 2	CLASS 3	CLASS 4	CLASS 5
mm	0.7	0.5	0.35	0.23	0.15
mils	27	20	14	9	6

Usually, the minimum clearance is very similar to the minimum track width.

8.5 Examples

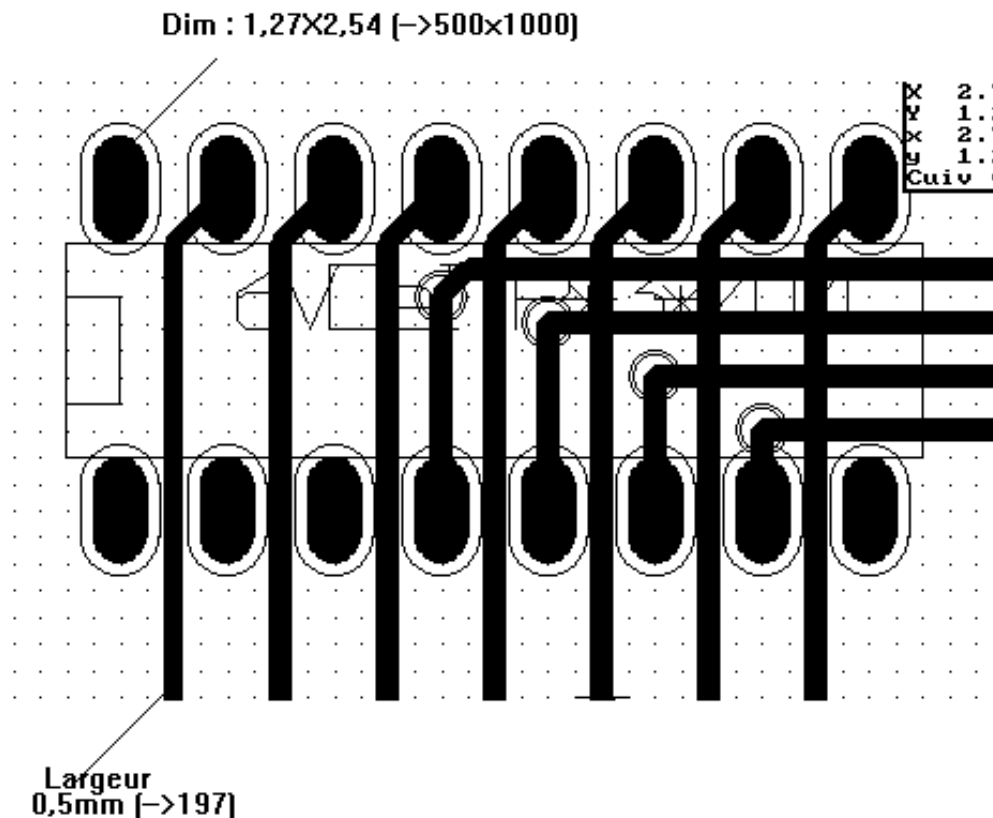
8.5.1 Rustic

- Clearance: 0.35mm (0.0138 inches).
- Track width: 0.8mm (0.0315 inches).
- Pad diameter for ICs and vias: 1.91mm (0.0750 inches).
- Pad diameter for discrete components: 2.54mm (0.1 inches).
- Ground track width: 2.54mm (0.1 inches).



8.5.2 Standard


- Clearance: 0.35mm (0.0138 inches).
- Track width: 0.5mm (0.0127 inches).
- Pad diameter for ICs: make them elongated in order to allow tracks to pass between IC pads and yet have the pads offer a sufficient adhesive surface (1.27 x 2.54 mm ->0.05x 0.1 inches).
- Vias: 1.27mm (0.0500 inches).




8.6 Manual routing

Manual routing is often recommended, because it is the only method offering control over routing priorities. For example, it is preferable to start by routing power tracks, making them wide and short and keeping analog and digital supplies well separated. Later, sensitive signal tracks should be routed. Amongst other problems, automatic routing often requires many vias. However, automatic routing can offer a useful insight into the positioning of footprints. With experience, you will probably find that the automatic router is useful for quickly routing the *obvious* tracks, but the remaining tracks will best be routed by hand.


8.7 Help when creating tracks

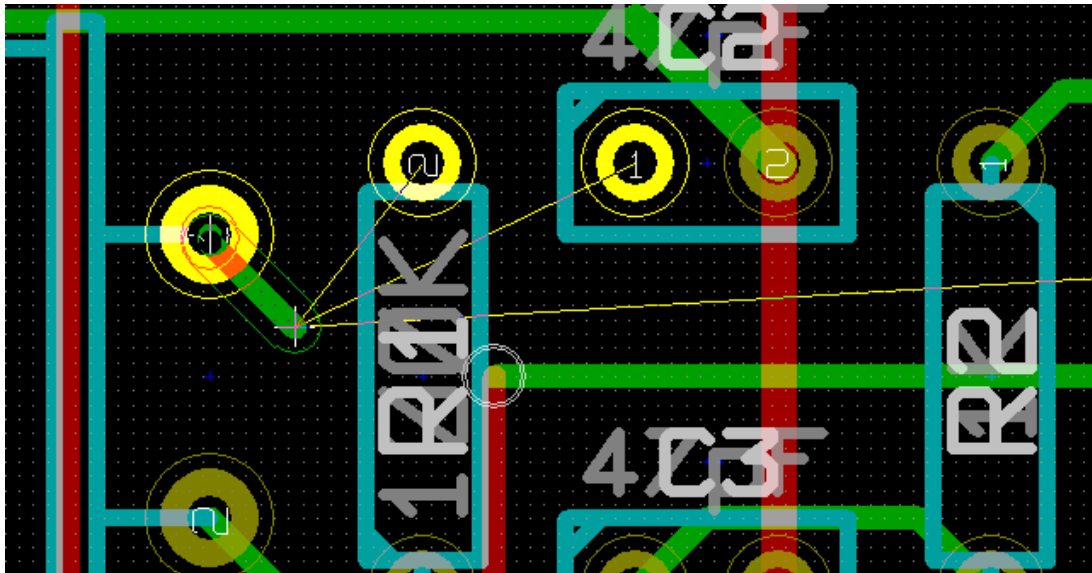
Pcbnew can display the full ratsnest, if the button  is activated.

The button  allows one to highlight a net (click to a pad or an existing track to highlight the corresponding net).

The DRC checks tracks in real time while creating them. One cannot create a track which does not match the DRC rules. It is possible to disable the DRC by clicking on the button. This is, however, not recommended, use it only in specific cases.

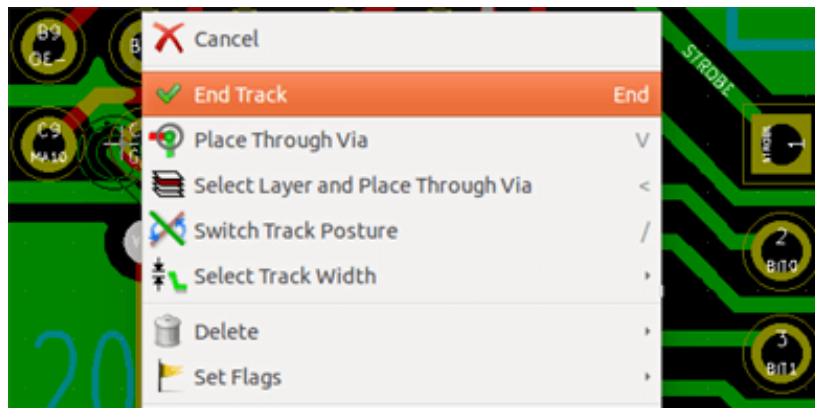
8.7.1 Creating tracks

A track can be created by clicking on the button . A new track must start on a pad or on another track, because Pcbnew must know the net used for the new track (in order to match the DRC rules).




When creating a new track, Pcbnew shows links to nearest unconnected pads, link number set in option Max. Links in General Options.

End the track by double-clicking, by the pop-up menu or by its hot key.



8.7.2 Moving and dragging tracks

When the button  is active, the track where the cursor is positioned can be moved with the hotkey *M*. If you want to drag the track you can use the hotkey *G*.

8.7.3 Via Insertion


A via can be inserted only when a track is in progress:

- By the pop-up menu.
- By the hotkey *V*.
- By switching to a new copper layer using the appropriate hotkey.

8.8 Select/edit the track width and via size

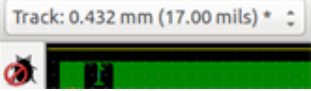
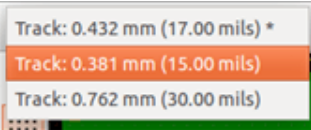

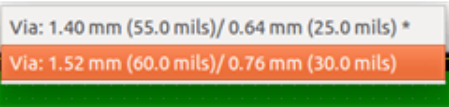

When clicking on a track or a pad, Pcbnew automatically selects the corresponding Netclass, and the track size and vias dimensions are derived from this netclass.

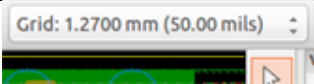
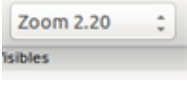
As previously seen, the Global Design Rules editor has a tool to insert extra tracks and vias sizes.

- The horizontal toolbar can be used to select a size.
- When the button  is active, the current track width can be selected from the pop-up menu (accessible as well when creating a track).
- The user can utilize the default Netclasses values or a specified value.

8.8.1 Using the horizontal toolbar

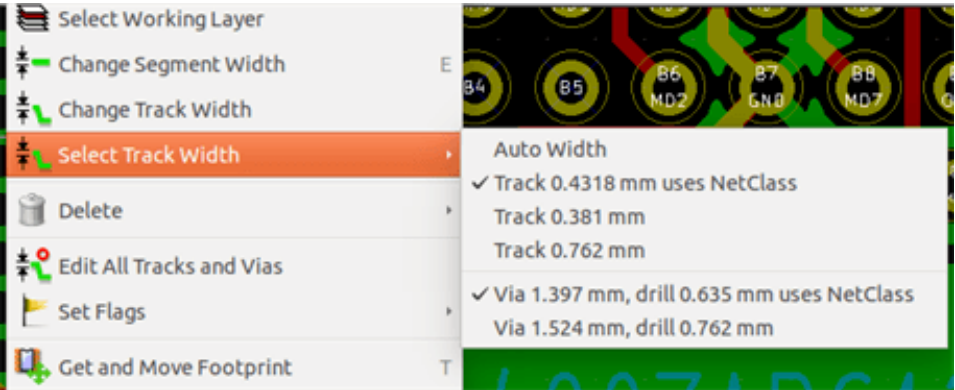


	Track width selection. The symbol * is a mark for default Netclass value selection.
	Selecting a specific track width value. The first value in list is always the netclass value. Others values are tracks widths entered from the Global Design Rules editor.
	Via size selection. The symbol * is a mark for default Netclass value selection.
	Selecting a specific via dimension value. The first value in list is always the netclass value. Others values are vias dimensions entered from the Global Design Rules editor.
	When enabled: Automatic track width selection. When starting a track on an existing track, the new track has the same width as the existing track.

	Grid size selection.
	Zoom selection.

8.8.2 Using the pop-up menu

One can select a new size for routing, or change to a previously created via or track segment:



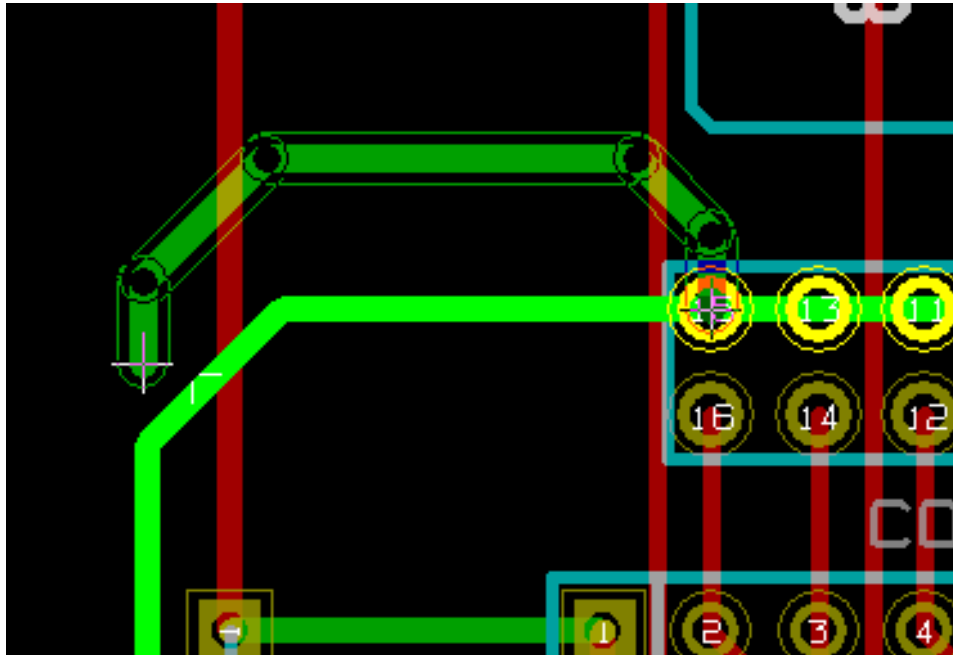
If you want to change many via (or track) sizes, the best way is to use a specific Netclass for the net(s) that must be edited (see global changes).

8.9 Editing and changing tracks

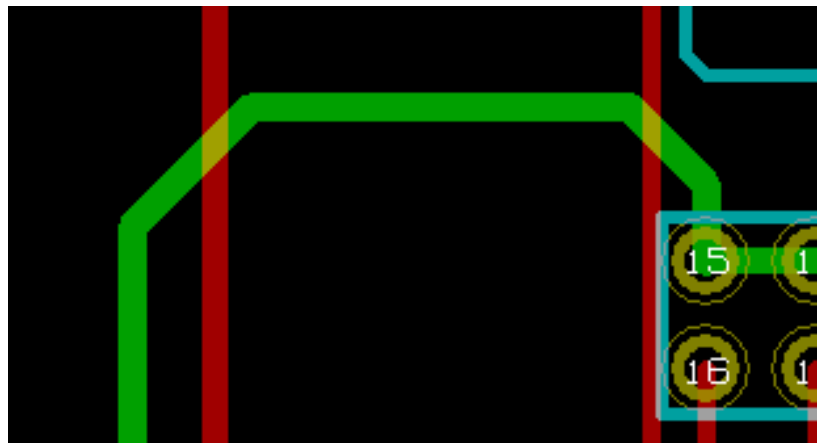
8.9.1 Change a track

In many cases redrawing a track is required.

New track (in progress):



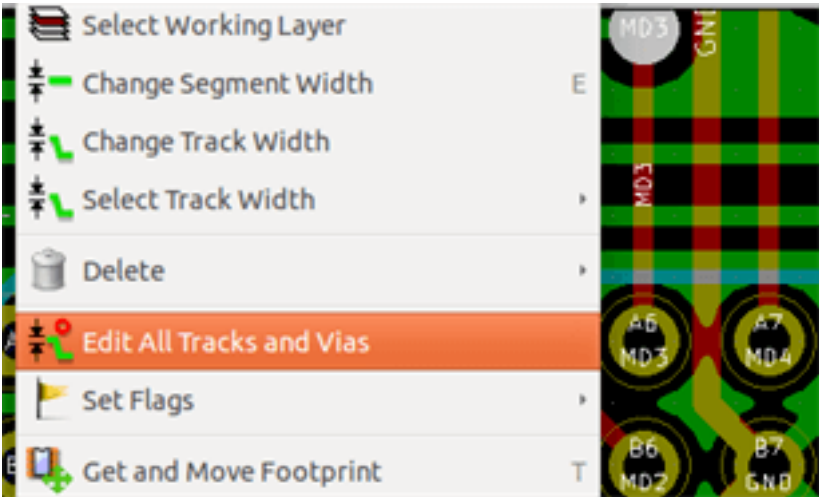
When finished:



Pcbnew will automatically remove the old track if it is redundant.

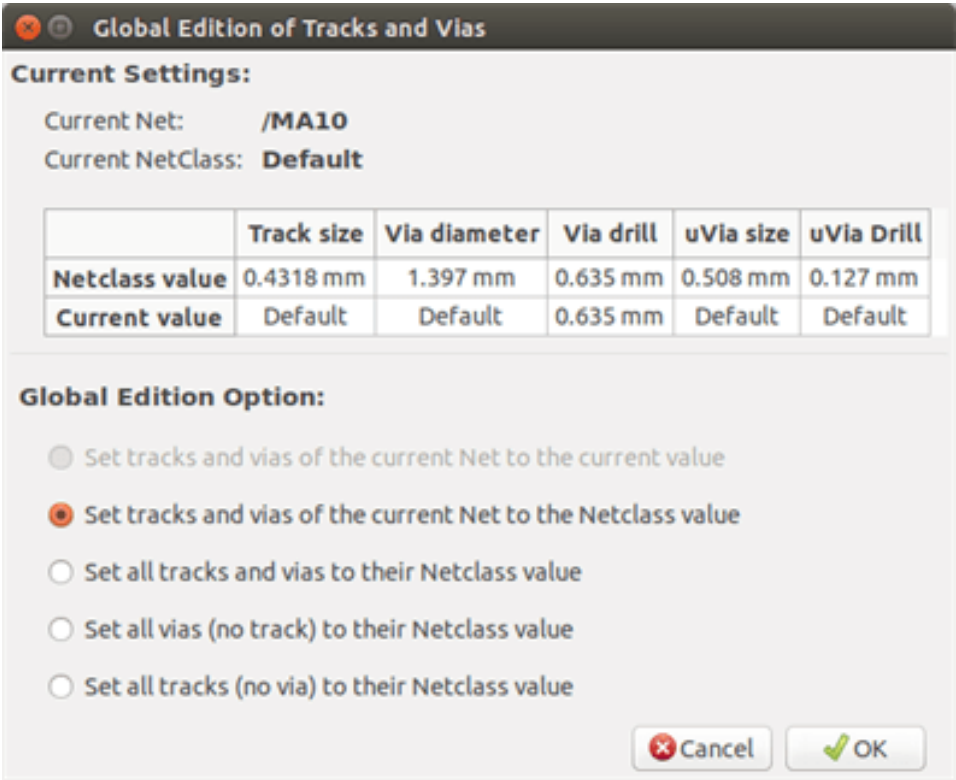
8.9.2 Global changes

Global tracks and via sizes dialog editor is accessible via the pop-up window by right clicking on a track:



The dialog editor allows global changes of tracks and/or vias for:

- The current net.
- The whole board.



Capitolo 9

Sbroglio Interattivo

Lo sbroglio interattivo permette di sbrogliare in maniera veloce ed efficiente i circuiti stampati, spingendo e girando attorno agli elementi sulla scheda che potrebbero collidere con le piste che si sta disegnando.

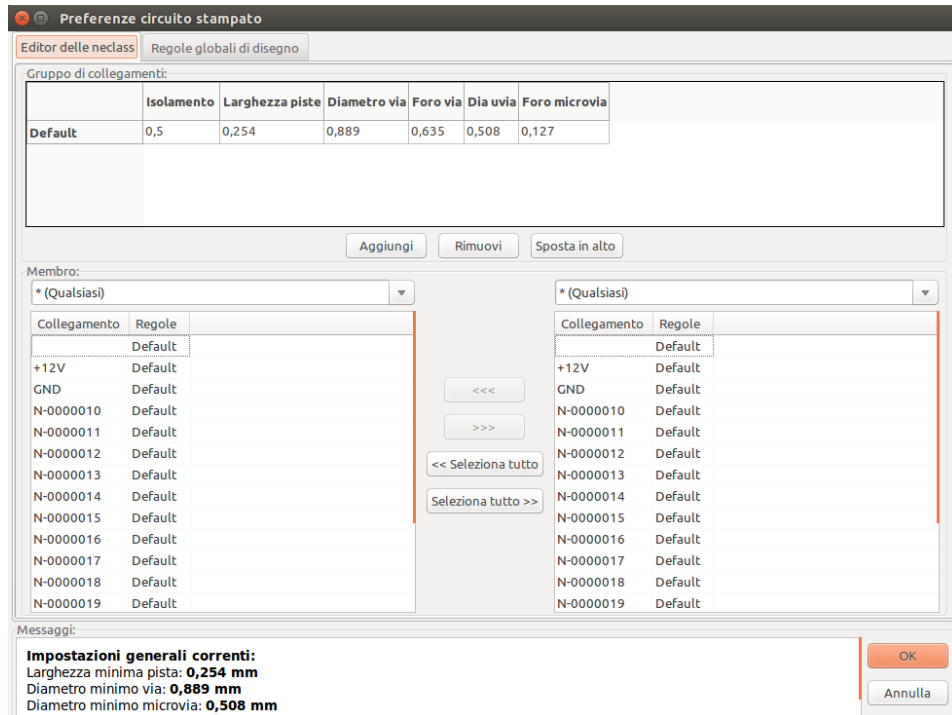
Sono supportate le seguenti modalità:

- **Evidenzia collisioni**, che evidenzia con un colore verde brillante tutti gli oggetti e le regioni che violano le regole di isolamento.
- **Spingi**, tenta di spingere e compattare tutti gli elementi che collidono con la pista che si sta attualmente sbrogliando.
- **Aggira**, tenta di evitare gli ostacoli circondandoli/girandoci attorno.

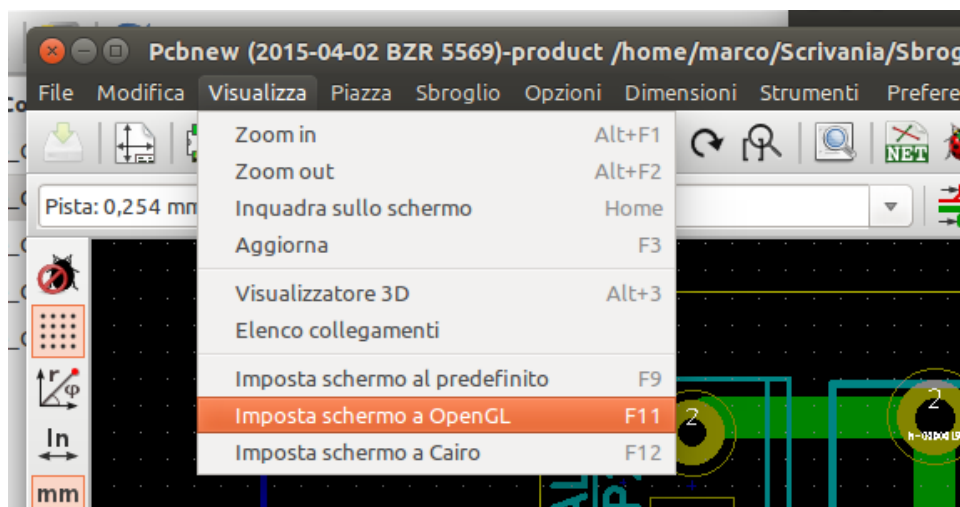
9.1 Impostazione

Prima di usare lo sbroglio interattivo, impostare queste due cose:


- **Impostazioni isolamento**. Per configurare le impostazioni di isolamento, aprire la finestra di dialogo delle *Regole di progettazione* e assicurarsi che i valori di isolamento predefiniti siano almeno ragionevoli.



