Kicad StepUp starter Guide

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1. Basic Info

kicad StepUp 3D mechanical exporter for collaborative exchange between KiCad and FreeCAD/MCAD; With **kicad StepUp**, it is possible to work in kicad EDA with the same component model data available in the **STEP AP214 3D format**, and obtain a 3D STEP AP214 model of the pcb board and a complete board assemblies with electronic modules, to be used for **MCAD interchange**. The accurate 3D visualization of components on board assemblies in kicad 3dviewer, is maintained in the same accuracy and aspect in STEP AP214 format.
The **kicad StepUp** maintains the usual way to work with kicad, but improves the process to work in a collaborative way with mechanical designers bringing near ECAD and MCAD environments.

New!!! now kicad StepUp comes in 3 flavours:
1. running as a **script**
2. running as a **GUI**
3. running as a **Mod** native FreeCAD **WorkBench**

kicadStepUp at sourceforge[1]
YouTube Kicad StepUp New Tutorial video[2]
YouTube Kicad StepUp old script video[3]

2. requirements

KiCad EDA[4] version 4.00 or later
FreeCAD[5] version 0.15 or later

1 http://sourceforge.net/projects/kicadstepup/
2 https://youtu.be/h6wMU3lE_sA
3 http://youtu.be/Ukd47VXYzQU
4 http://kicad-pcb.org/
5 http://freecadweb.org/

3. Quick Facts

kicad StepUp tools are for:
1. export kicad board and parts to STEP (or IGES) for a full ECAD MCAD integration (no need of VRML if using kicad 5 or dev)
2. convert your STEP model of parts, board, enclosure to VRML for a bidirectional use back in kicad
3. ability to load directly the .kicad_mod footprint in FreeCAD to easy align the mechanical model to kicad footprint
4. ability to load directly the .kicad_pcb board and parts in FreeCAD
5. *bounding boxes*, *minimum volume*, *minimum heigh*, *drill size*, *blacklist* and *virtual* options to tailor your MCAD exporting
6. interference and collisions detect for enclosure and footprint design
7. exporting of VRML models with Material Properties for best result in 3D rendering/raytracing
8. ability to create simple models in MCAD using boxes or cylinders with dimensions as in scale values of wrl models
create boxes or cylinders using dimensions as in scale values of wrl model[6]
requirements:
- kicad stable >= 4.0 or development release
- FreeCAD stable >= 0.15 or development release
- a library of STEP (or IGES) 3D models
tips:
- never use a scale different from 1:1:1 in your 3D models
- configure your [prefix3D] in ksu-config.ini to your KISYS3DMOD path
- use STEP or IGES or VRML or **mixed type of models** in your board
Latest Enhancements:
- **STEP multi-part** allowed (managing union or compound)
- **EdgeCuts allowed for footprint** that will generate Cuts in Board
- **Pcb Edge as footprint** allowed
- **edge tolerance on vertex coincidence** for easier designing
- utf8 characters allowed for path and model names
- turntable section
- better theme integration in FreeCAD

[6] https://forum.kicad.info/t/generic-3d-shapes-in-library/2555/10

4. OverView

to run the demo:

in Linux: change dir to the folder in which you have extracted the demo
`./launch-kicad_StepUp-Tools-demo.sh`

in windows: change dir to the folder in which you have extracted the demo
`launch-kicad_StepUp-Tools-demo.bat`