- Abilita la modalità OpenGL, selezionando l'opzione di menu *Visualizza→Imposta schermo a OpenGL* o premendo **F11**.



9.2 Disposizione delle piste

Per attivare lo strumento di sbroglio premere il pulsante *Sbroglio interattivo*  o il pulsante **X**. Il puntatore si trasformerà in una croce e il nome dello strumento apparirà nella barra di stato.

Per cominciare a tracciare una pista, fare clic su un qualsiasi elemento (una piazzola, una pista o un via) o premere nuovamente il tasto **X** con il puntatore del mouse sopra l'elemento. La nuova pista userà il collegamento (net) dell'elemento di partenza. Facendo clic o premendo **X** su una zona vuota del circuito stampato farà cominciare una pista senza un collegamento assegnato.

Spostare il mouse per definire la forma della pista. Lo sbrogliatore proverà a seguire il mouse, scartando gli ostacoli inamovibili (come le piazzole) e spostando piste/via in rotta di collisione, a seconda della modalità in cui si trova. Ritirando il puntatore del mouse, gli elementi spostati torneranno alle loro posizioni iniziali.

Facendo clic su una piazzola/pista/via dello stesso collegamento (net) finisce lo sbroglio. Facendo clic in uno spazio vuoto fissa i segmenti sbrogliati fino a quel momento e continua lo sbroglio della pista.

Per bloccare lo sbroglio e annullare tutti i cambiamenti (elementi spostati, ecc.), basta premere il tasto **Esc**.

Premendo **V** o selezionando *Piazza via passante* dal menu contestuale durante lo sbroglio di una pista, si collega un via in cima alla pista che si sta sbrogliando. Premendo **V** ulteriormente si disabilita l' inserimento del via. Facendo clic in qualsiasi punto del circuito stampato, si piazza il via e lo sbroglio continua.

Premendo **/** o selezionando *commuta postura pista* dal menu contestuale commuta la direzione del segmento di pista iniziale tra diritto e diagonale.

Nota

Come valore predefinito, lo sbroglio si aggancia automaticamente al centro o agli assi degli elementi. Questo magnetismo può essere disabilitato tenendo premuto il tasto **Maiusc** durante lo sbroglio o la selezione degli elementi.

9.3 Impostazione larghezze piste e dimensioni via

Ci sono diversi metodi per pre-selezionare la larghezza pista/dimensione via o per cambiarle durante lo sbroglio:

- Usare le scorciatoie da tastiera standard.
- Premere **W** o selezionare *Dimensione pista personalizzata* dal menu contestuale per battere un valore personalizzato di spessore pista/dimensione via.
- Selezionare una larghezza predefinita dal sotto-menu *Seleziona larghezza pista* del menu contestuale.
- Selezionare *Usa la larghezza iniziale pista* nel menu *Seleziona larghezza pista* per prelevare la larghezza dall' elemento iniziale (o le piste già connesse ad esso).

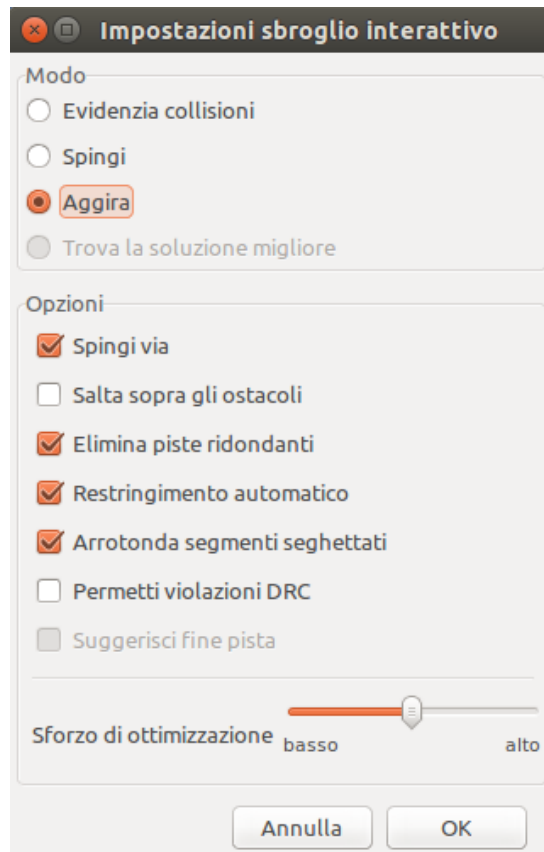
9.4 Trascinamento

Lo sbrogliatore può trascinare segmenti di pista, angoli e via. Per trascinare un elemento, fare clic su di esso con il tasto **Ctrl** premuto, posizionare il puntatore del mouse sopra di esso e premere il **G** o selezionare *Trascina pista/via* dal menu contestuale. Concludere trascinando e facendo clic nuovamente o interrompere premendo il tasto *Esc*.

9.5 Opzioni

Il comportamento dello sbrogliatore può essere configurato premendo il tasto **E** o selezionando *Opzioni di sbroglio* dal menu contestuale mentre si sta nella modalità Pista. Si aprirà una finestra come questa riportata in basso:

Le opzioni sono:



- **Modo** - seleziona come lo sbroglio gestisce la violazione delle regole di progettazione (DRC) (spingendo, girando attorno, ecc.)
- **Spingi via** - se disabilitato, i via vengono trattati come oggetti inamovibili e circondati anziché spostati.
- **Salta sopra gli ostacoli** - se abilitata, lo sbrogliatore prova a spostare le piste collidenti dietro gli ostacoli pieni (come le piazzole) invece di riflettere indietro la collisione
- **Elimina piste ridondanti** - elimina gli anelli durante lo sbroglio (cioè se la nuova pista garantisce la stessa connettività di una già esistente, la vecchia pista viene rimossa). La rimozione degli anelli funziona localmente (solo tra l' inizio e la fine della pista in fase di sbroglio).
- **Restringimento automatico** - se abilitata, lo sbrogliatore prova a connettere piazzole/via in modo pulito, evitando angoli acuti e piste di connessione seghettate.
- **Arrotonda segmenti seghettati** - se abilitata, lo sbrogliatore cerca di fondere assieme diversi segmenti seghettati in uno singolo e dritto (modalità trascinamento).
- **Permetti violazioni DRC** (solo modalità *evidenzia collisioni*) - permette di stendere una pista anche se sta violando le regole di progettazione.
- **Sforzo di ottimizzazione** - definisce quanto tempo lo sbroglio dovrà impiegare nell' ottimizzazione della disposizione/spostamento di piste. Un valore maggiore significa uno sbroglio più pulito (ma più lento), mentre valori più bassi portano a sbrogli più veloci ma con tracce più seghettate.

Capitolo 10

Creating copper zones

Copper zones are defined by an outline (closed polygon), and can include holes (closed polygons inside the outline). A zone can be drawn on a copper layer or alternatively on a technical layer.

10.1 Creating zones on copper layers

Pad (and track) connections to filled copper areas are checked by the DRC engine. A zone must be filled (not just created) to connect pads. Pcbnew currently uses track segments or polygons to fill copper areas.

Each option has its advantages and its disadvantages, the main disadvantage being increased screen redraw time on slower machines. The final result is however the same.

For calculation time reasons, the zone filling is not recreated after each change, but only:

- If a filling zone command is executed.
- When a DRC test is performed.

Copper zones must be filled or refilled after changes in tracks or pads are made. Copper zones (usually ground and power planes) are usually attached to a net.

In order to create a copper zone you should:


- Select parameters (net name, layer...). Turning on the layer and highlighting this net is not mandatory but it is good practice.
- Create the zone limit (If not, the entire board will be filled.).
- Fill the zone.

Pcbnew tries to fill all zones in one piece, and usually, there will be no unconnected copper blocks. It can happen that some areas remain unfilled. Zones having no net are not cleaned and can have insulated areas.

10.2 Creating a zone

10.2.1 Creating the limits of a zone



Use the tool . The active layer must be a copper layer. When clicking to start the zone outline, the following dialog box will be opened.

You can specify all parameters for this zone:

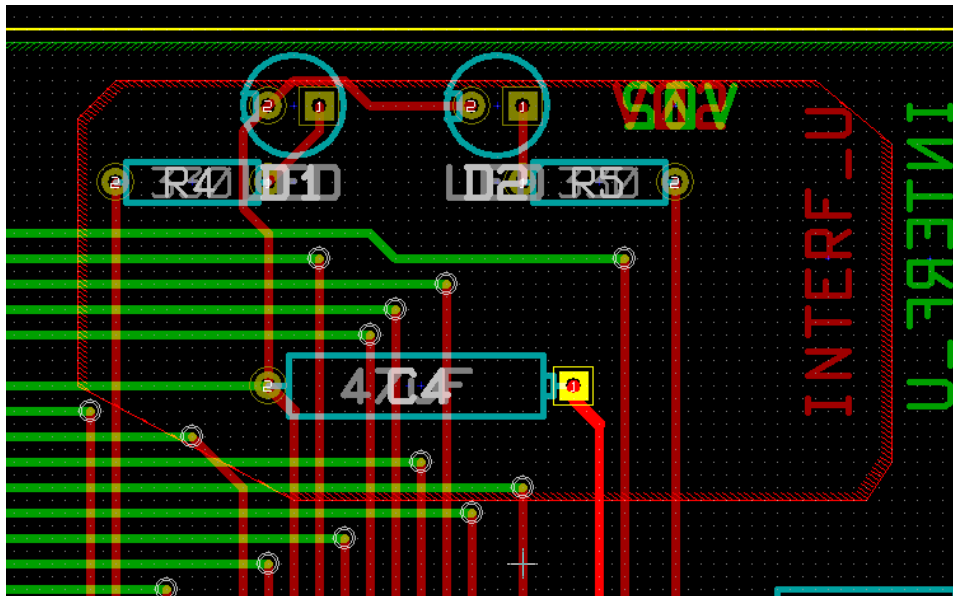
- Collegamento
- Strato
- Opzioni riempimenti
- Opzioni piazzole
- Livello priorità

Draw the zone limit on this layer. This zone limit is a polygon, created by a left-clicking at each corner. A double-click will end and close the polygon. If the starting point and ending point are not at the same coordinate, Pcbnew will add a segment from the end point to the start point.

Nota

- The DRC control is active when creating zone outlines.
 - A corner which creates a DRC error will not be accepted by Pcbnew.
-

In the following image you can see an example of a zone limit (polygon in thin hatched line):

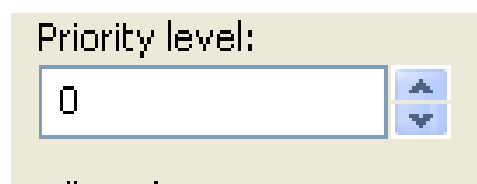


10.2.2 Livello priorità

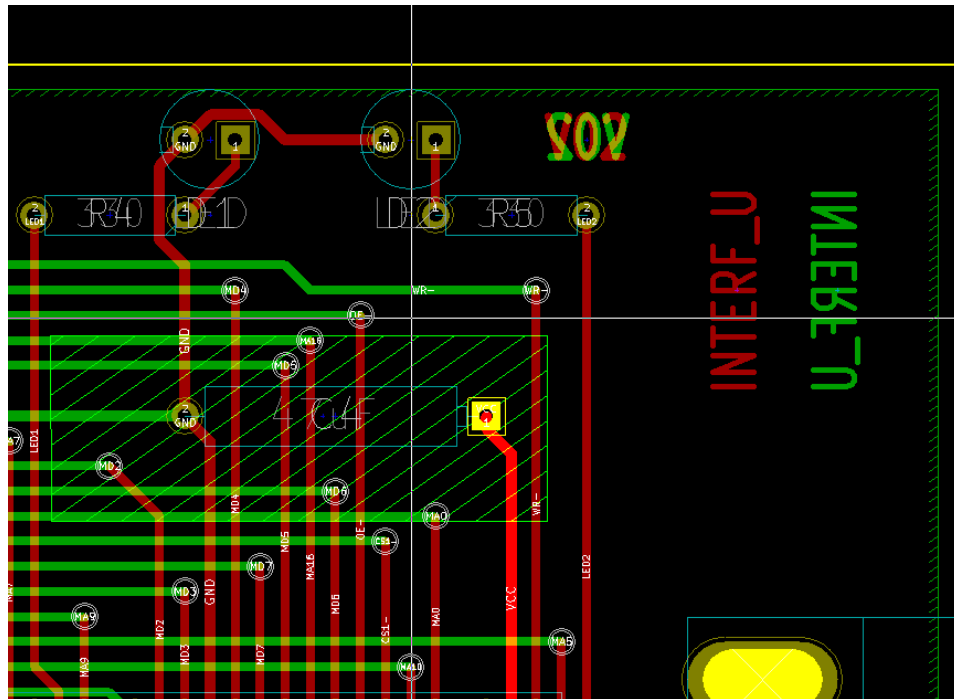
Sometimes a small zone must be created inside a large zone.

This is possible if the small zone has a higher priority level than the large zone.

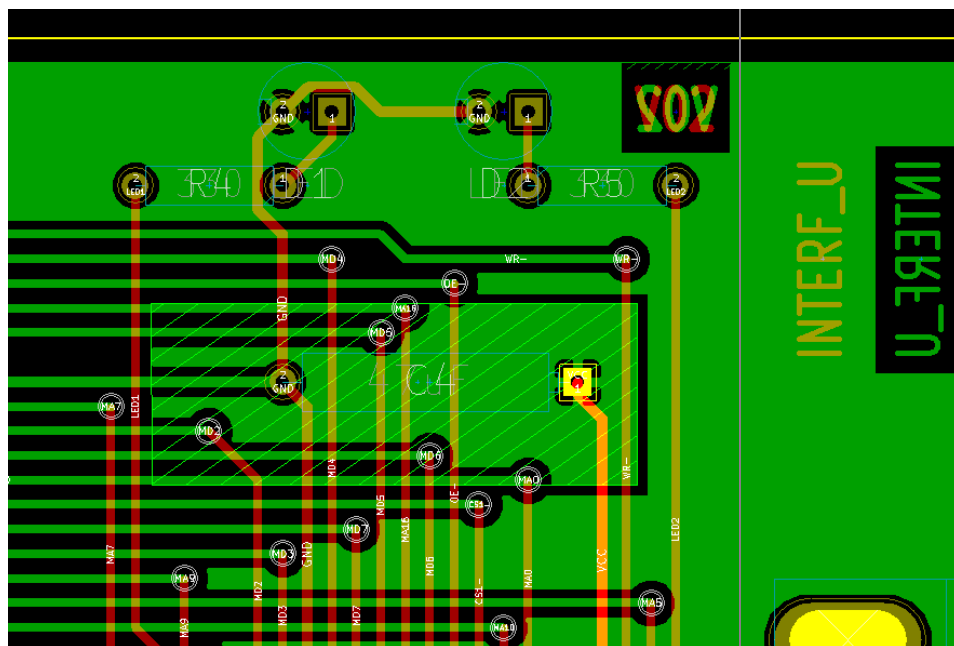
Level setting:



Here is an example:

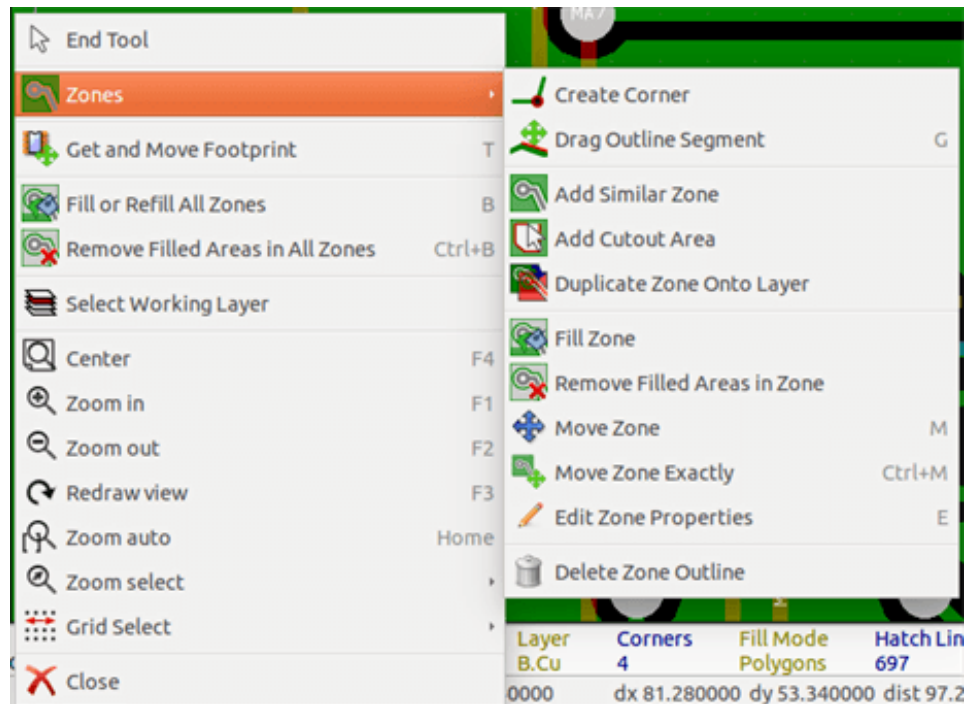


Dopo lo riempimento:

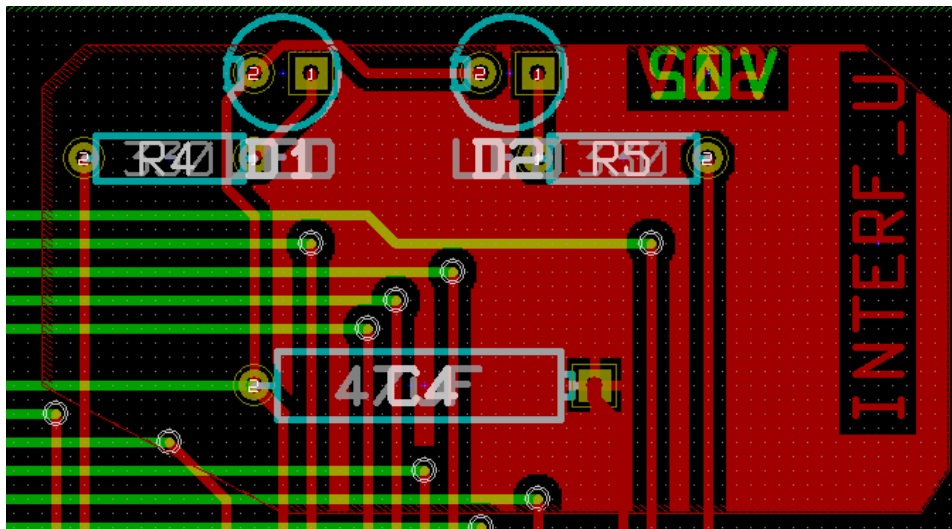


10.2.3 Riempimento della zona

Durante lo riempimento di una zona, Pcbnew rimuove tutte le isole di rame non connesse. Per accedere al comando di riempimento zone, fare clic destro sulla zona bordo.



Activate the Fill Zone command. Below is the filling result for a starting point inside the polygon:

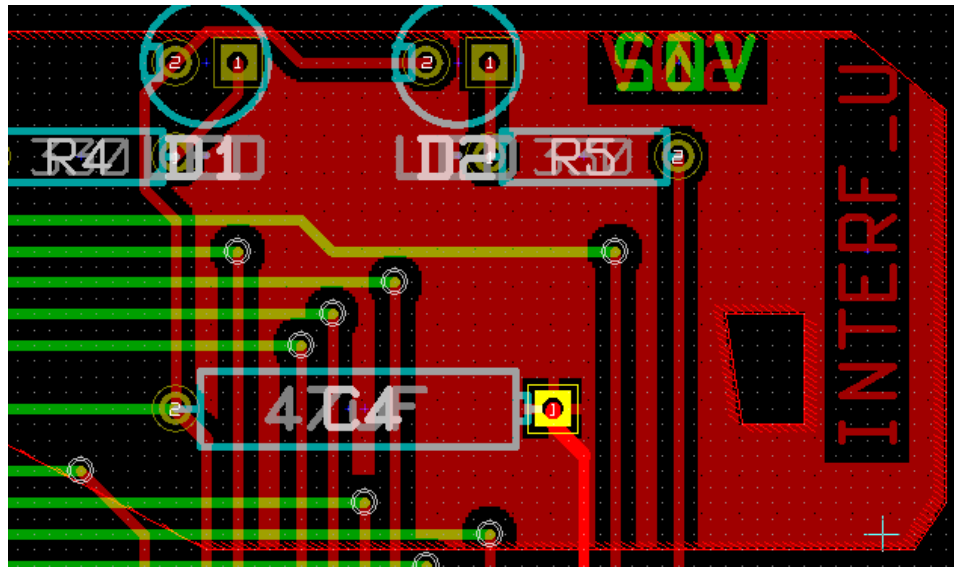


The polygon is the border of the filling area. You can see a non-filled area inside the zone, because this area is not accessible:

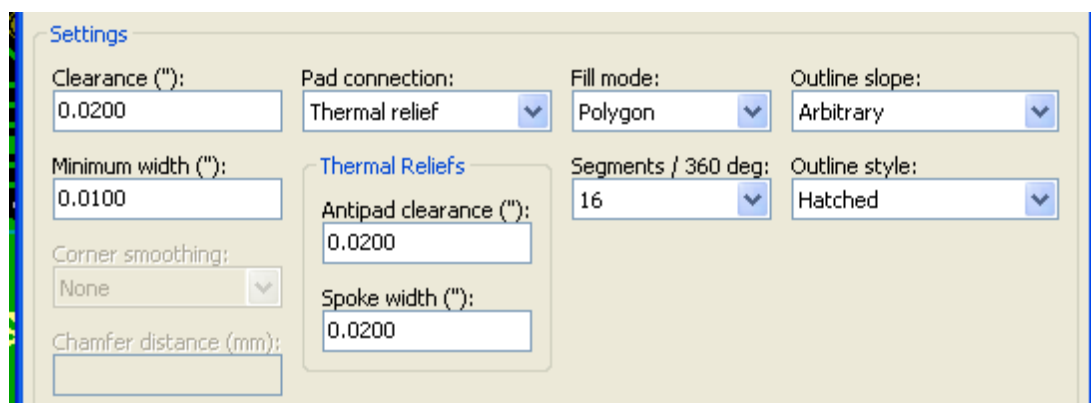
- Una pista crea un confine, e
- Non c'è punto di inizio per riempire quest' area.

Nota

You can use many polygons to create cutout areas. Here you can see an example:



10.3 Opzioni riempimenti



When you fill an area, you must choose:

- The mode for filling.
- The clearance and minimum copper thickness.
- How pads are drawn inside the zone (or connected to this zone).
- Thermal relief parameters.

10.3.1 Filling mode

Zones can be filled using polygons or segments. The result is the same. If you have problems with polygon mode (slow screen refresh) you should use segments.

10.3.2 Clearance and minimum copper thickness

A good choice for clearance is a grid that is a bit bigger than the routing grid. Minimum copper thickness value ensures that there are no too small copper areas.



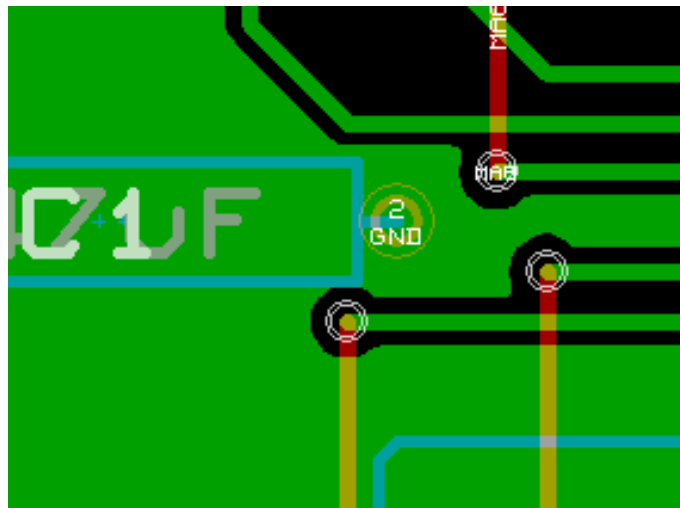
avvertimento

if this value is too large, small shapes like thermal stubs in thermal reliefs cannot be drawn.

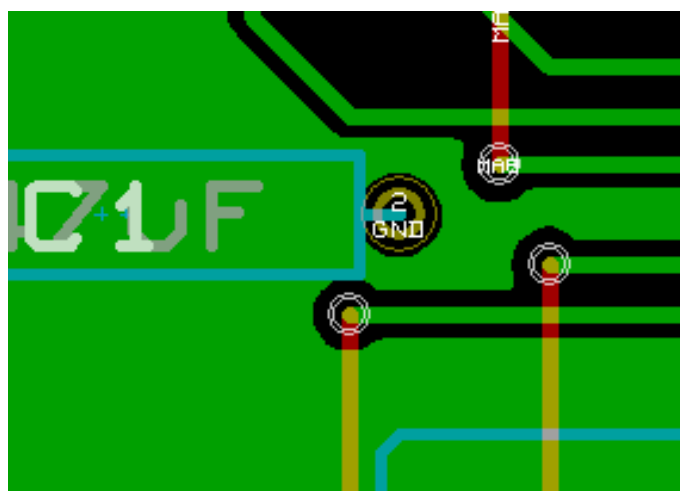
10.3.3 Opzioni piazzole

Pads of the net can either be included or excluded from the zone, or connected by thermal reliefs.

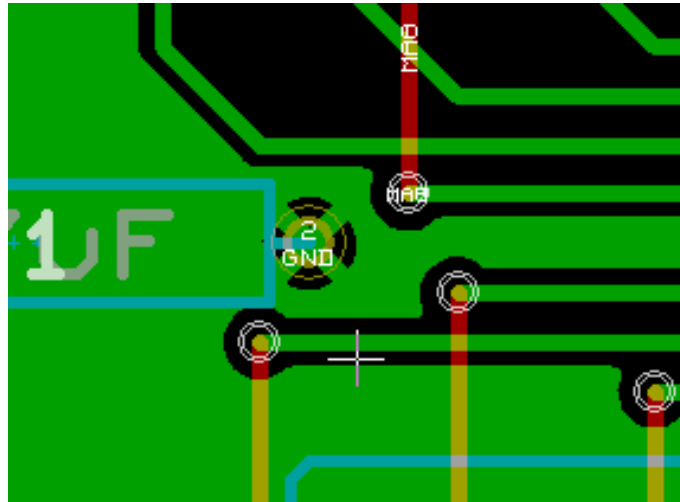
- If included, soldering and un-soldering can be very difficult due to the high thermal mass of the large copper area.



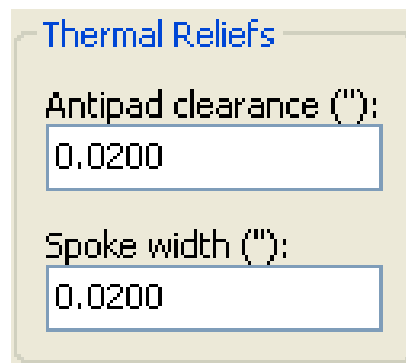
- If excluded, the connection to the zone will not be very good.
 - The zone can be filled only if tracks exists to connect zones areas.
 - Pads must be connected by tracks.



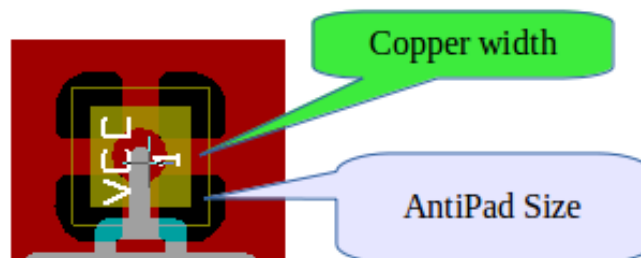
- A thermal relief is a good compromise.
 - Pad is connected by 4 track segments.
 - The segment width is the current value used for the track width.



10.3.4 Thermal reliefs parameters



You can set two parameters for thermal reliefs:



10.3.5 Choice of parameters

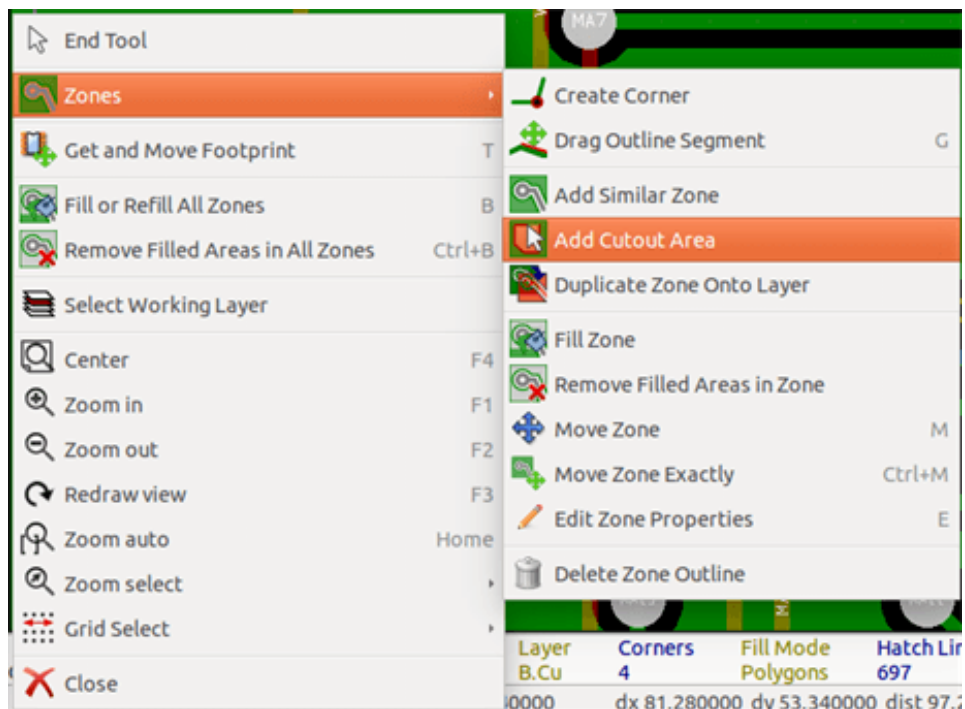
The copper width value for thermal reliefs must be bigger than the minimum thickness value for the copper zone. If not, they cannot be drawn.

Additionally, a too large value for this parameter or for antipad size does not allow one to create a thermal relief for small pads (like pad sizes used for SMD components).

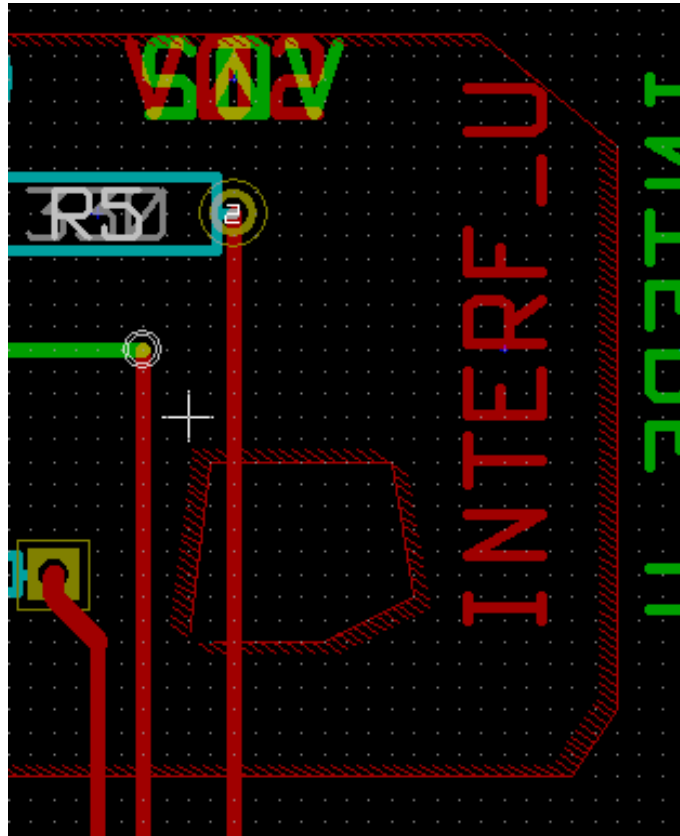
10.4 Adding a cutout area inside a zone

A zone must already exist. To add a cutout area (a non-filled area inside the zone):

- Right-click on an existing edge outline.
- Select Add Cutout Area.



- Creazione di un nuovo contorno.

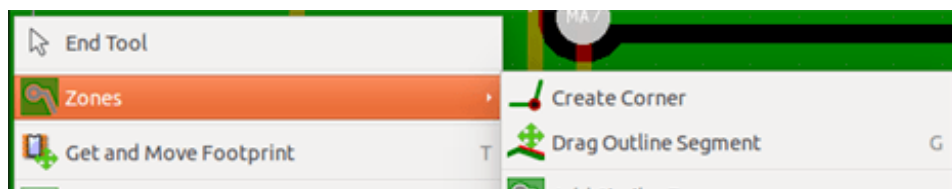


10.5 Modifica dei contorni

Un contorno può essere modificato da:

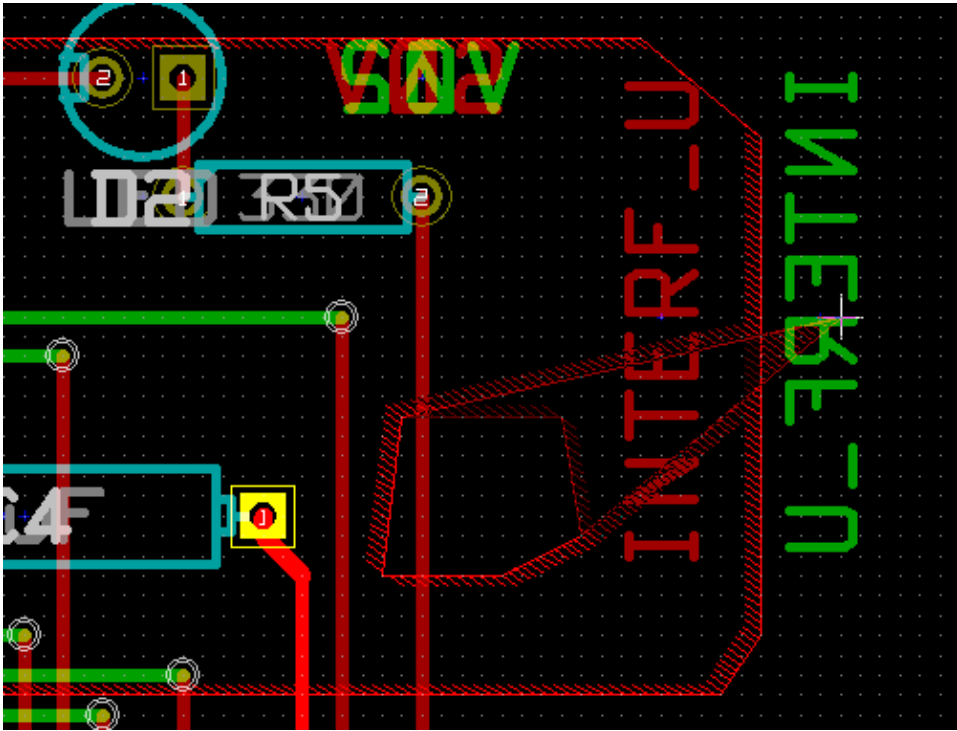
- Spostamento di un angolo o di uno spigolo.
- Cancellazione o aggiunta di un angolo.
- Adding a similar zone, or a cutout area.

If polygons are overlapping they will be combined.

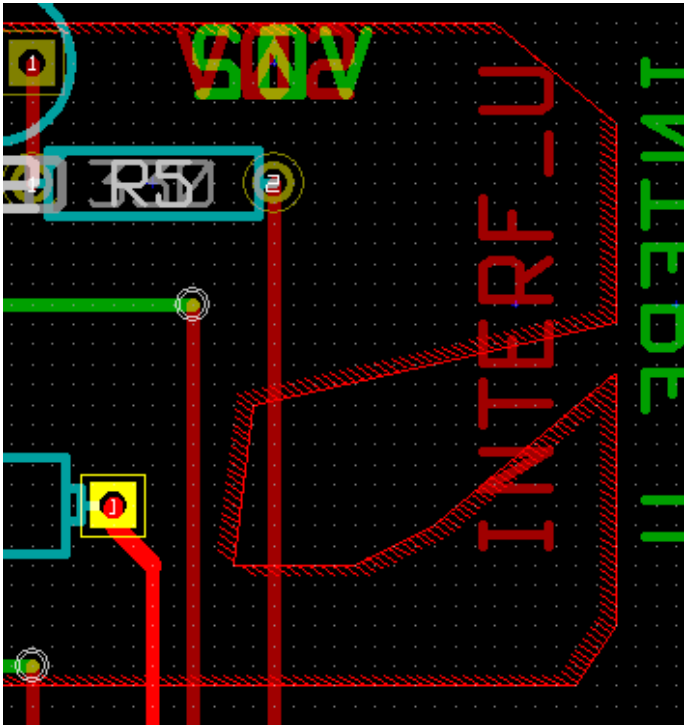


To do that, right-click on a corner or on an edge, then select the proper command.

Here is a corner (from a cutout) that has been moved:



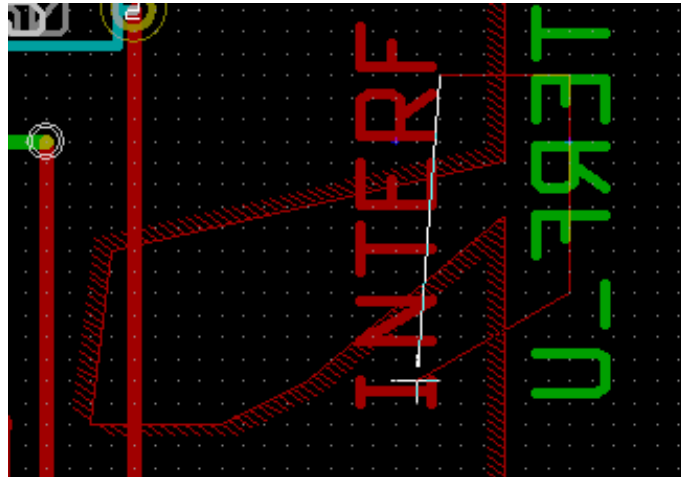
Here is the final result:



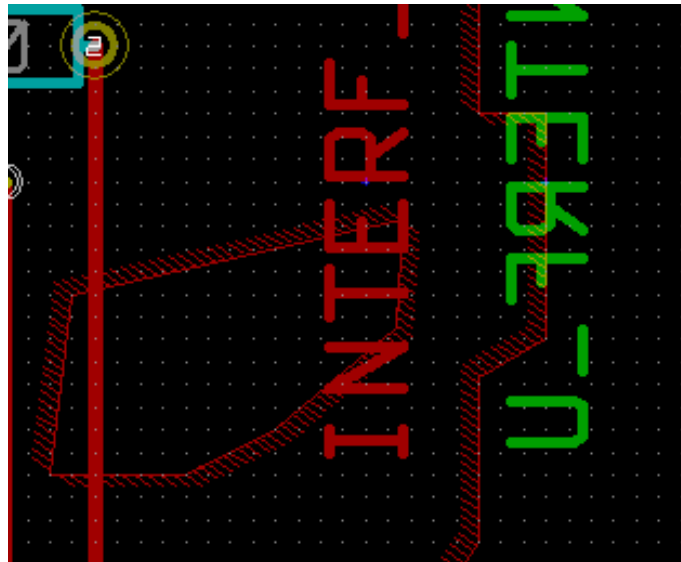
Polygons are combined.

10.5.1 Adding a similar zone

Adding the similar zone:



Final result:




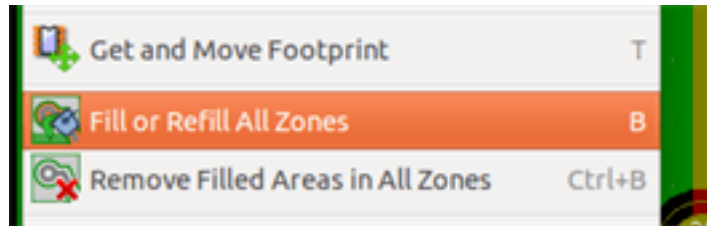
10.6 Editing zone parameters

When right-clicking on an outline, and using *Edit Zone Params* the Zone params Dialog box will open. Initial parameters can be inputted. If the zone is already filled, refilling it will be necessary.

10.7 Final zone filling

When the board is finished, one must fill or refill all zones. To do this:

- Activate the tool zones via the button .
- Right-click to display the pop-up menu.



- Use Fill or Refill All Zones:

**avvertimento**

Calculation can take some time if the filling grid is small.

10.8 Change zones net names

After editing a schematic, you can change the name of any net. For instance VCC can be changed to +5V.

When a global DRC control is made Pcbnew checks if the zone net name exists, and displays an error if not.

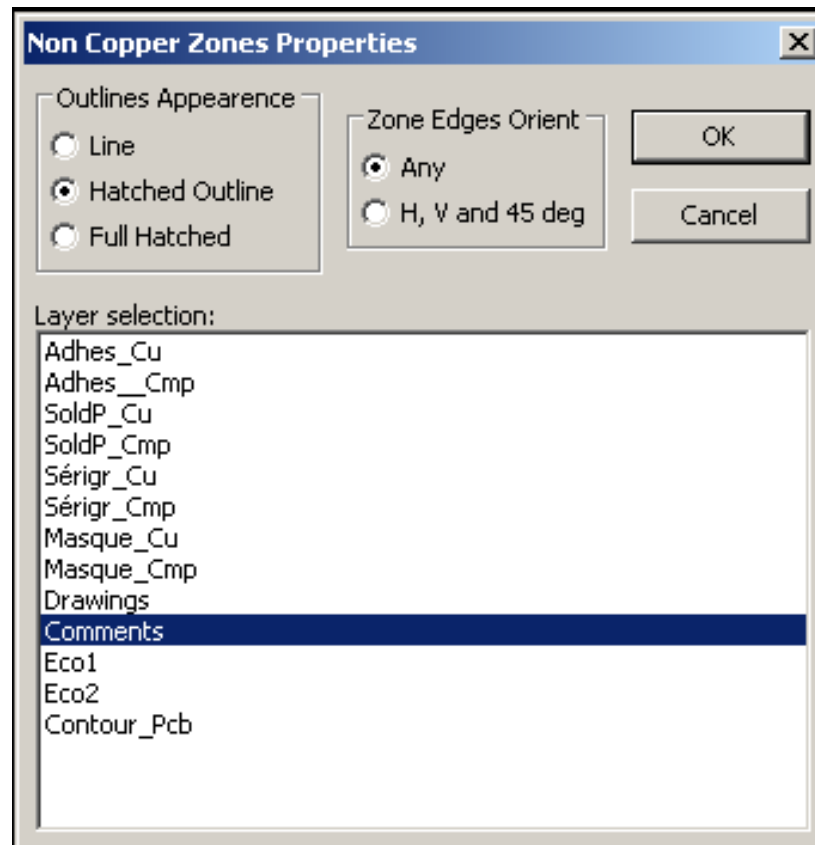
Manually editing the zone parameters will be necessary to change the old name to the new one.

10.9 Creating zones on technical layers

10.9.1 Creating zone limits

This is done using the button . The active layer must be a technical layer.

When clicking to start the zone outline, this dialog box is opened:



Select the technical layer to place the zone and draw the zone outline like explained previously for copper layers.