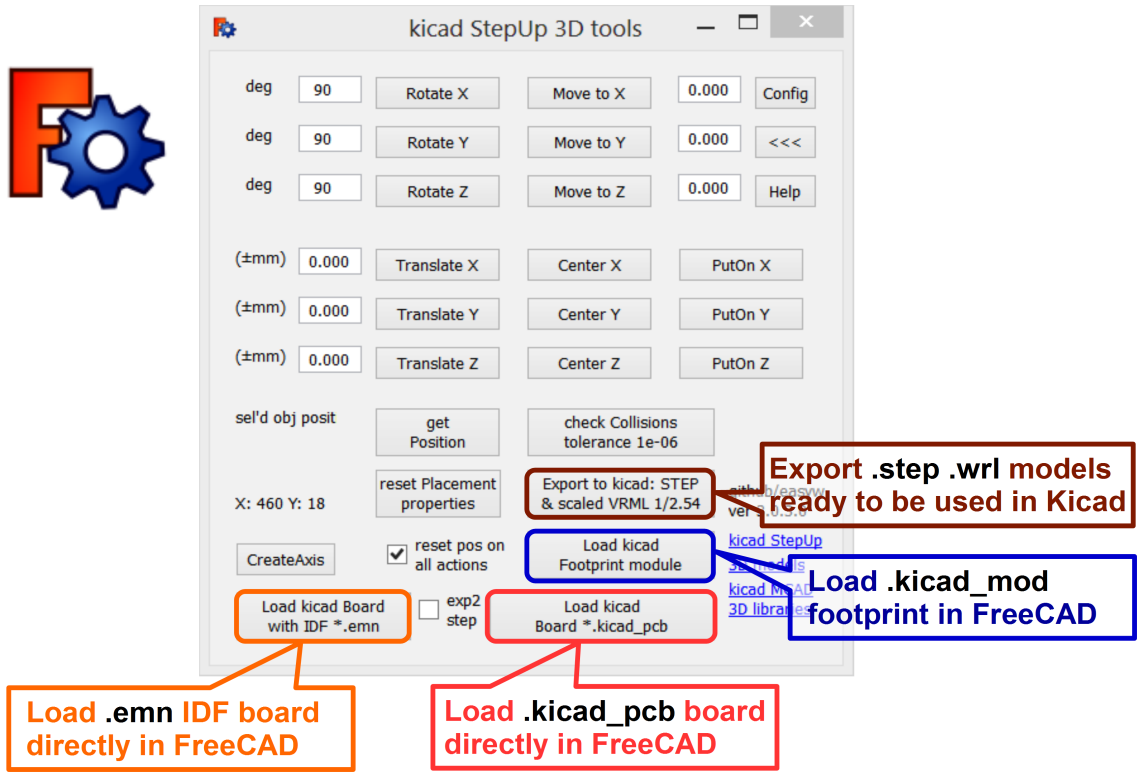
in OSX: change dir to the folder in which you have extracted the demo
`./launch-kicad_StepUp-Tools-OSX-demo.sh`

the demo comes with a kicad project, along with all needed STEP and wrl modules, just to be used just out of the box
(**NB** use the script from inside the dir)
to see the kicad board, change dir to the folder in which you have extracted the demo
in windows:
`launch-kicad-demo-project.bat`
in linux:
`./launch-kicad-demo-project.sh`
in OSX:
`./launch-kicad-demo-project-OSX.sh`

for some ready to go libraries please refer to: https://github.com/easyw/kicad-3d-mcad-models4 and other useful libs in up this thread