Nota

- For editing outlines use the same method as for copper zones.
 - If necessary, cutout areas can be added.
-

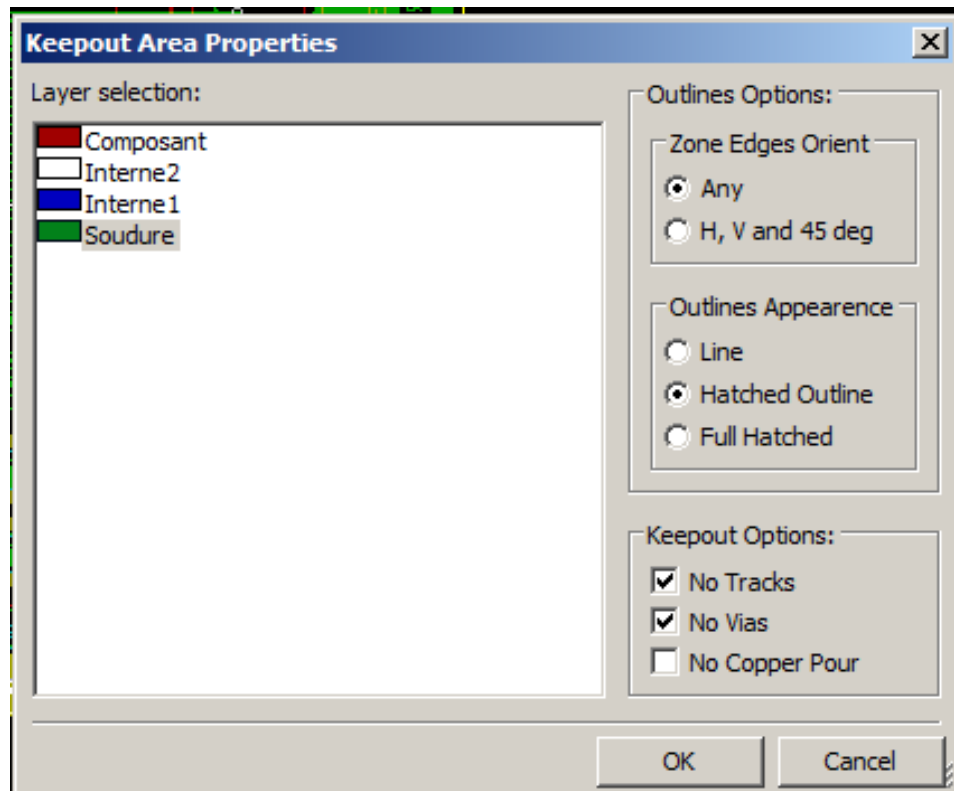
10.10 Creazione di un' area proibita



Select the tool

Lo strato attivo dovrebbe essere uno strato rame.

After clicking on the starting point of a new keepout area, the dialog box is opened:



One can select disallowed items:

- Piste.
- Via.
- Copper pours.

When a track or a via is inside a keepout which does not allow it, a DRC error will be raised.

Per le zone in rame, l' area dentro un' area proibita senza diffusione di rame non verrà riempita. Un' area proibita è come una zona, perciò la modifica dei suoi bordi è analoga alla modifica di una zone in rame.

Capitolo 11

Files for circuit fabrication

Let us see now what are the steps necessary for the creation of the necessary files for the production of your printed circuit board.

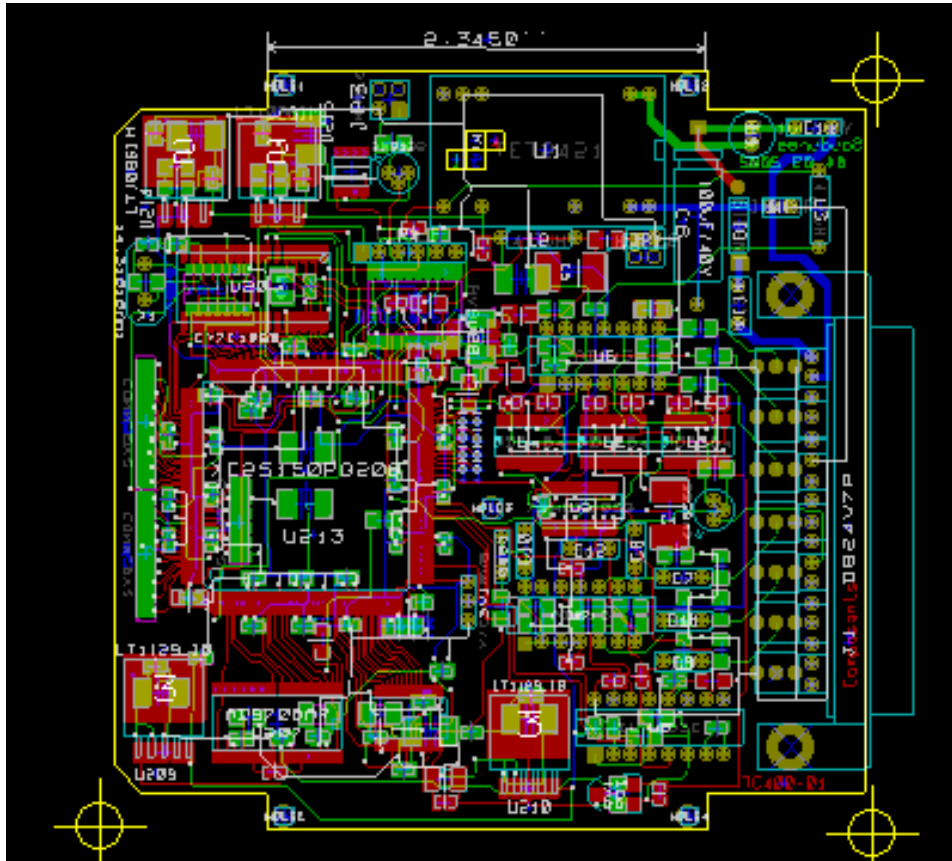
All files generated by KiCad are placed in the working directory which is the same directory that contains the xxxx.brd file for the printed circuit board.

11.1 Final preparations

The generation of the necessary files for the production of your printed circuit board includes the following preparatory steps.

- Mark any layer (e.g., *top or front* and *bottom or back*) with the project name by placing appropriate text upon each of the layers.
- All text on copper layers (sometimes called *solder* or *bottom*) must be mirrored.
- Create any ground planes, modifying traces as required to ensure they are contiguous.
- Place alignment crosshairs and possibly the dimensions of the board outline (these are usually placed on one of the general purpose layers).

Here is an example showing all of these elements, except ground planes, which have been omitted for better visibility:




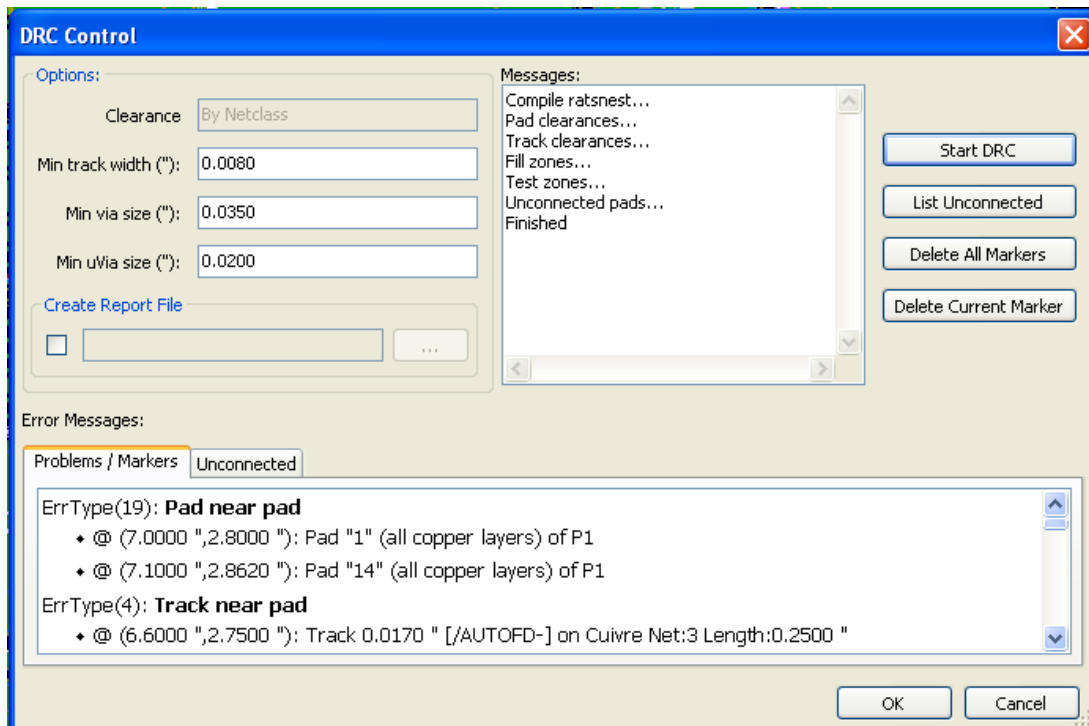
A color key for the 4 copper layers has also been included:



11.2 Final DRC test

Before generating the output files, a global DRC test is very strongly recommended.

Zones are filled or refilled when starting a DRC. Press the button  to launch the following DRC dialog:




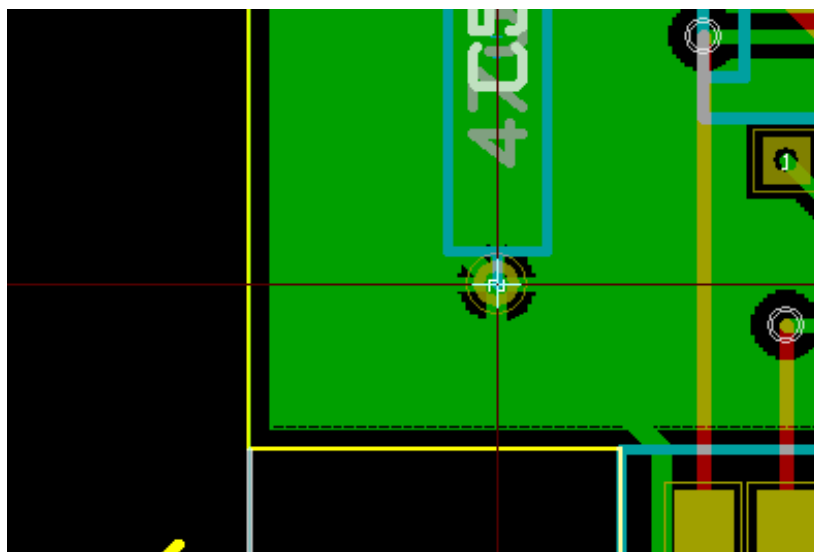
Adjust the parameters accordingly and then press the Start DRC button.

This final check will prevent any unpleasant surprises.

11.3 Setting coordinates origin

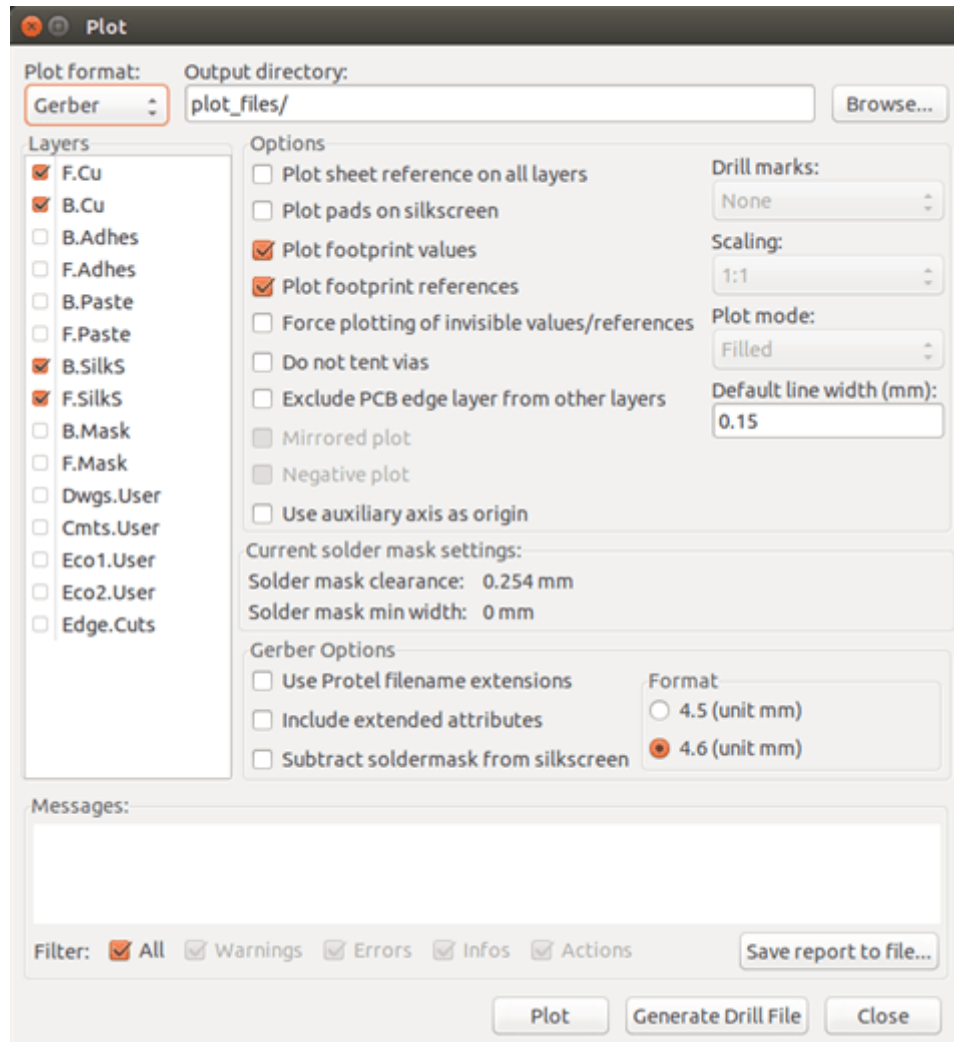
Set the coordinates origin for the photo plot and drill files, one must place the auxiliary axis on this origin. Activate

the icon . Move the auxiliary axis by left-clicking on the chosen location.

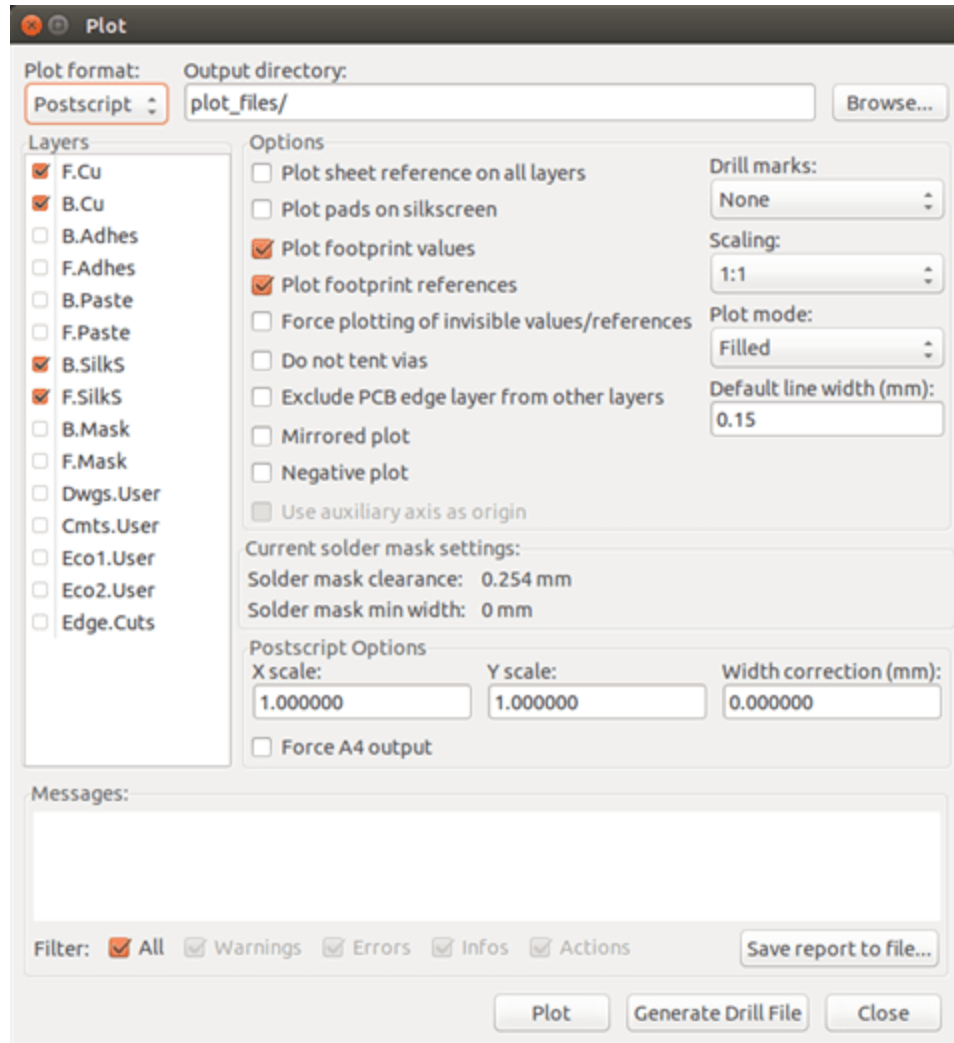


11.4 Generating files for photo-tracing

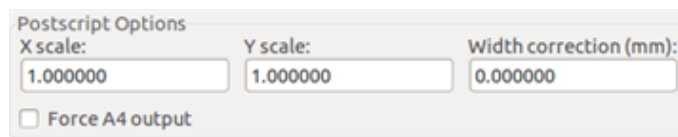
This is done via the Files/Plot menu option and invokes the following dialog:



Usually, the files are in the GERBER format. Nevertheless, it is possible to produce output in both HPGL and POSTSCRIPT formats. When Postscript format is selected, this dialog will appear.



In these formats, a fine scale adjust can be used to compensate for the plotter accuracy and to have a true scale of 1 for the output:



11.4.1 GERBER format

For each layer, Pcbnew generates a separate file following the GERBER 274X standard, by default in 4.6 format (each coordinate in the file is represented by 10 digits, of which 4 are before the decimal point and 6 follow it), units in inches, and a scale of 1.

It is normally necessary to create files for all of the copper layers and, depending on the circuit, for the silkscreen, solder mask, and solder paste layers. All of these files can be produced in one step, by selecting the appropriate check boxes.

For example, for a double-sided circuit with silkscreen, solder mask and solder paste (for SMD components), 8 files should be generated (*xxxx* represents the name of the .brd file).

- xxxx-F_Cu.gbr for the component side.
- xxxx-B_Cu.gbr for the copper side.
- xxxx-F_SilkS.gbr for the component-side silkscreen markings.
- xxxx-B_SilkS.gbr for the copper-side silkscreen markings.
- xxxx-F_Paste.gbr for the component-side solder paste.
- xxxx-B_Paste.gbr for the copper-side solder paste.
- xxxx-F_Mask.gbr for the component-side solder mask.
- xxxx-B_Mask.gbr for the copper-side solder mask.

GERBER file format:

The format used by Pcbnew is RS274X format 4.6, Imperial, Leading zero omitted, Abs format. These are very usual settings.

11.4.2 POSTSCRIPT format

The standard extension for the output files is .ps in the case of postscript output. As for HPGL output, the tracing can be at user-selected scales and can be mirrored. If the Org = Centre option is active, the origin for the coordinates of the tracing table is assumed to be in the centre of the drawing.

If the Print Sheet Ref option is active, the sheet cartridge is traced.

11.4.3 Plot options

Gerber format:

Options

☐ Plot sheet reference on all layers

☐ Plot pads on silkscreen

☒ Plot footprint values

☒ Plot footprint references

☐ Force plotting of invisible values/references

☐ Do not tent vias

☐ Exclude PCB edge layer from other layers

☐ Mirrored plot

☐ Negative plot

☐ Use auxiliary axis as origin

Drill marks:
None

Scaling:
1:1

Plot mode:
Filled

Default line width (mm):
0.15

Current solder mask settings:
Solder mask clearance: 0.254 mm
Solder mask min width: 0 mm

Gerber Options

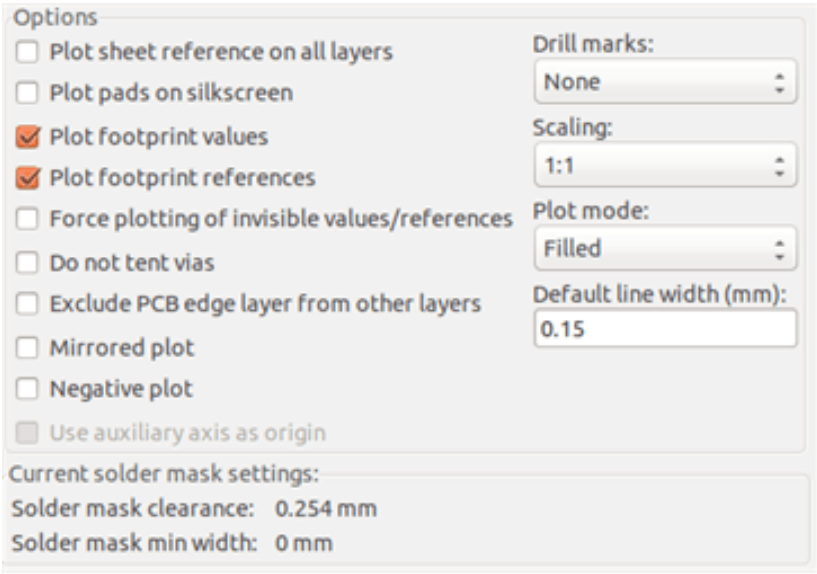
☐ Use Protel filename extensions

☐ Include extended attributes

☐ Subtract soldermask from silkscreen

Format
☐ 4.5 (unit mm)
☒ 4.6 (unit mm)

Altri formati:



GERBER format specific options:

Use Protel filename extensions	Use .gbl .gtl .gbs .gts .gbp .gtp .gbo .gto instead of .gbr for file name extensions.
Include extended attributes	Output extended attributes to file.
Subtract soldermask from silkscreen	Remove all Silk from solder paste areas.

11.4.4 Other formats

The standard extension depends on the output file type.

Some options are not available for some formats.

The plot can be done at user-selected scales and can be mirrored.

The Print Drill Opt list offers the option of pads that are filled, drilled to the correct diameter or drilled with a small hole (to guide hand drilling).

If the Print Sheet Ref option is active, the sheet cartridge is traced.

11.5 Global clearance settings for the solder stop and the solder paste mask

Mask clearance values can be set globally for the solder mask layers and the solder paste layers. These clearances can be set at the following levels.