5. kicad StepUp tools GUI

KiCad StepUp GUI:
new tools for ECAD/MCAD collaboration



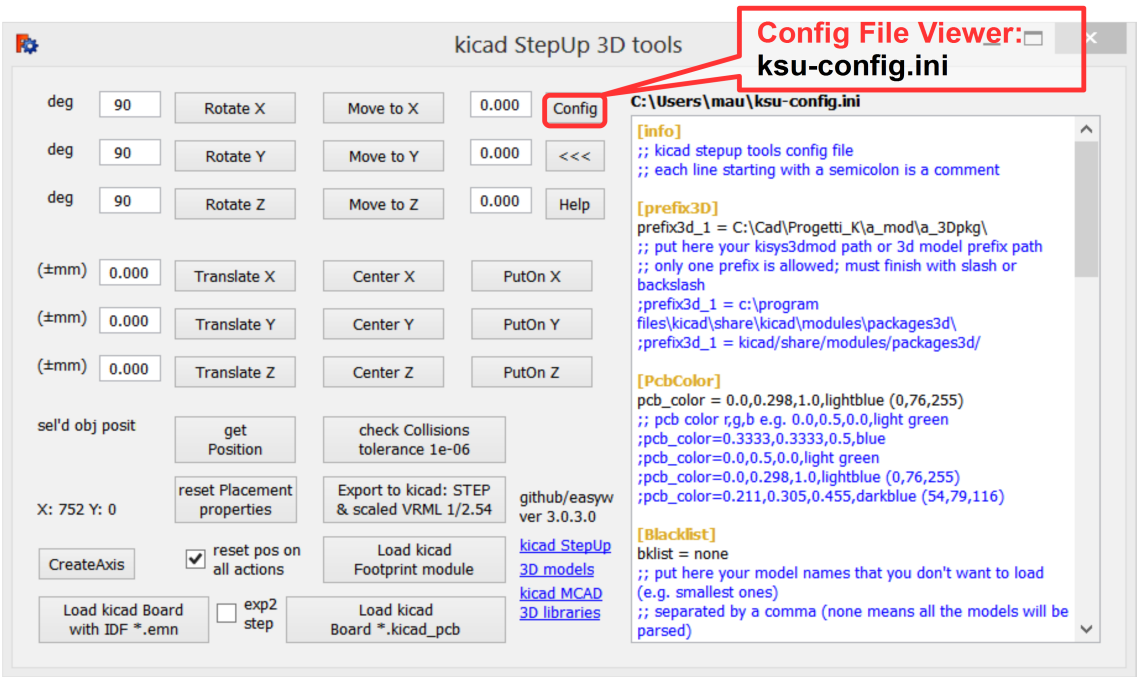


Figure 1. kicad StepUp tools GUI Overview

6. Introduction

kicad StepUp is a 3D mechanical exporter for kicad board and assemblies
It will improve a collaborative exchange between KiCad and FreeCAD/MCAD
With **kicad StepUp** script, it is possible to work in kicad EDA with the same component model data available in the **STEP AP214 3D format**, and obtain a 3D STEP AP214 model of the pcb board and a complete board assemblies with electronic modules, to be used for **MCAD interchange**.
The accurate 3D visualization of components on board assemblies in kicad 3dviewer, can then be maintained in the same accuracy and aspect in STEP AP214 format, just generating VRML models from STEP or FreeCAD mechanical models and exporting the board through kicad StepUp script.
The **kicad StepUp** script maintains the usual way to work with kicad, but improves the process to work in a collaborative way with mechanical designers bringing near ECAD and MCAD environments.

Kicad StepUp allows the user to modeling the 3D modules starting from FreeCAD (instead of using Wings3D), creating models in STEP AP214 and rendering the pcb board and components in native STEP AP214.
Note: kicad StepUp 3D MCAD exporter is compatible with:
STEP with colors files (*.step*, *.stp* extensions)
IGES with colors files (*.iges*, *.igs* extensions)

Designing in kicad native 3d-viewer will produce a fully aligned STEP version with the same view of kicad 3d render.
Now the two words have the same accurate 3D visualization; it is possible to design in kicad EDA and transfer the artwork to MCAD (FreeCAD) smoothly