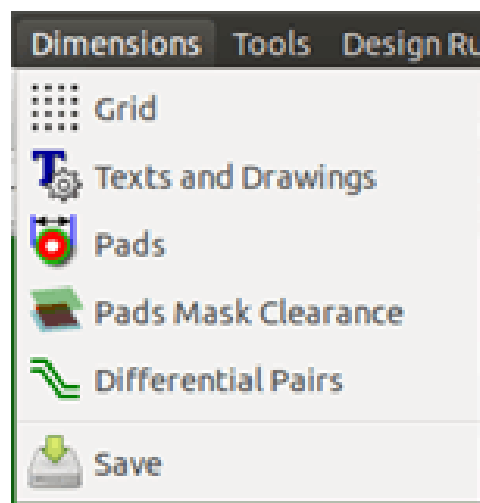
- At pads level.
- At footprint level.
- Globally.

And Pcbnew uses by priority order.

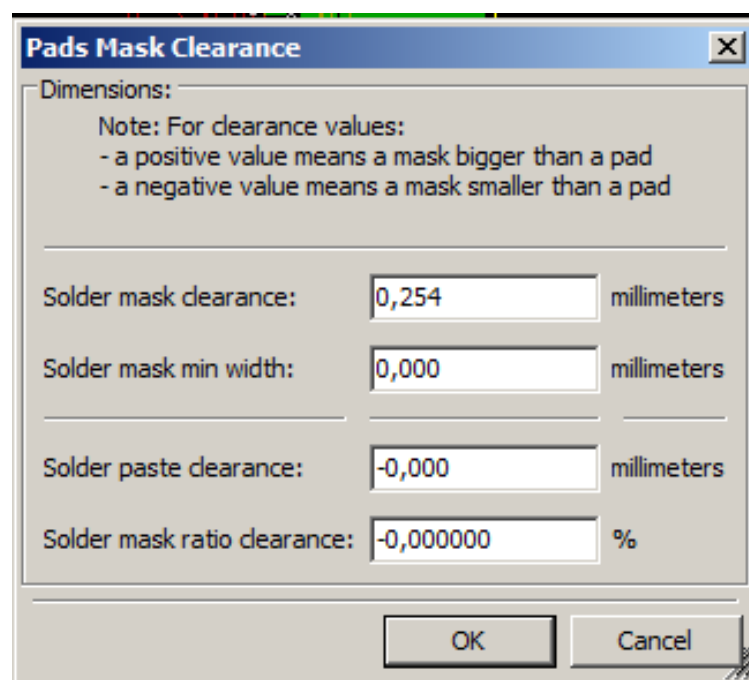
- Pad values. If null:
- Footprint values. If null:
- Global values.

11.5.1 Access

The menu option for this is available via the Dimensions menu:



The dialog box is the following:



11.5.2 Solder mask clearance

A value near to 0.2 mm is usually good. This value is positive because the mask is usually bigger than the pad.

One can set a minimum value for the solder mask width, between 2 pads.

If the actual value is smaller than the minimum value, the 2 solder mask shapes will be merged.

11.5.3 Solder paste clearance

The final clearance is the sum of the solder paste clearance and a percentage of the pad size.

This value is negative because the mask is usually smaller than the pad.

11.6 Generating drill files

The creation of a drill file xxxx.drl following the EXCELLON standard is always necessary.

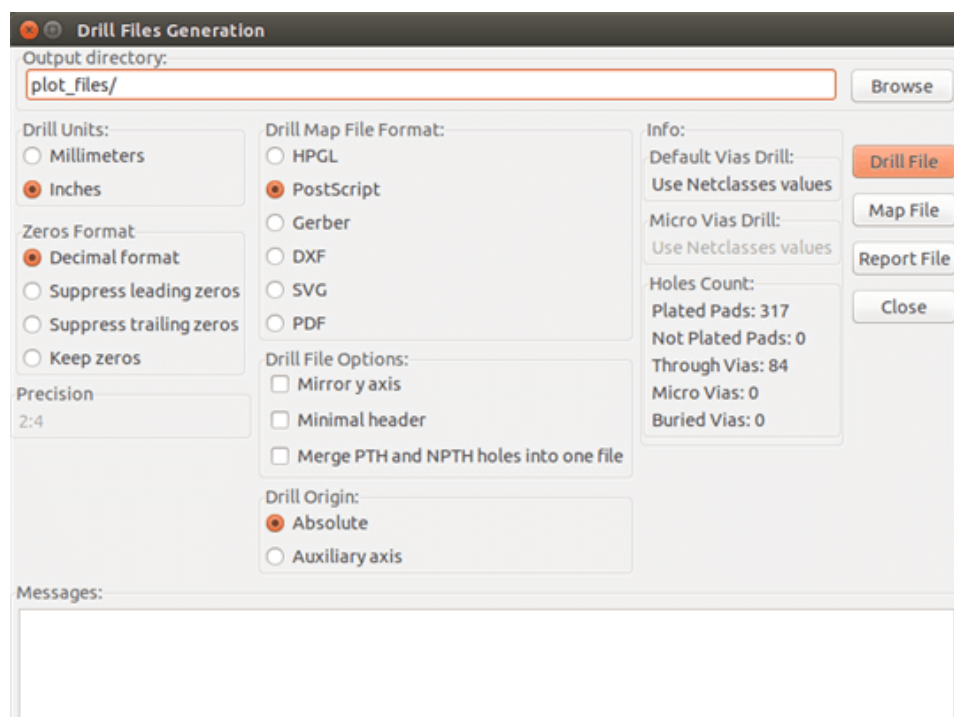
One can also produce an optional drill report, and an optional drill map.

- The drill map can be plotted using several formats.
- The drill report is a plain text file.

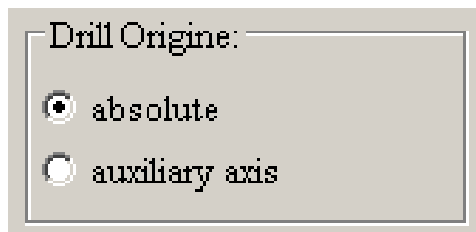
The generation of these files is controlled via:

- Create Drill File button, or
- Files/Fabrication Outputs/Drill file menu selection.

The Drill tools dialog box will be the following:



For setting the coordinate origin, the following dialog box is used:



- Absolute: absolute coordinate system is used.
- Auxiliary axis: coordinates are relative to the auxiliary axis, use the icon (right toolbar) to set it.

11.7 Generating wiring documentation

To produce wiring documentation files, the component and copper silkscreen layers can be traced. Usually, just the component-side silkscreen markings are sufficient for wiring a PCB. If the copper-side silkscreen is used, the text it contains should be mirrored in order to be readable.

11.8 Generation of files for automatic component insertion

This option is accessed via the Postprocess/Create Cmp file menu option. However, no file will be generated unless at least one footprint has the Normal+Insert attribute activated (see Editing Footprints). One or two files will be produced, depending upon whether insertable components are present on one or both sides of the PCB. A dialogue box will display the names of the file(s) created.

11.9 Advanced tracing options

The options described below (part of the Files/Plot dialogue) allow for fine-grained control of the tracing process. They are particularly useful when printing the silkscreen markings for wiring documentation.

The available options are:

Plot sheet reference on all layers	Trace sheet outline and the cartridge.
Plot pads on silkscreen	Enables/disables printing of pad outlines on the silkscreen layers (if the pads have already been declared to appear on these layers). Prevents any pads from being printed in the disabled mode.
Plot footprint values	Enables printing of VALUE text on the silkscreen.
Plot footprint references	Enables printing of the REFERENCE text on the silkscreen.
Force plotting of invisible values/ references	Forces printing of fields (reference, value) declared as invisible. In combination with <i>Plot footprint values</i> and <i>Plot footprint references</i> , this option enables production of documents for guiding wiring and repair. These options have proven necessary for circuits using components that are too small (SMD) to allow readable placement of two separate text fields.
Do not tent vias	Delete the mask over the vias.
Exclude PCB edge layer from other layers	GERBER format specific. Do not plot graphic items on edge layer.
Use Protel filename extensions	GERBER format specific. When creating files, use specific extensions for each file. If disabled the Gerber file extension is .gbr.

Capitolo 12

Footprint Editor - Managing Libraries

12.1 Overview of Footprint Editor

Pcbnew can simultaneously maintain several libraries. Thus, when a footprint is loaded, all libraries that appear in the library list are searched until the first instance of the footprint is found. In what follows, note that the active library is the library selected within the Footprint Editor, the program will now be described

Footprint Editor enables the creation and the editing of footprints:

- Adding and removing pads.
- Changing pad properties (shape, layer) for individual pads or globally for all pads of a footprint.
- Editing graphic elements (lines, text).
- Editing information fields (value, reference, etc.).
- Editing the associated documentation (description, keywords).

Footprint Editor allows the maintenance of the active library as well by:


- Listing the footprints in the active library.
- Deletion of a footprint from the active library.
- Saving a footprint to the active library.
- Saving all of the footprints contained by a printed circuit.

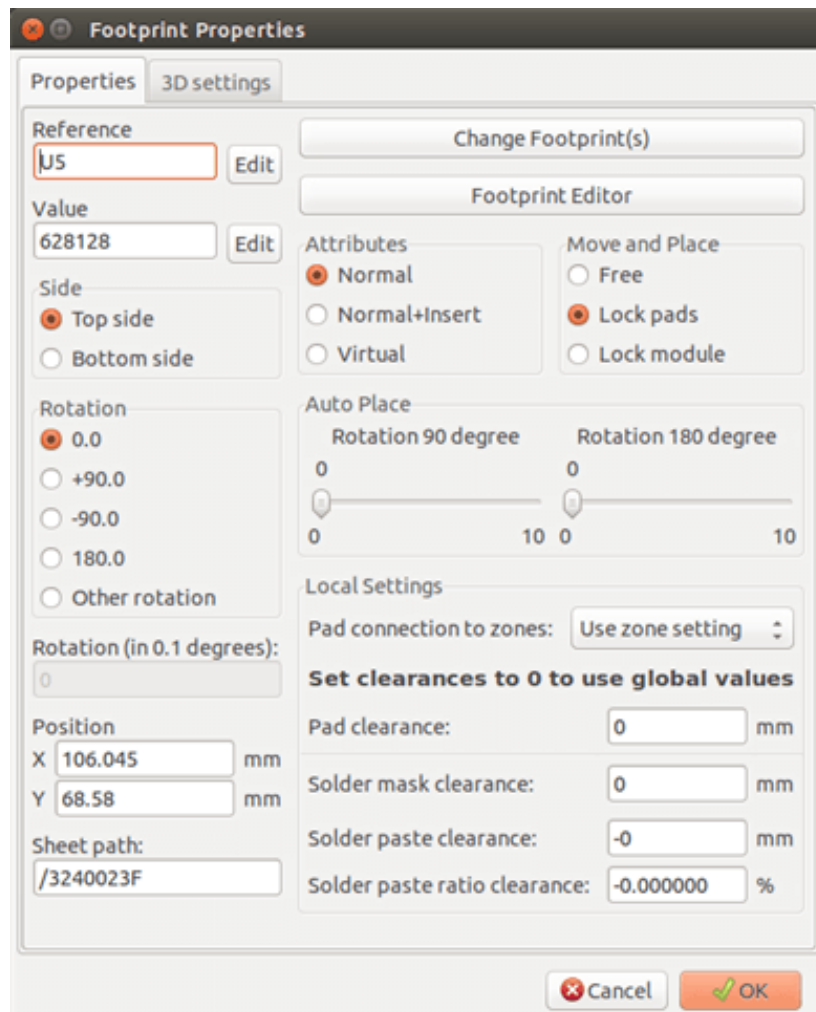
It is also possible to create new libraries.

The library extension is `.mod`.

12.2 Accessing Footprint Editor

The Footprint Editor can be accessed in two different ways:

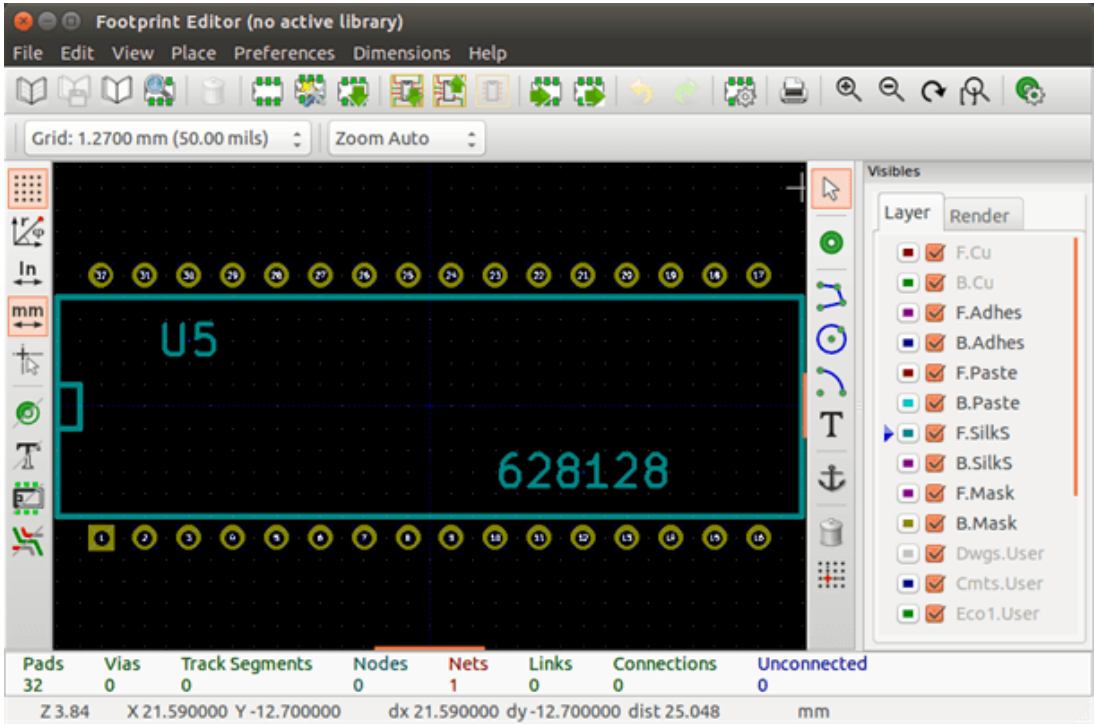
- Directly, via the icon  in the main toolbar of Pcbnew.
- In the edit dialog for the active footprint (see figure below: accessed via the context menu), there is the button Footprint Editor.



In this case, the active footprint of the board will be loaded automatically in Footprint Editor, enabling immediate editing or archiving.

12.3 Footprint Editor user interface










By calling Footprint Editor the following window will appear:













12.4 Top toolbar in Footprint Editor





From this toolbar, the following functions are available:

	Select the active library.
	Save the current footprint to the active library, and write it to disk.
	Create a new library and save the current footprint in it.
	Open the Footprint Viewer
	Access a dialog for deleting a footprint from the active library.
	Create a new footprint.
	Create a footprint using a wizard
	Load a footprint from the active library.
	Load (import) a footprint from the printed circuit board.

	Export the current footprint to the printed circuit board. when the footprint was previously imported from the current board. It will replace the corresponding footprint on the board (i.e., respecting position and orientation).
	Export the current footprint to the printed circuit board. It will be copied on to the printed circuit board at position 0.
	Import a footprint from a file created by the Export command.
	Export a footprint. This command is essentially identical to that for creating a library, the only difference being that creates a library in the user directory, while creates a library in the standard library directory (usually kicad/modules).
	Undo and Redo
	Invokes the footprint properties dialog.
	Call the print dialog.
	Standard zoom commands.
	Call the pad editor.
	Perform a check of footprint correctness

12.5 Creating a new library

The creation of a new library is done via the button  , in this case the file is created by default in the library directory or via the button  , in which case the file is created by default in your working directory.


A file-choosing dialog allows the name of the library to be specified and its directory to be changed. In both cases, the library will contain the footprint being edited.



avvertimento





If an old library of the same name exists, it will be overwritten without warning.

12.6 Saving a footprint in the active library



The action of saving a footprint (thereby modifying the file of the active library) is performed using this button . If a footprint of the same name already exists, it will be replaced. Since you will depend upon the accuracy of the library footprints, it is worth double-checking the footprint before saving.

It is recommended to edit either the reference or value field text to the name of the footprint as identified in the library.

12.7 Transferring a footprint from one library to another

- Select the source library via the button .
- Load the footprint via the button .
- Select the destination library via the button .
- Save the footprint via the button .

You may also wish to delete the source footprint.

- Reselect the source library with .
- Delete the old footprint via the button .

12.8 Saving all footprints of your board in the active library

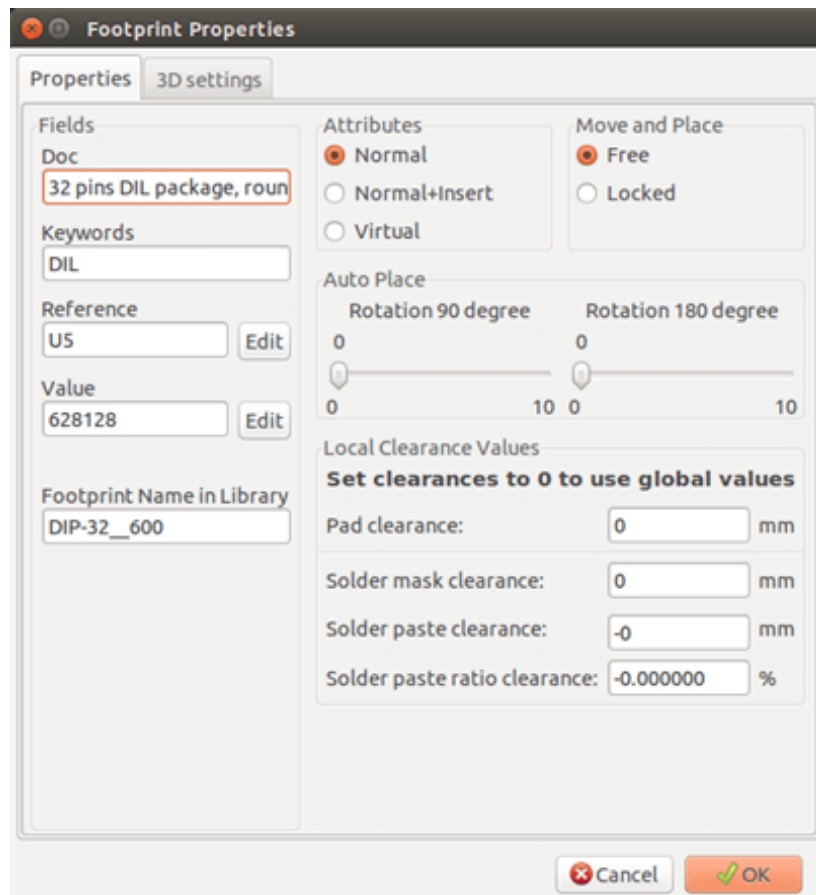
It is possible to copy all of the footprints of a given board design to the active library. These footprints will keep their current library names. This command has two uses:

- To create an archive or complete a library with the footprints from a board, in the event of the loss of a library.
- More importantly, it facilitates library maintenance by enabling the production of documentation for the library, as below.

12.9 Documentation for library footprints

It is strongly recommended to document the footprints you create, in order to enable rapid and error-free searching.

For example, who is able to remember all of the multiple pin-out variants of a TO92 package? The Footprint Properties dialog offers a simple solution to this problem.



This dialog accepts:

- A one-line comment/description.
- Multiple keywords.

The description is displayed with the component list in Cypcb and, in Pcbnew, it is used in the footprint selection dialogs.

The keywords enable searches to be restricted to those footprints corresponding to particular keywords.

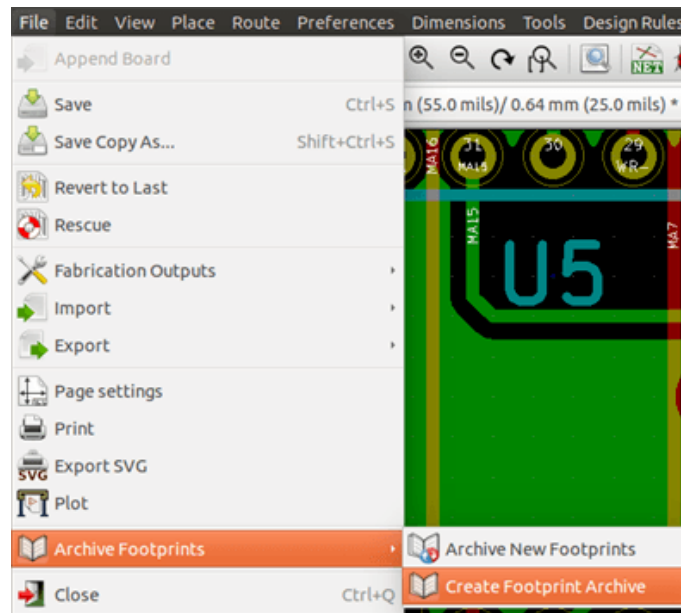


When directly loading a footprint (the icon of the right-hand Pcbnew toolbar), keywords may be entered in the dialog box. Thus, entering the text =CONN will cause the display of the list of footprints whose keyword lists contain the word CONN.

12.10 Documenting libraries - recommended practice

It is recommended to create libraries indirectly, by creating one or more auxiliary circuit boards that constitute the source of (part of) the library, as follows: Create a circuit board in A4 format, in order to be able to print easily to scale (scale = 1).