WYSIWYG from EDA to MCAD

7. WYSIWYG from EDA to MCAD

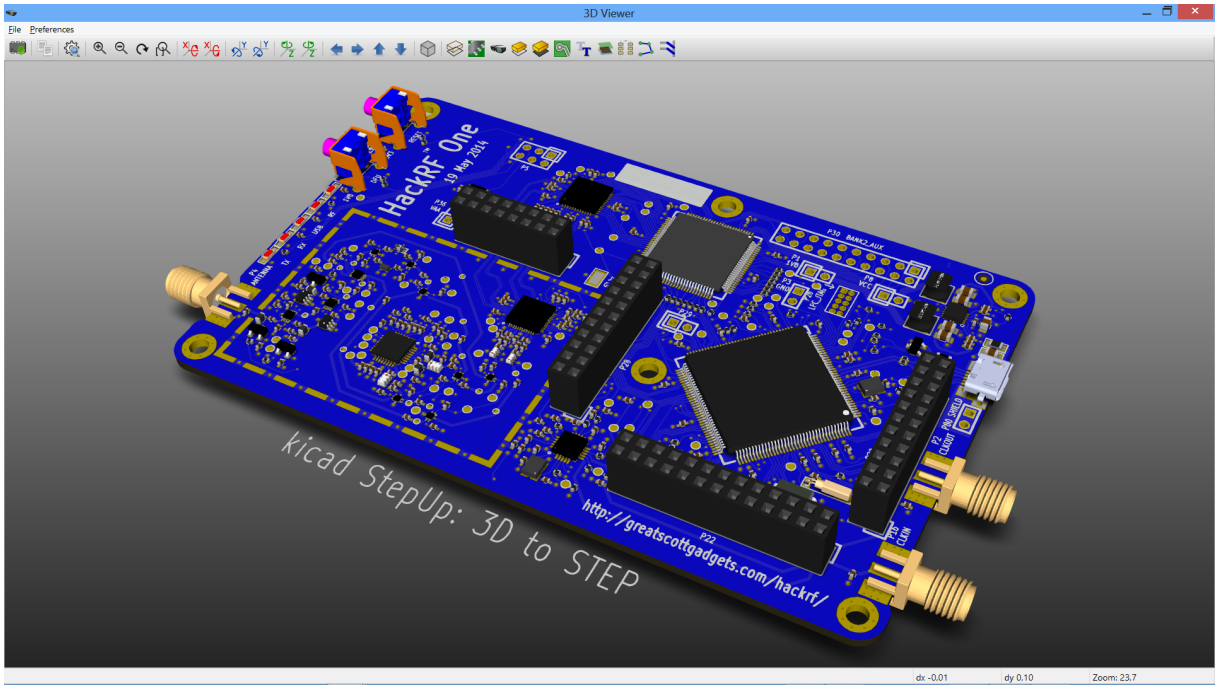


Figure 2. kicad StepUp in Kicad 3d-viewer

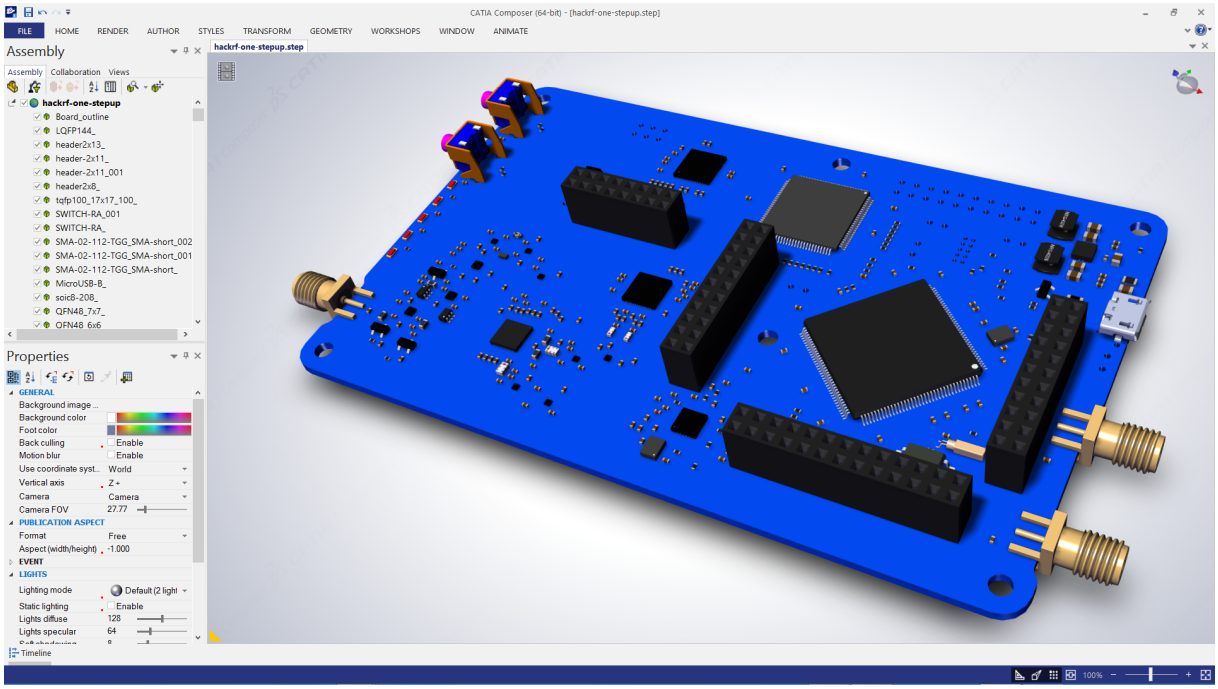


Figure 3. kicad StepUp in MCAD Catia

8. Basic How To *(using kicad StepUp the easiest way)*

(not changing the way you use kicad)

1. just copy the STEP 3d models in the same folder in which there are your wrl 3d models and use the same name of the wrl model name (e.g. r_0603.wrl # r_0603.step)
2. open in FreeCAD the Macro kicad-StepUp-tools.FCMacro and edit the config file ksu-config.ini (wich is autogenerate at first running of the macro) with e.g. notepad changing your model prefix to your KISYS3DMOD path
3. clik on the button to open your kicad pcbnew board file
4. watch the script assembling your 3D board with 3D models :)
you can also add the macro button to the FreeCAD toolbar following these instructions:
Note: FreeCAD forum Customize Toolbar[7] how to add a button to Toolbar in FreeCAD adding also the kicad StepUp icon
5. the Macro can be executed as a script <path to Freecad executable file>/freecad <path to the Macro file>/kicad-StepUp-tools.FCMacro <name_of_board_without_extension>
(e.g. freecad kicad-StepUp-tools.FCMacro myboard)
just watch the Macro assembling your 3D board with 3D models :)
6. the kicad StepUp can be also a Mod WorkBench for FreeCAD:
copy the folder kicadStepUpMod in the right folder for your OS
FreeCAD Installing workbenches[8]

9. How To *(using kicad StepUp the best way)*

(getting the best from STEP models)

1. just copy the STEP 3d models in the same folder in which there are your wrl 3d models
2. export the STEP models, scaled 1/2.54 to wrl with the same name of the STEP model (e.g. r_0603.wrl # r_0603.step); in this way your 3D board in kicad pcbnew 3d-viewer and in FreeCAD workbench will look perfectly aligned
3. open in FreeCAD the Macro kicad-StepUp-tools.FCMacro and edit the config file ksu-config.ini (wich is autogenerate at first running of the macro) with e.g. notepad changing your model prefix to your KISYS3DMOD path

[7] http://www.freecadweb.org/wiki/index.php?title=Customize_ToolsBar
[8] http://www.freecadweb.org/wiki/index.php?title=Installing_more_workbenches