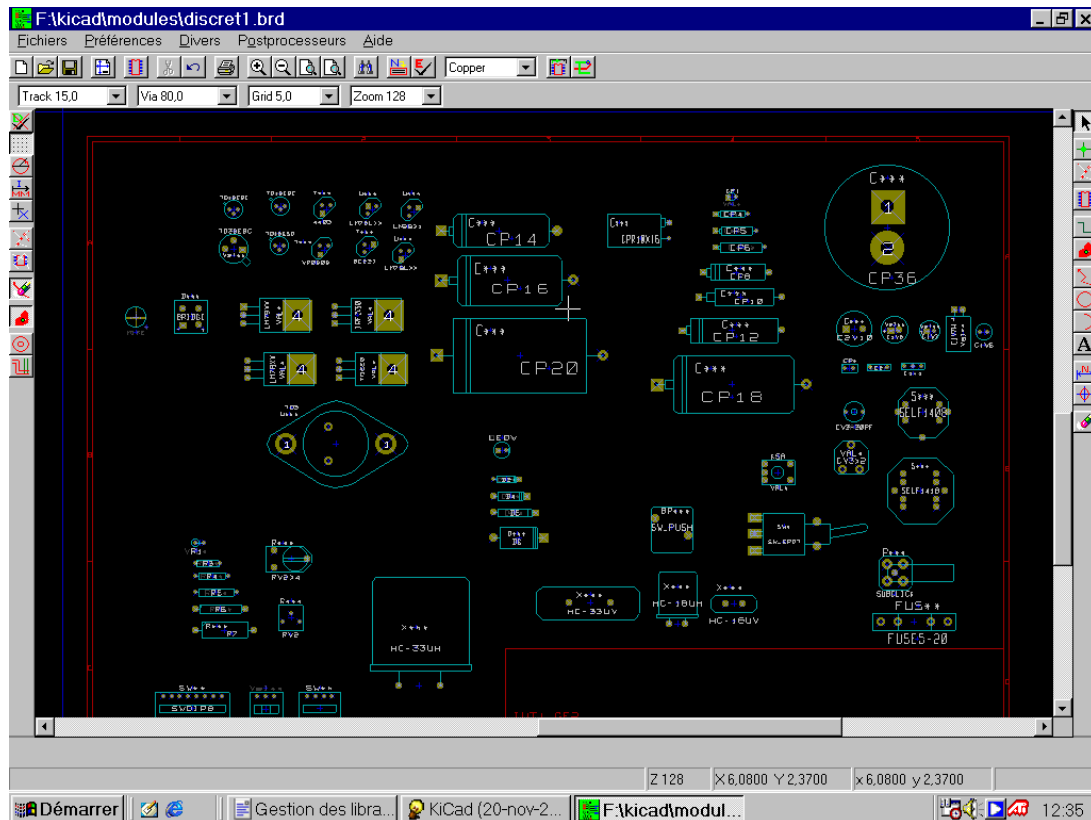
Create the footprints that the library will contain on this circuit board. The library itself will be created with the File/Archive footprints/Create footprint archive command.



The true source of the library will thus be the auxiliary circuit board, and it is on this circuit that any subsequent alterations of footprints will be made. Naturally, several circuit boards can be saved in the same library.

It is generally a good idea to make different libraries for different kinds of components (connectors, discretes,...), since Pcbnew is able to search many libraries when loading footprints.

Here is an example of such a library source:



This technique has several advantages:

- The circuit can be printed to scale and serve as documentation for the library with no further effort.
- Future changes of Pcbnew may require regeneration of the libraries, something that can be done very quickly if circuit-board sources of this type have been used. This is important, because the circuit board file formats are guaranteed to remain compatible during future development, but this is not the case for the library file format.

12.11 Footprint Libraries Management

The list of footprint libraries in Pcbnew can be edited using the Footprint Libraries Manager. This allows you to add and remove footprint libraries by hand, and also allows you to invoke the Footprint Libraries Wizard by pressing the Append With Wizard button.

L' assistente librerie di impronte può essere invocato anche tramite il menu delle preferenze, e può automaticamente aggiungere una libreria (rilevandone il tipo) da un file o da un URL Github. L' URL delle librerie ufficiali è: <https://github.com/KiCad>.

Ulteriori dettagli sulle tabelle di librerie di impronte, sul manager e sull' assistente relativo, sono reperibili sul manuale di riferimento del programma CvPcb nella sezione *Tabelle librerie impronte*.

12.12 Gestione librerie forme 3D

The 3D shape libraries can be downloaded by 3D Shape Libraries Wizard. It can be invoked from the menu Preferences → 3D Shapes Libraries Downloader.

Capitolo 13

Footprint Editor - Creating and Editing Footprints

13.1 Footprint Editor overview

Footprint Editor is used for editing and creating PCB footprints. This includes:

- Adding and removing pads.
- Changing pad properties (shape, layer), for individual pads or for all the pads in a footprint.
- Adding and editing graphic elements (contours, text).
- Editing fields (value, reference, etc.).
- Editing the associated documentation (description, keywords).

13.2 Footprint elements

A footprint is the physical representation (footprint) of the part to be inserted in the PCB and it must be linked to the relative component in your schematic. Each footprint includes three different elements:

- The pads.
- Graphical contours and text.
- Fields.

In addition, a number of other parameters must be correctly defined if the auto-placement function will be used. The same holds for the generation of auto-insertion files.

13.2.1 Pads

Two pad properties are important:

- Geometry (shape, layers, drill holes).
- The pad number, which is constituted by up to four alphanumeric characters. Thus, the following are all valid pad numbers: 1, 45 and 9999, but also AA56 and ANOD. The pad number must be identical to that of the corresponding pin number in the schematic, because it defines the matching pin and pad numbers that Pcbnew links pins and pads with.

13.2.2 Contours


Graphical contours are used to draw the physical shape of the footprint. Several different types of contour are available: lines, circles, arcs, and text. Contours have no electrical significance, they are simply graphical aids.

13.2.3 Fields

These are text elements associated with a footprint. Two are obligatory and always present: the reference field and the value field. These are automatically read and updated by Pcbnew when a netlist is read during the loading of footprints into your board. The reference is replaced by the appropriate schematic reference (U1, IC3, etc.). The value is replaced by the value of the corresponding part in the schematic (47K, 74LS02, etc.). Other fields can be added and these will behave like graphical text.

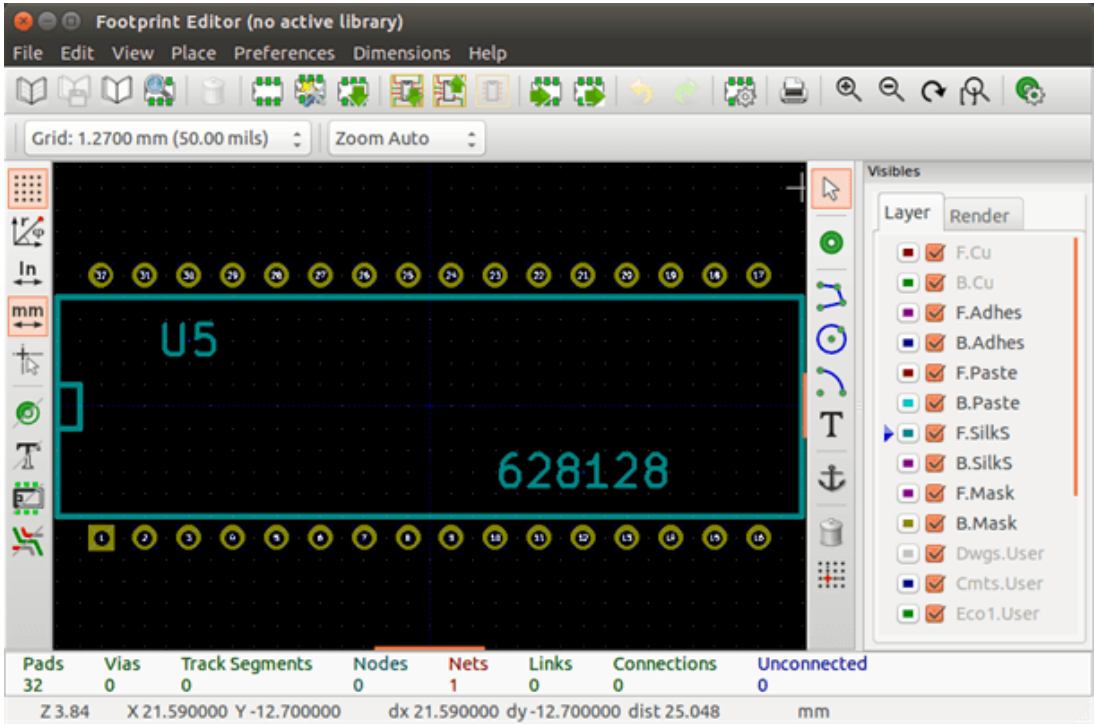
13.3 Starting Footprint Editor and selecting a footprint to edit

Footprint Editor can be started in two ways:

- Directly via the  icon from the main toolbar of Pcbnew. This allows the creation or modification of a footprint in the library.
- Double-clicking a footprint will launch the *Footprint Properties* menu, which offers a *Go to Footprint Editor* button. If this option is used, the footprint from the board will be loaded into the editor, for modification or for saving.

13.4 Footprint Editor Toolbars

Calling Footprint Editor will launch a new window that looks like this:












13.4.1 Edit toolbar (right-hand side)

This toolbar contains tools for:

- Placing pads.
- Adding graphic elements (contours, text).
- Positioning the anchor.
- Deleting elements.









The specific functions are the following:

	No tool.
	Add pads.
	Draw line segments and polygons.
	Draw circles.
	Draw circular arcs.
	Add graphical text (fields are not managed by this tool).
	Position the footprint anchor.

	Delete elements.
	Grid origin. (grid offset). Useful for placement of pads. The grid origin can be put on a given location (the first pad to place), and after the grid size can be set to the pad pitch. Placing pads is therefore very easy

13.4.2 Display toolbar (left-hand side)

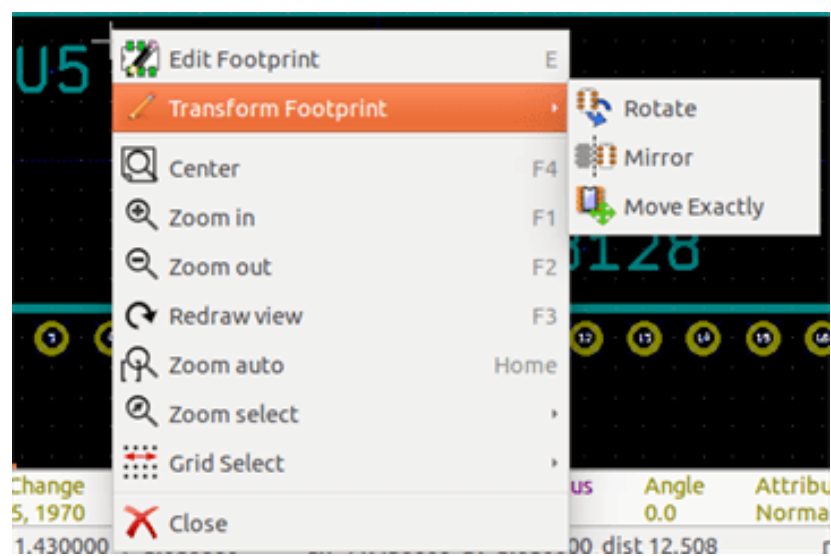
These tools manage the display options in Footprint Editor:

	Display the grid.
	Display polar coordinates.
	Use units of mm or inch
	Toggle cursor crosshair shape
	Display pad in outline mode.
	Display text in outline mode.
	Display contours in outline mode.
	Toggle high-contrast mode

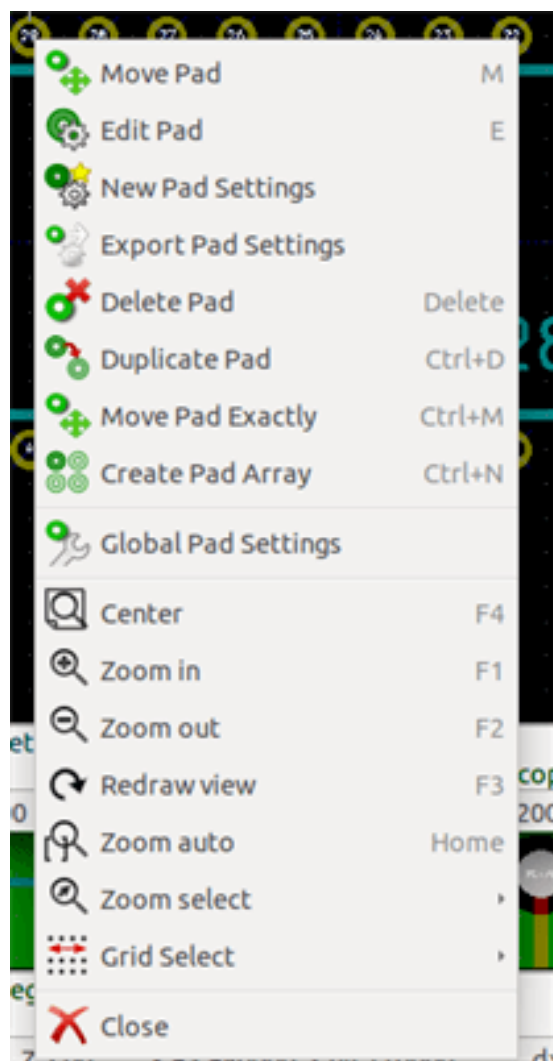
13.5 Context Menus

The right mouse button calls up menus that depend upon the element beneath the cursor.

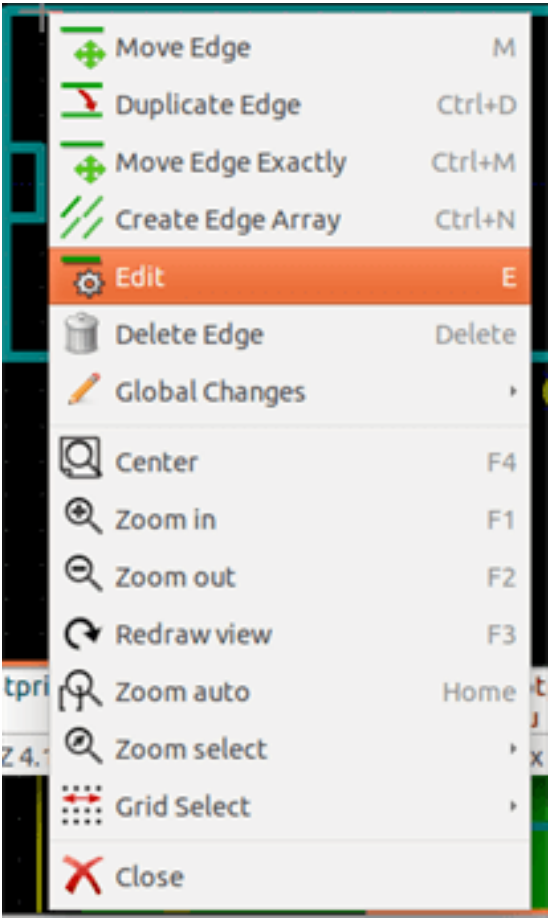
The context menu for editing footprint parameters:



The context menu for editing pads:

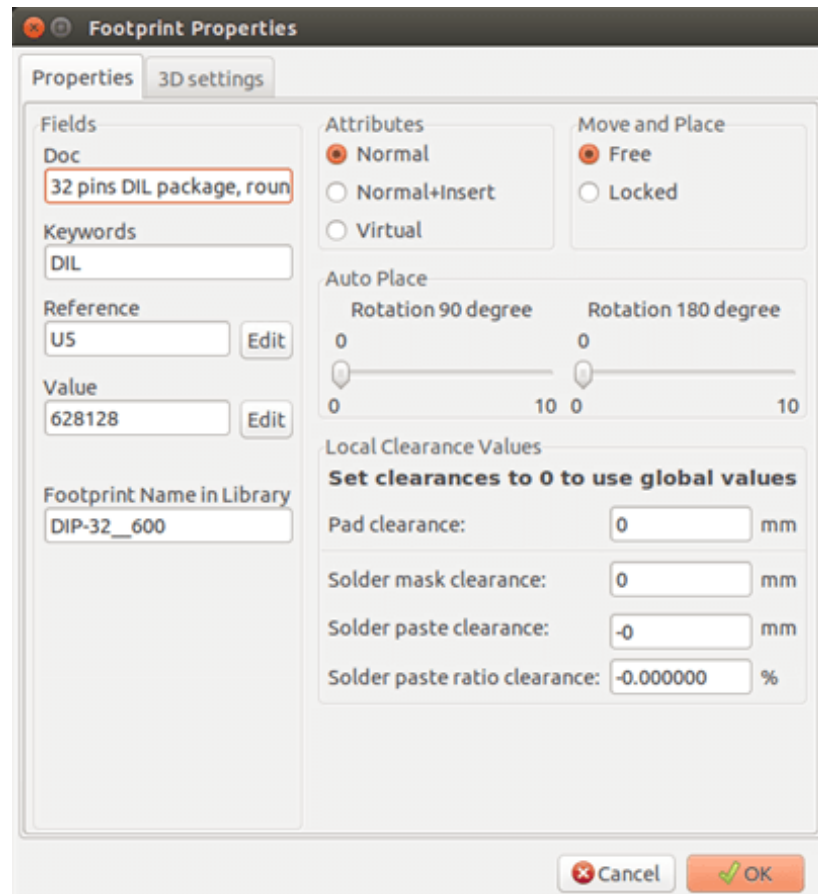


The context menu for editing graphic elements:



13.6 Footprint properties dialog


This dialog can be launched when the cursor is over a footprint by clicking on the right mouse button and then selecting *Edit Footprint*.



The dialog can be used to define the main footprint parameters.

13.7 Creazione di una nuova impronta



A new footprint can be created via the button . The name of the new footprint will be requested. This will be the name by which the footprint will be identified in the library.




This text also serves as the footprint value, which is ultimately replaced by the real value (100uF_16V, 100_0.5W, ...).

The new footprint will require:

- Contours (and possibly graphic text).
- Pads.
- A value (hidden text that is replaced by the true value when used).

Alternative method:


When a new footprint is similar to an existing footprint in a library or a circuit board, an alternative and quicker method of creating the new footprint is as follows:

- Load the similar footprint (,  or ).
- Modify the Footprint Name in Library field in order to generate a new identifier (name).
- Modifica e salvataggio di una nuova impronta.

13.8 Aggiunta e modifica piazzole

Once a footprint has been created, pads can be added, deleted or modified. Modification of pads can be local, affecting only the pad under the cursor, or global, affecting all pads of the footprint.


13.8.1 Aggiunta piazzole

Select the  icon from the right hand toolbar. Pads can be added by clicking in the desired position with the left mouse button. Pad properties are predefined in the pad properties menu.

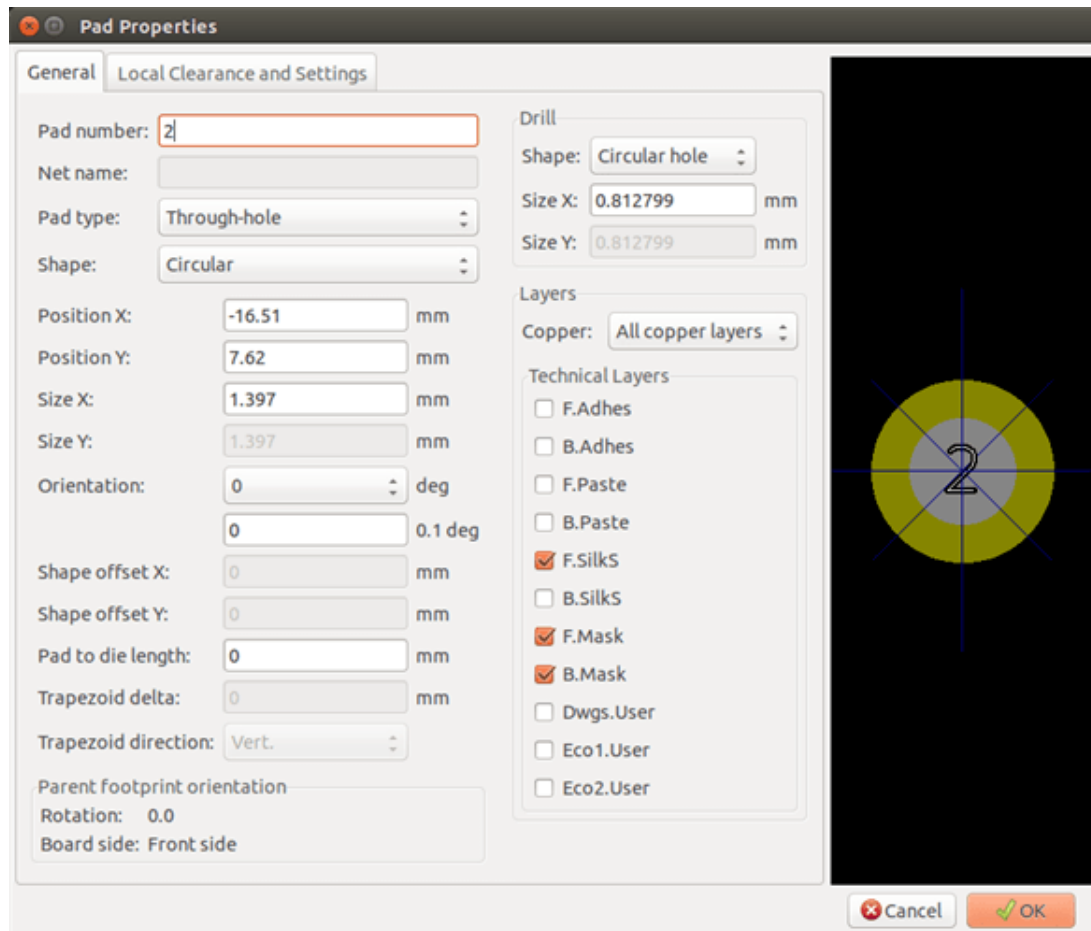
Do not forget to enter the pad number.

13.8.2 Setting pad properties

This can be done in three different ways:

- Selecting the  icon from the horizontal toolbar.
- Clicking on an existing pad and selecting *Edit Pad*. The pad's settings can then be edited.
- Clicking on an existing pad and selecting *Export Pad Settings*. In this case, the geometrical properties of the selected pad will become the default pad properties.

In the first two cases, the following dialog window will be displayed:



Care should be taken to define correctly the layers to which the pad will belong. In particular, although copper layers are easy to define, the management of non-copper layers (solder mask, solder pads...) is equally important for circuit manufacture and documentation.

The Pad Type selector triggers an automatic selection of layers that is generally sufficient.

13.8.2.1 Rectangular pads

For SMD footprints of the VQFP/PQFP type which have rectangular pads on all four sides (both horizontal and vertical) it is recommended to use just one shape (for example, a horizontal rectangle) and to place it with different orientations (0 for horizontal and 90 degrees for vertical). Global resizing of pads can then be done in a single operation.

13.8.2.2 Rotate pads

Rotations of -90 or -180 are only required for trapezoidal pads used in microwave footprints.

13.8.2.3 Non-plated through hole pads

Pads can be defined as Non-Plated Through Hole pads (NPTH pads).

These pads must be defined on one or all copper layers (obviously, the hole exists on all copper layers).

This requirement allows you to define specific clearance parameters (for instance clearance for a screw).

When the pad hole size is the same as the pad size, for a round or oval pad, this pad is NOT plotted on copper layers in GERBER files.

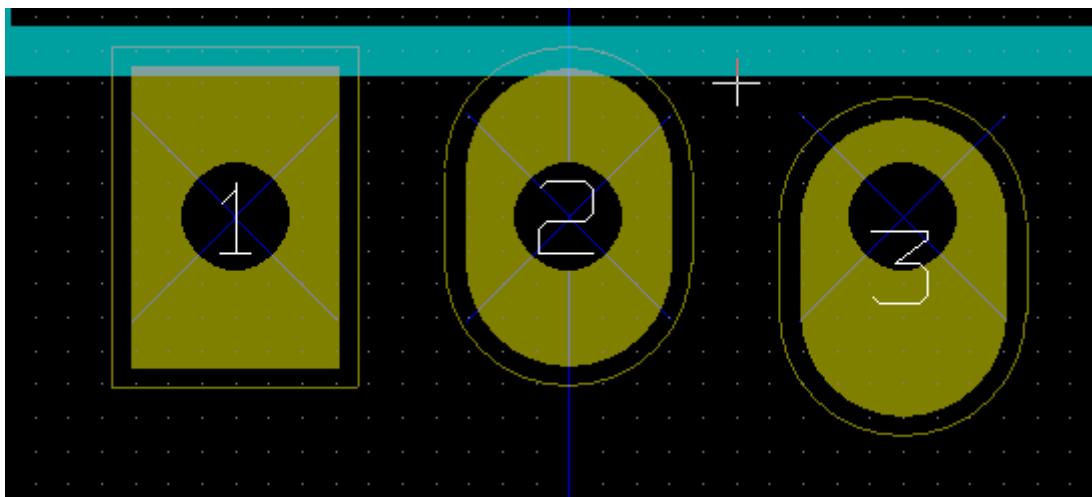
These pads are used for mechanical purposes, therefore no pad name or net name is allowed. A connection to a net is not possible.

13.8.2.4 Pads not on copper layers

These are unusual pads. This option can be used to create fiducials or masks on technical layers.

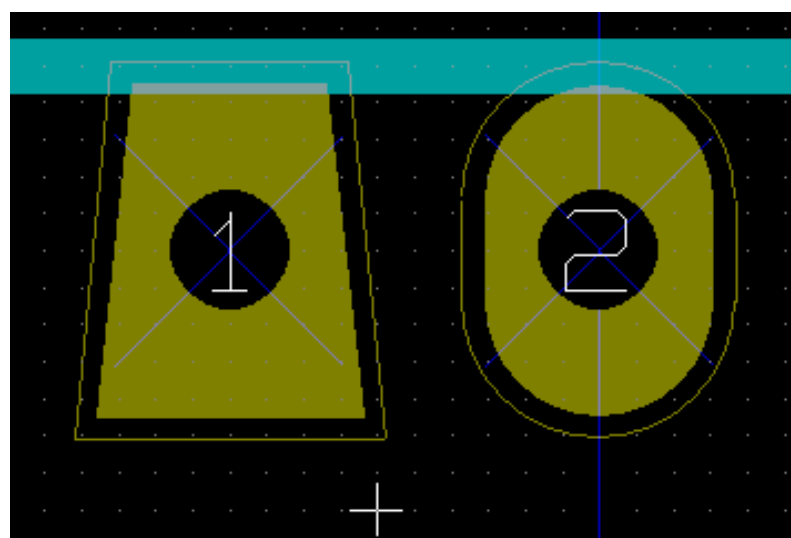
13.8.2.5 Offset parameter

Pad 3 has an offset $Y = 15$ mils:



13.8.2.6 Delta Parameter (trapezoidal pads)

Pad 1 has its parameter Delta $X = 10$ mils



13.8.3 Setting clearance for solder mask and solder paste mask layers

Setting a clearance can be made at 3 levels:

- Global level.
- Footprint level.
- Pad level.

Pcbnew uses the following to calculate clearances:

- Pad settings. If null,
- Footprint settings. If null,
- Global settings.

13.8.3.1 Remarks

The solder mask pad shape is usually bigger than the pad itself. So the clearance value is positive. The solder paste mask pad shape is usually smaller than the pad itself. So the clearance value is negative.

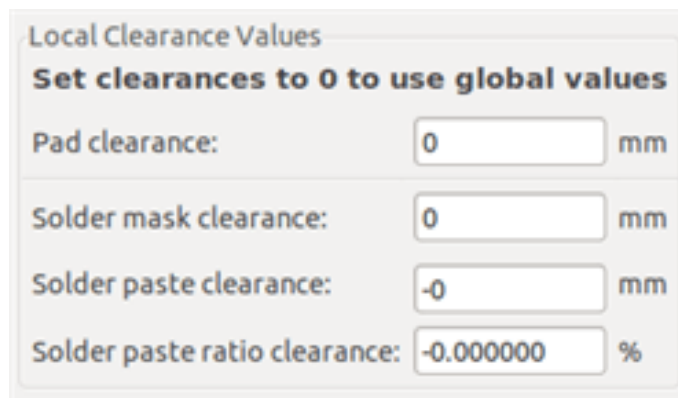
13.8.3.2 Solder paste mask parameters

For solder paste mask there are two parameters:

- A fixed value.
- A percentage of the pad size.

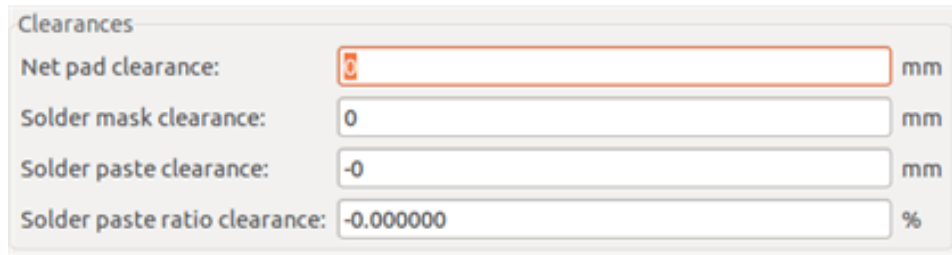
The real value is the sum of these two values.

Footprint level settings:



Local Clearance Values	
Set clearances to 0 to use global values	
Pad clearance:	0 mm
Solder mask clearance:	0 mm
Solder paste clearance:	-0 mm
Solder paste ratio clearance:	-0.000000 %

Pad level settings:



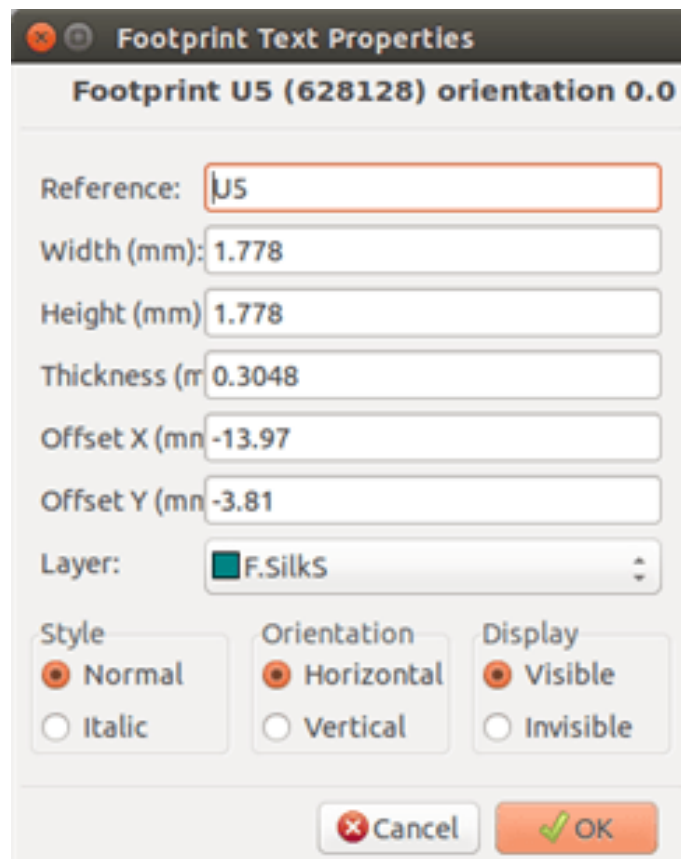
Clearances

Net pad clearance:	<input type="text" value="3"/>	mm
Solder mask clearance:	<input type="text" value="0"/>	mm
Solder paste clearance:	<input type="text" value="-0"/>	mm
Solder paste ratio clearance:	<input type="text" value="-0.000000"/>	%

13.9 Fields Properties

There are at least two fields: reference and value.

Their parameters (attribute, size, width) must be updated. You can access the dialog box from the pop-up menu, by double clicking on the field, or by the footprint properties dialog box:



Footprint Text Properties

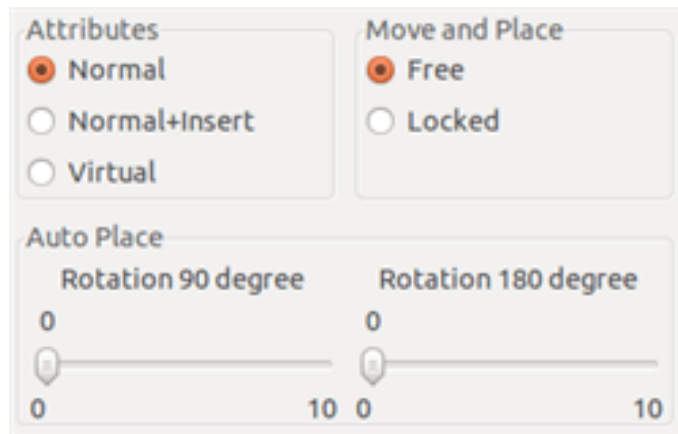
Footprint U5 (628128) orientation 0.0

Reference:	<input type="text" value="U5"/>
Width (mm):	<input type="text" value="1.778"/>
Height (mm):	<input type="text" value="1.778"/>
Thickness (mm):	<input type="text" value="0.3048"/>
Offset X (mm):	<input type="text" value="-13.97"/>
Offset Y (mm):	<input type="text" value="-3.81"/>
Layer:	<input checked="" type="checkbox"/> F.Silks

Style	Orientation	Display
<input checked="" type="radio"/> Normal	<input checked="" type="radio"/> Horizontal	<input checked="" type="radio"/> Visible
<input type="radio"/> Italic	<input type="radio"/> Vertical	<input type="radio"/> Invisible

13.10 Automatic placement of a footprint

If the user wishes to exploit the the full capabilities of the auto-placement functions, it is necessary to define the allowed orientations of the footprint (Footprint Properties dialog).



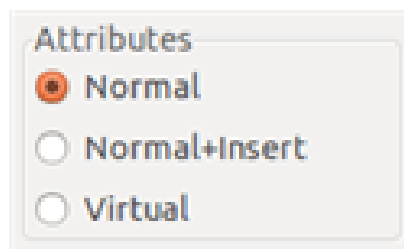
Usually, rotation of 180 degrees is permitted for resistors, non-polarized capacitors and other symmetrical elements.

Some footprints (small transistors, for example) are often permitted to rotate by +/- 90 or 180 degrees. By default, a new footprint will have its rotation permissions set to zero. This can be adjusted according to the following rule:

A value of 0 makes rotation impossible, 10 allows it completely, and any intermediate value represents a limited rotation. For example, a resistor might have a permission of 10 to rotate 180 degrees (unrestrained) and a permission of 5 for a +/- 90 degree rotation (allowed, but discouraged).

13.11 Attributes

The attributes window is the following:

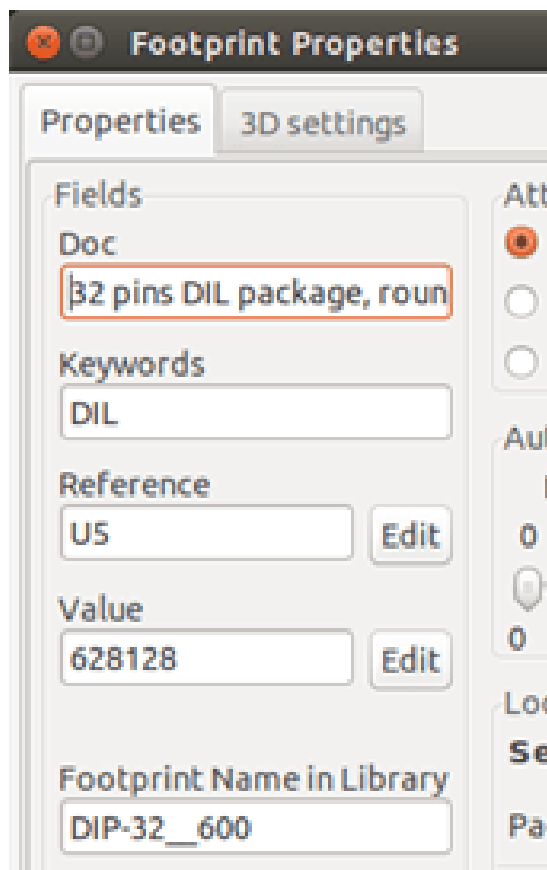


- Normal is the standard attribute.
- Normal+Insert indicates that the footprint must appear in the automatic insertion file (for automatic insertion machines). This attribute is most useful for surface mount components (SMDs).
- Virtual indicates that a component is directly formed by the circuit board. Examples would be edge connectors or inductors created by a particular track shape (as sometimes seen in microwave footprints).

13.12 Documenting footprints in a library

It is strongly recommended to document newly created footprints, in order to facilitate their rapid and accurate retrieval. Who is able to recall the multiple pin-out variants of a TO92 footprint?

The Footprint Properties dialog offers a simple and yet powerful means for documentation generation.



This menu allows:

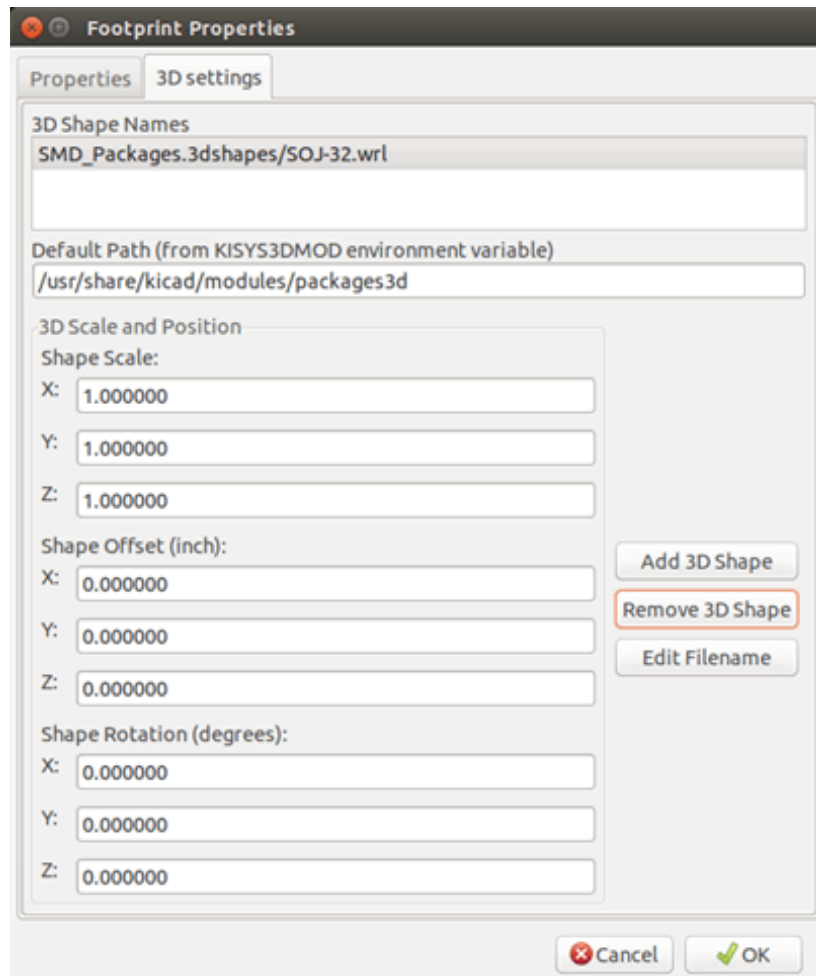
- The entry of a comment line (description).
- Multiple keywords.

The comment line is displayed with the component list in CvPcb and in the footprint selection menus in Pcbnew. The keywords can be used to restrict searches to those parts possessing the given keywords.

Thus, while using the load footprint command (icon in the right-hand toolbar in Pcbnew), it is possible to type the text =T0220 into the dialog box to have Pcbnew display a list of the footprints possessing the keyword T0220

13.13 3-dimensional visualisation

A footprint may have been associated with a file containing a three-dimensional representation of itself. In order to associate such a file with a footprint, select the 3D Settings tab. The options panel is the following:



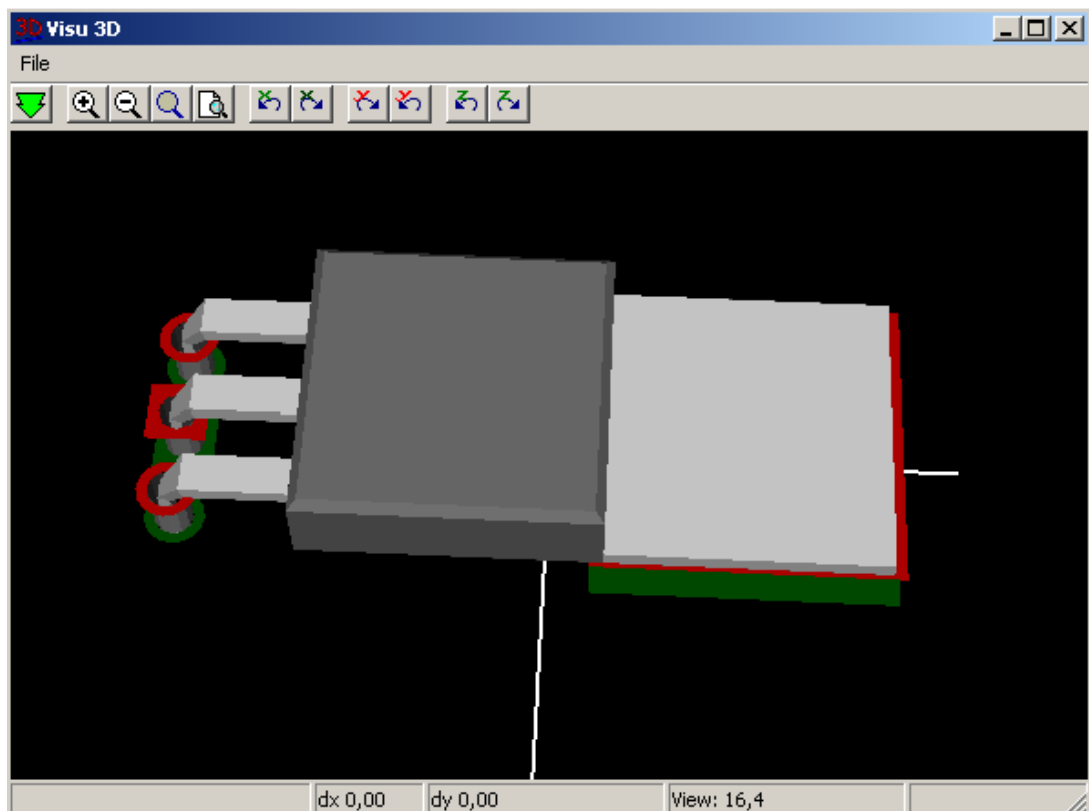
The data information should be provided:

- The file containing the 3D representation (created by the 3D modeler Wings3D, in vrmf format, via the export to vrmf command).
- The default path is kicad/modules/package3d. In the example, the file name is discret/to_220horiz.wrl, using the default path)
- The x, y and z scales.
- The offset with respect to the anchor point of the footprint (usually zero).
- The initial rotation in degrees about each axis (usually zero).

Setting scale allows:

- To use the same 3D file for footprints which have similar shapes but different sizes (resistors, capacitors, SMD components...)
- For small (or very large) packages, a better use of the Wings3D grid is to scale **0.1 inch in Pcbnew = 1 grid unit** in Wings3D.

If such a file has been specified, it is possible to view the component in 3D.



The 3D model will automatically appear in the 3D representation of the printed circuit board.

13.14 Saving a footprint into the active library



The save command (modification of the file of the active library) is activated by the button.

If a footprint of the same name exists (an older version), it will be overwritten. Because it is important to be able to have confidence in the library footprints, it is worth double-checking the footprint for errors before saving.

Before saving, it is also recommended to change the reference or value of the footprint to be equal to the library name of the footprint.

13.15 Saving a footprint to the board



If the edited footprint comes from the current board, the button will update this footprint on the board.

Capitolo 14

Advanced PCB editing tools

There are some more advanced editing tools available in Pcbnew and Footprint Editor, which can help you to efficiently lay out components on the canvas.

14.1 Duplicating items

Duplication is a method to clone an item and pick it up in the same action. It is broadly similar to copy-and-pasting, but it allows you to sprinkle components over the PCB and it allows you to manually lay out components using the Move Exact tool (see below) more easily.

Duplication is done by using the hotkey (which defaults to Ctrl-D) or the duplicate item option in the context menu. In the legacy renderer, these appear as below, depending on the item type:

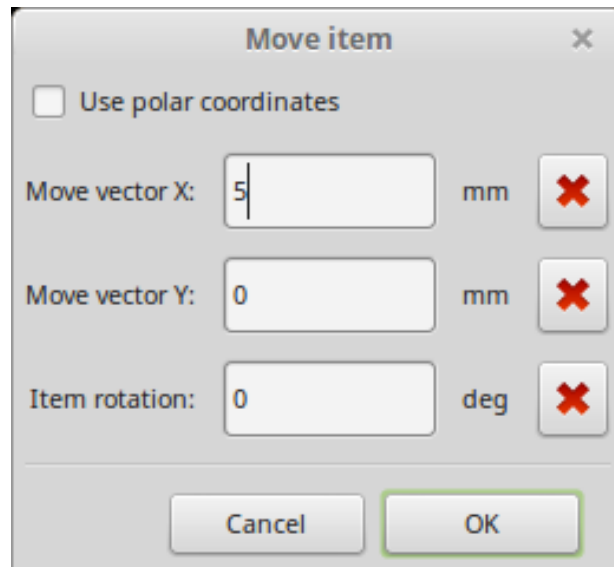


14.2 Moving items exactly

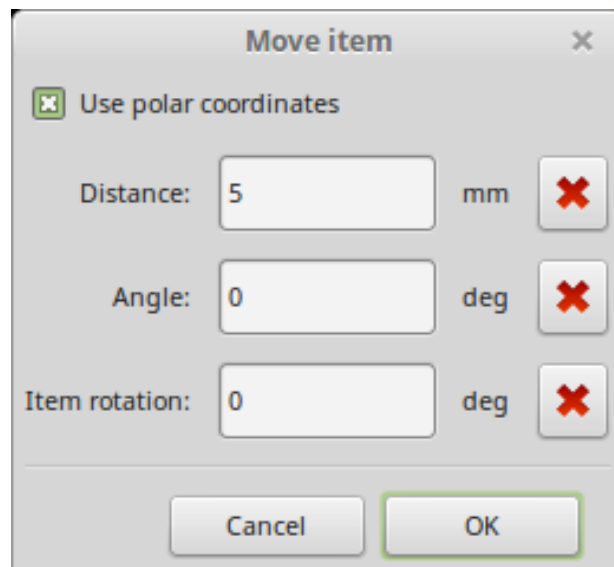
The Move Exact tool allows you to move an item (or group of items) by a certain amount, which can be entered in Cartesian or polar formats and which can be entered in any supported units. This is useful when it would otherwise be cumbersome to switch to a different grid, or when a feature is not spaced according to any existing grids.