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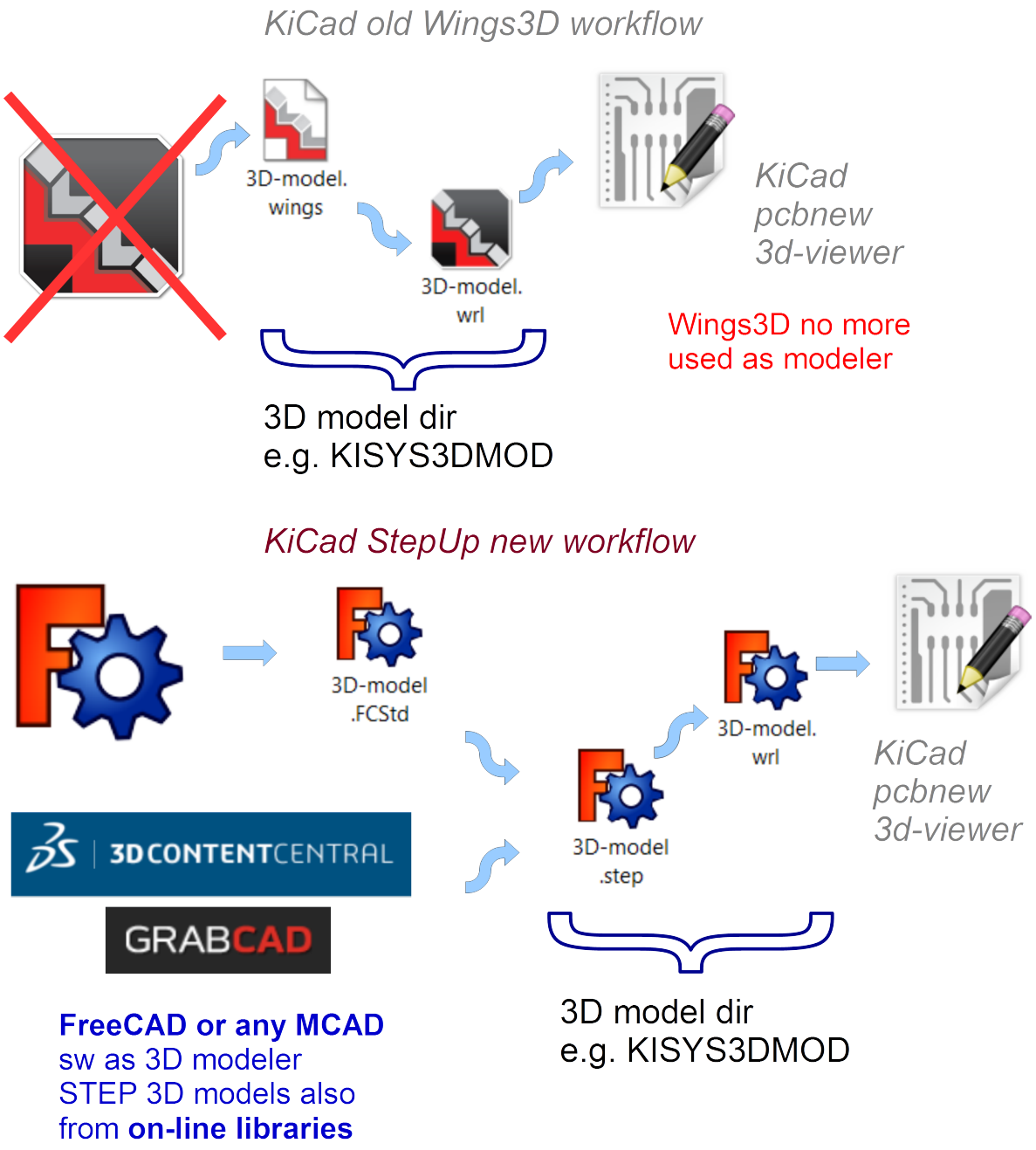
copy the folder kicadStepUpMod in the right folder for your OS
FreeCAD Installing workbenches[10]

[9] http://www.freecadweb.org/wiki/index.php?title=Customize_ToolsBar
[10] http://www.freecadweb.org/wiki/index.php?title=Installing_more_workbenches

10. kicad StepUp workflow



With this workflow, your KiCad design is ready to be converted to MCAD in just one click!!!

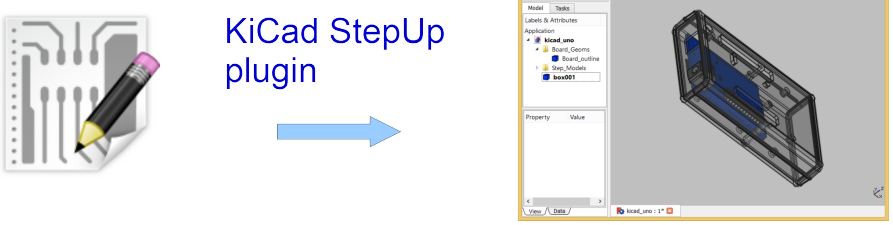


Figure 4. kicad StepUp WorkFlow

11. Create your own Library

The way to build a STEP models library to be easily used by the script is:

1. **Load the kicad footprint** inside FreeCAD using kicad StepUp tools
2. use the footprint as a reference for your model position
3. start modeling your 3d object in scale 1:1 in mm (which is the way in which mechanical stuff are used to be)
4. export STEP and VRML of your model just clicking on the "Export STEP & VRML" button
5. assure that your STEP module **is fused to just one solid object**
   (*Part Boolean Union in FreeCAD* or *Part Makecompound in FreeCAD*)
   Note: here FreeCAD forum fusion howto[11] some tips to fuse correctly objects in FreeCAD
6. use the same name to wrl and STEP model
7. put the STEP model and VRML model in the same place
8. check if your vrml model is aligned to the kicad pcb footprint in pcbnew 3d-viewer
   all the conversion steps can be done with the use of ***kicad-SteUp-tools.FCMacro***
   It is possible to **Load the kicad footprint** inside FreeCAD to *interactively align 3d model to the footprint* in a live visual feedback
   Note: kicad StepUp 3D MCAD exporter is compatible with:
   STEP with colors files (*.step*, *.stp* extensions)
   IGES with colors files (*.iges*, *.igs* extensions)

Using kicad pre-built libraries:
some ready-to-go 3D libraries are ready at
kicad 3D MCAD VRML libraries[12]
and you can get more info at the forum
kicad info forum 3D MCAD libs[13]
kicad info MCAD related arguments[14]

[11] http://forum.freecadweb.org/viewtopic.php?t=8451#p69489
[12] https://github.com/easyw/kicad-3d-mcad-models
[13] https://forum.kicad.info/t/3d-new-library-for-mechanical-cad-exporting-and-enclosure-design/1763
[14] https://forum.kicad.info/search?q=mcad

12. Interactively align 3D part to kicad footprint

With ***kicad-SteUp-tools Macro*** it is possible to **Load the kicad footprint** in FreeCAD and align the 3D part with a visual real time feedback of the 3d model and footprint reciprocal position.
Once the 3D part is aligned to the footprint pads and silk, the model can be exported in STEP format and in VRML format for kicad 3d-rendering, just clicking on the **Export STEP & VRML** button.
That will align EDA to MCAD 3d viewers. No need to reiterate the aligning process or empiric calculate offset and rotation to apply to VRML model.
You can also click on ***Create axis*** button to have an other help in the part orienting process

Tip.
footprint aligner workflow:
- load the Macro
- open the 3d STEP model in FC
- Load the footprint with the macro Button
or
- Load the footprint with the macro Button
- import the 3d model in FC
(**NB Import Ctrl+I**, *not Open Ctrl+O*)

Tip.
use the ***kicad-SteUp-tools.FCMacro*** to easily align the 3D model to the footprint (then it will be aligned to the footprint also in kicad)
(previously known as ***move-rotate-scale macro***)
the macro can be launched with:
`./launch-kicad_StepUp-Tools.sh`
or with
`launch-kicad_StepUp-Tools.bat`
or just open the macro in FreeCAD and run it
or add the macro button to the FreeCAD toolbar following these instructions:
Note: FreeCAD forum Customize Toolbar[15] how to add a button to Toolbar in FreeCAD adding also the kicad StepUp icon

[15] http://www.freecadweb.org/wiki/index.php?title=Customize_ToolsBar

Note:
the macro takes care of 2D footprint rotation of kicad for the footprint alignment
it does take care of vrml model *z* rotation, it doesn't take care of *x* and *y* 3d model rotation
it doesn't take care of *x*, *y*, *z* 3d model translation

this behaviour is intentional… you have to align your 3d STEP model of Freecad to your 2D footprint of kicad,
then if you export your step model to vrml (scaling 1/2.54) the vrml model will be aligned too

one has to check/modify, if needed, the part of 3D vrml model in kicad as following

```
(model path/name.wrl
(at (xyz 0 0 0))
(scale (xyz 1 1 1))
(rotate (xyz 0 0 0))
```