To use this tool, select the items you wish to move and then use either the hotkey (defaults to Ctrl-M) or the context menu items to invoke the dialog. You can also invoke the dialog with the hotkey when moving or duplicating items, which can make it easy to repeatedly apply an offset to multiple components.

Move exact with Cartesian move vector entry



Move exact with polar move vector entry



The checkbox allows you to switch between Cartesian and polar co-ordinate systems. Whatever is currently in the form will be converted automatically to the other system.

Then you enter the desired move vector. You can use the units indicated by the labels (mm in the images above) or you can specify the units yourself (e.g. 1 in for an inch, or 2 rad for 2 radians).

Pressing OK will apply the translation to the selection, and cancel will close the dialog and the items will not be moved. If OK is pressed, the move vector will be saved and pre-filled next time the dialog is opened, which allows repeated application of the same vector to multiple objects.

14.3 Array tools

Pcbnew and the Footprint Editor both have assistants for creating arrays of features and components, which can be used to easily and accurately lay out repetitive elements on PCBs and in footprints.

14.3.1 Activating the array tool

The array tool acts on the component under the cursor, or, in GAL mode, on a selection. It can be accessed either via the context menu for the selection or by a keyboard shortcut (defaults to Ctrl-N). In legacy mode, the context menu icons indicate an array of the selected type:



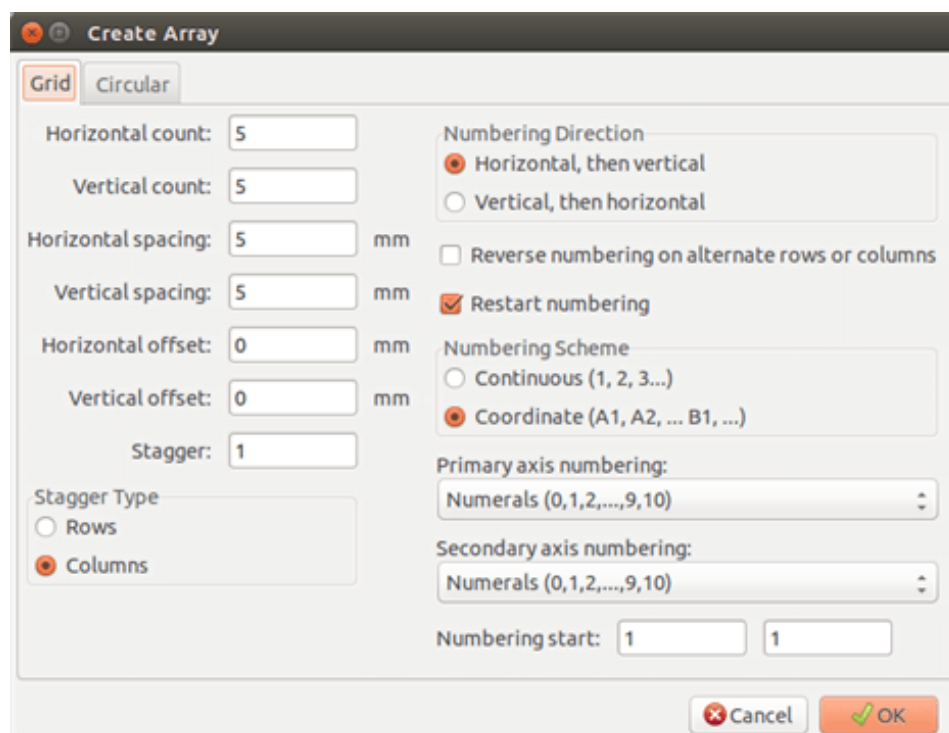
The array tool is presented as a dialog window, with a pane for the types of array. There are two type of array supported so far: grid, and circular.

Each type of array can be fully specified on the respective panes. Geometric options (how the grid is laid out) go on the left; numbering options (including how the numbers progress across the grid) on the right.

14.3.2 Grid arrays

Grid arrays are arrays that lay components out according to a 2-dimensional square grid. This kind of array can also produce a linear array by only laying out a single row or column.

The settings dialog for grid arrays look like this:



14.3.2.1 Geometric options

The geometric options are as follow:

- **Horizontal count:** the number of columns in the grid.
- **Vertical count:** the number of rows in the grid.

- **Horizontal spacing:** the horizontal distance from item to the item in the same row and next column. If this is negative, the grid progresses from right to left.
- **Vertical spacing:** the vertical distance from one item to the item in the same column and the next row. If this is negative, the grid progress bottom to top.
- **Horizontal offset:** start each row this distance to the right of the previous one
- **Vertical offset:** start each column this distance below the previous one

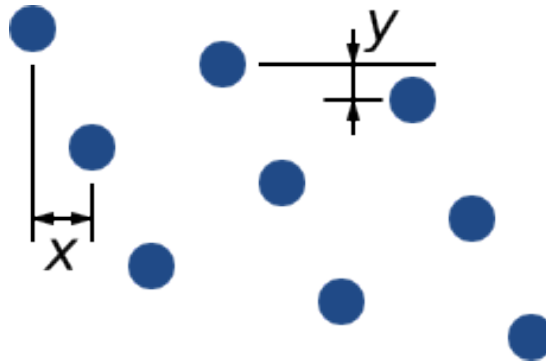


Figura 14.1: 3x3 grid with x and y offsets

- **Stagger:** add an offset to every set of n rows/columns, with each row progressing by $1/n'$ th of the relevant spacing dimension:

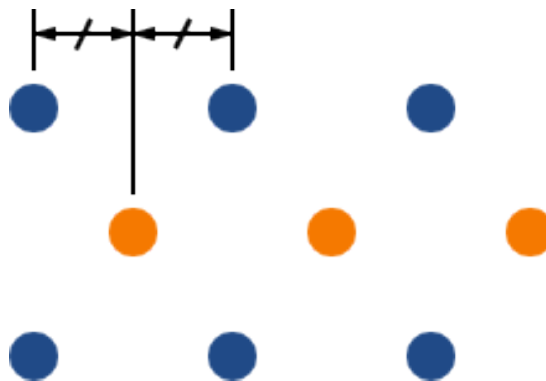


Figura 14.2: 3x3 grid with a row stagger of 2

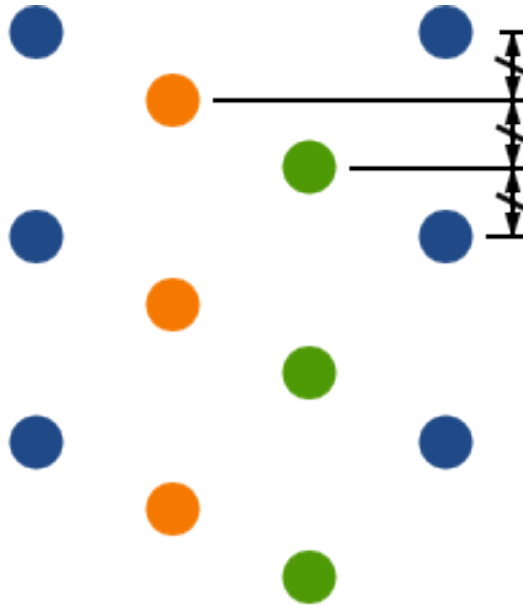


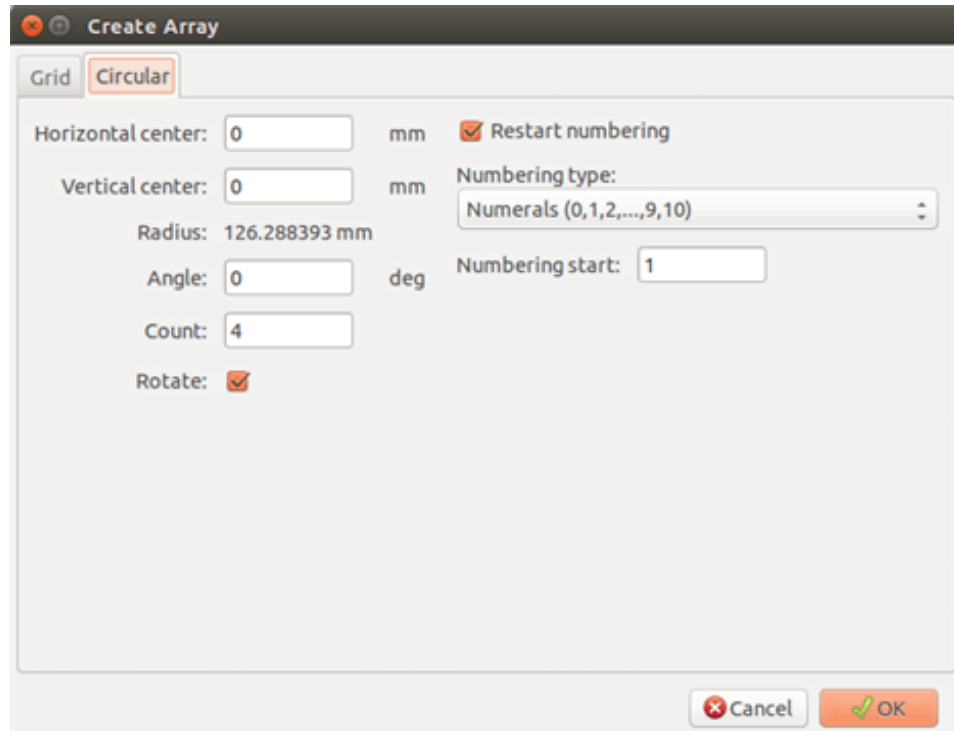
Figura 14.3: 4x3 grid with a column stagger of 3

14.3.2.2 Numbering options

- **Numbering Direction:** Determines whether numbers proceed along rows and then moves to the next row, or down columns and then to the next column. Note that the direction on numbering is defined by the sign of the spacing: a negative spacing will result in right-to-left or bottom-to-top numbering. *i*
- **Reverse numbering on alternate rows or columns:** If selected, the numbering order (left-to-right or right-to-left, for example) on alternate rows or columns. Whether rows or columns alternate depends on the numbering direction. This option is useful for packages like DIPs where the numbering proceeds up one side and down the other.
- **Restart numbering:** if laying out using items that already have numbers, reset to the start, otherwise continue if possible from this items number
- **Numbering Scheme**
 - **Continuous:** the numbering just continues across a row/column break - if the last item in the first row is numbered 7, the first item in the second row will be 8.
 - **Coordinate:** the numbering uses a two-axis scheme where the number is made up of the row and column index. Which one comes first (row or column) is determined by the numbering direction.
- **Axis numberings:** what alphabet to use to number the axes. Choices are
 - **Numerals** for normal integer indices
 - **Hexadecimal** for base-16 indexing
 - **Alphabetic, minus IOSQXZ**, a common scheme for electronic components, recommended by ASME Y14.35M-1997 sec. 5.2 (previously MIL-STD-100 sec. 406.5) to avoid confusion with numerals.
 - **Full alphabet** from A-Z.

14.3.3 Circular arrays

Circular arrays lay out items around a circle or a circular arc. The circle is defined by the location of the selection (or the centre of a selected group) and a centre point that is specified. Below is the circular array configuration dialog:



14.3.3.1 Geometric options

- **Horizontal center, Vertical center:** The centre of the circle. The radius field below will update automatically when you adjust these.
- **Angle:** The angular difference between two adjacent items in the array. Set this to zero to evenly divide the circle with count elements.
- **Count:** Number of items in the array (including the original item)
- **Rotate:** Rotate each item around its own location. Otherwise, the item will be translated but not rotated (for example, a square pad will always remain upright if this option is not set).

14.3.3.2 Numbering options

Circular arrays have only one dimension and a simpler geometry than grids. The meanings of the available options are the same as for grids. Items are numbered clockwise - for an anticlockwise array, specify a negative angle.

Capitolo 15

Manuale di riferimento scripting di KiCad

Lo scripting permette di automatizzare delle operazioni in KiCad usando il linguaggio [Python](#).

Also see the doxygen documentation on [Python Scripting Reference](#).

You can see python module help by typing `pydoc pcbnew` on your terminal.

Using scripting you can create:

- **Plugins:** this type of script is loaded when KiCad starts. Examples:
 - **Footprint Wizards:** To help you build footprints easily filling in parameters. See the dedicated section [Footprint Wizards](#) below.
 - **File I/O** (*planned*): To let you write plugins to export/import other filetypes
 - **Actions** (*planned*): Associate events to scripting actions or register new menus or toolbar icons.
- **Command Line Scripts:** scripts that can be used from the command line, load boards or libraries, modify them, and render outputs or new boards.

It shall be noted that the only KiCad applicaiton that supports scripting is Pcbnew. It is also planned for Eeschema in the future.

15.1 KiCad Objects

The scripting API reflects the internal object structure inside KiCad/pcbnew. BOARD is the main object, that has a set of properties and a set of MODULEs, and TRACKs/SEGVIAs, TEXTE_PCB, DIMENSION, DRAWSEGMENT. Then MODULEs have D_PADs, EDGEs, etc.

- See the BOARD section below.

15.2 Basic API Reference

All the pcbnew API is provided from the pcbnew module in Python. GetBoard() method will return the current pcb open at editor, useful for commands written from the integrated scripting shell inside pcbnew or action plugins.

15.3 Loading and Saving a Board

- **LoadBoard(filename):** loads a board from file returning a BOARD object, using the file format that matches the filename extension.
- **SaveBoard(filename,board):** saves a BOARD object to file, using the file format that matches the filename extension.
- **board.Save(filename):** same as above, but it's a method of BOARD object.

Example that loads a board, hides all values, shows all references

```
#!/usr/bin/python
import sys
from pcbnew import *

filename=sys.argv[1]

pcb = LoadBoard(filename)
for module in pcb.GetModules():
    print "* Module: %s"%module.GetReference()
    module.GetValueObj().SetVisible(False)      # set Value as Hidden
    module.GetReferenceObj().SetVisible(True)     # set Reference as Visible

pcb.Save("mod_"+filename)
```

15.4 Listing and Loading Libraries

Enumerate library, enumerate modules, enumerate pads

```
#!/usr/bin/python

from pcbnew import *

libpath = "/usr/share/kicad/modules/sockets.mod"
lst = FootprintEnumerate(libpath)

for name in lst:
    m = FootprintLoad(libpath,name)
    print name,"->",m.GetLibRef(), m.GetReference()
    for p in m.GetPads():
        print "\t",p.GetPadName(),p.GetPosition(),p.GetPos0(), p.GetOffset()
```

15.5 BOARD

Board is the basic object in KiCad pcbnew, it's the document.

BOARD contains a set of object lists that can be accessed using the following methods, they will return iterable lists that can be iterated using for obj in list:

- **board.GetModules():** This method returns a list of MODULE objects, all the modules available in the board will be exposed here.
- **board.GetDrawings():** Returns the list of BOARD_ITEMS that belong to the board drawings
- **board.GetTracks():** This method returns a list of TRACKs and SEGVIAs inside a BOARD
- **board.GetSegZones():** Returns a list of SEGZONES
- **board.GetFullRatsnest():** Returns the list of ratsnets (connections still not routed)
- **board.GetLocalRatsnest():** Returns the list of ratsnest of a moving footprint (as it's dragged)
- **board.GetNetClasses():** Returns the list of net classes
- **board.GetCurrentNetClassName():** Returns the current net class
- **board.GetViasDimensionsList():** Returns the list of Via dimensions available to the board.
- **board.GetTrackWidthList():** Returns the list of Track Widths available to the board.

Board Inspection Example

```
#!/usr/bin/python
import sys
from pcbnew import *

filename=sys.argv[1]
pcb = LoadBoard(filename)

ToUnits=ToMils
FromUnits=FromMils

print "LISTING VIAS:"
for item in pcb.GetTracks():
    if type(item) is SEGVIA:

        pos = item.GetPosition()
        drill = item.GetDrillValue()
        width = item.GetWidth()
        print " * Via:    %s - %f/%f"%(ToUnits(pos),ToUnits(drill),ToUnits(width))

    elif type(item) is TRACK:

        start = item.GetStart()
        end = item.GetEnd()
        width = item.GetWidth()
```



```

        print " * Track: %s to %s, width %f" % (ToUnits(start),ToUnits(end),ToUnits(width))

    else:
        print "Unknown type      %s" % type(item)

print ""
print "LISTING DRAWINGS:"
for item in pcb.GetDrawings():
    if type(item) is TEXTE_PCB:
        print "* Text:      '%s' at %s"%(item.GetText(),item.GetPosition())
    elif type(item) is DRAWSEGMENT:
        print "* Drawing: %s"%item.GetShapeStr() # dir(item)
    else:
        print type(item)

print ""
print "LIST MODULES:"
for module in pcb.GetModules():
    print "* Module: %s at %s"%(module.GetReference(),ToUnits(module.GetPosition()))

print ""
print "LIST ZONES:"
for zone in pcb.GetSegZones():
    print zone

print ""
print "RATSNEST:",len(pcb.GetFullRatsnest())

```

15.6 Examples

15.6.1 Change a component pins paste mask margin

We only want to change pins from 1 to 14, 15 is a thermal pad that must be keep as it is.

```

b = pcbnew.GetBoard()
u304 = b.FindModuleByReference('U304')
pads = u304.GetPads()

for p in pads:
    print p.GetPadName(), pcbnew.ToMM(p.GetLocalSolderPasteMargin())
    id = int(p.GetPadName())
    if id<15: p.SetLocalSolderPasteMargin(0)

```

15.7 Footprint Wizards

The footprint wizards are a collection of python scripts that can be access via from the Footprint Editor. If you invoke the footprint dialog you select a given wizard that allows you to see the footprint rendered, and you have some parameters you can edit.

If the plugins are not properly distributed to your system package, you can find the latest versions in the KiCad source tree at [launchpad](#).

They should be located in for example C:\Program Files\KiCad\bin\scripting\plugins.

On linux you can also keep your user plugins in \$HOME/.kicad_plugins.

Build footprints easily filling in parameters.

```
#!/usr/bin/python

from pcbnew import *

class FPCFootprintWizard(FootprintWizardPlugin):
    def __init__(self):
        FootprintWizardPlugin.__init__(self)
        self.name = "FPC"
        self.description = "FPC Footprint Wizard"
        self.parameters = {
            "Pads":
                {
                    "*n": 40,          # not internal units preceded by "*"
                    "pitch":          FromMM(0.5),
                    "width":          FromMM(0.25),
                    "height":         FromMM(1.6)},
            "Shield":
                {
                    "shield_to_pad":  FromMM(1.6),
                    "from_top":       FromMM(1.3),
                    "width":          FromMM(1.5),
                    "height":         FromMM(2)}
        }

        self.ClearErrors()

    # build a rectangular pad
    def smdRectPad(self, module, size, pos, name):
        pad = D_PAD(module)
        pad.SetSize(size)
        pad.SetShape(PAD_RECT)
        pad.SetAttribute(PAD_SMD)
        pad.SetLayerMask(PAD_SMD_DEFAULT_LAYERS)
        pad.SetPos0(pos)
        pad.SetPosition(pos)
        pad.SetPadName(name)
        return pad
```

```

# This method checks the parameters provided to wizard and set errors
def CheckParameters(self):
    p = self.parameters
    pads = p["Pads"]["*n"]
    errors = ""
    if (pads<1):
        self.parameter_errors["Pads"]["n"]="Must be positive"
        errors += "Pads/n has wrong value, "
    p["Pads"]["n"] = int(pads) # make sure it stays as int (default is float)

    pad_width = p["Pads"]["width"]
    pad_height = p["Pads"]["height"]
    pad_pitch = p["Pads"]["pitch"]
    shl_width = p["Shield"]["width"]
    shl_height = p["Shield"]["height"]
    shl_to_pad = p["Shield"]["shield_to_pad"]
    shl_from_top = p["Shield"]["from_top"]

    return errors

# build the footprint from parameters
def BuildFootprint(self):

    print "parameters:",self.parameters
    #self.ClearErrors()
    #print "errors:",self.parameter_errors

    module = MODULE(None) # create a new module
    self.module = module

    p = self.parameters
    pads = int(p["Pads"]["*n"])
    pad_width = p["Pads"]["width"]
    pad_height = p["Pads"]["height"]
    pad_pitch = p["Pads"]["pitch"]
    shl_width = p["Shield"]["width"]
    shl_height = p["Shield"]["height"]
    shl_to_pad = p["Shield"]["shield_to_pad"]
    shl_from_top = p["Shield"]["from_top"]

    size_pad = wxSize(pad_width,pad_height)
    size_shld = wxSize(shl_width,shl_height)

    module.SetReference("FPC"+str(pads)) # give it a reference name
    module.m_Reference.SetPos0(wxPointMM(-1,-2))
    module.m_Reference.SetPosition(wxPointMM(-1,-2))

```

```
# create a pad array and add it to the module
for n in range (0,pads):
    pad = self.smdRectPad(module,size_pad,wxPoint(pad_pitch*n,0),str(n+1))
    module.Add(pad)

pad_s0 = self.smdRectPad(module,
                        size_shld,
                        wxPoint(-shl_to_pad,shl_from_top),
                        "0")
pad_s1 = self.smdRectPad(module,
                        size_shld,
                        wxPoint((pads-1)*pad_pitch+shl_to_pad,shl_from_top),
                        "0")

module.Add(pad_s0)
module.Add(pad_s1)

e = EDGE_MODULE(module)
e.SetStartEnd(wxPointMM(-1,0),wxPointMM(0,0))
e.SetWidth(FromMM(0.2))
e.SetLayer(EDGE_LAYER)
e.SetShape(S_SEGMENT)
module.Add(e)

module.SetLibRef("FPC"+str(pads))

# create our footprint wizard
fpc_wizard = FPCFootprintWizard()

# register it into pcbnew
fpc_wizard.register()
```