`at (xyz 0 0 0)` is mandatory, as much as `scale (1 1 1)`
`rotate (xyz 0 0 z_value)` can have a z rotation value
(those fields can be changed on the .kicad_mod text file or through the kicad GUI)
rotation values and position translations are taken in care ONLY by the StepUp assembler when loading a board and models

Figure 5. kicad StepUp icon

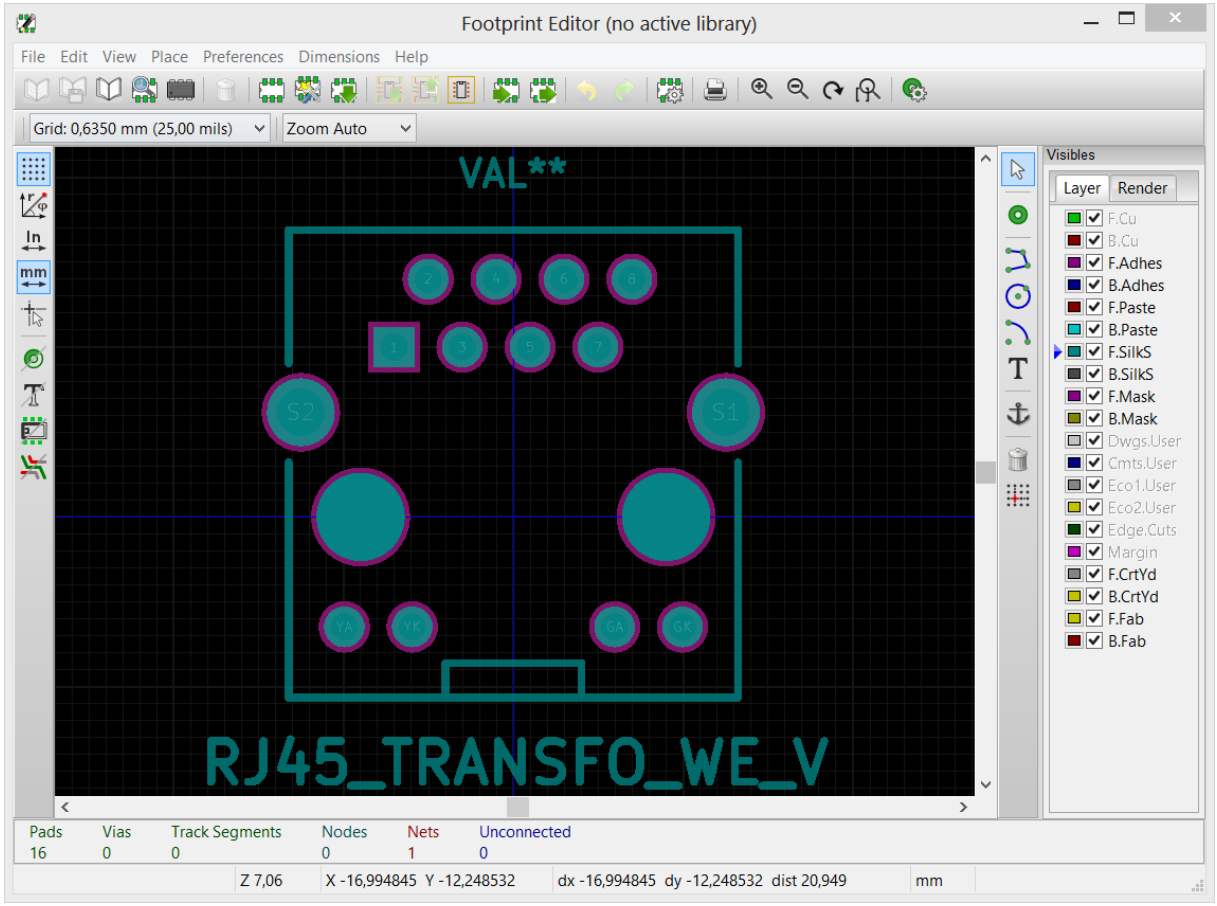


Figure 6. kicad pcbnew: Load Footprint

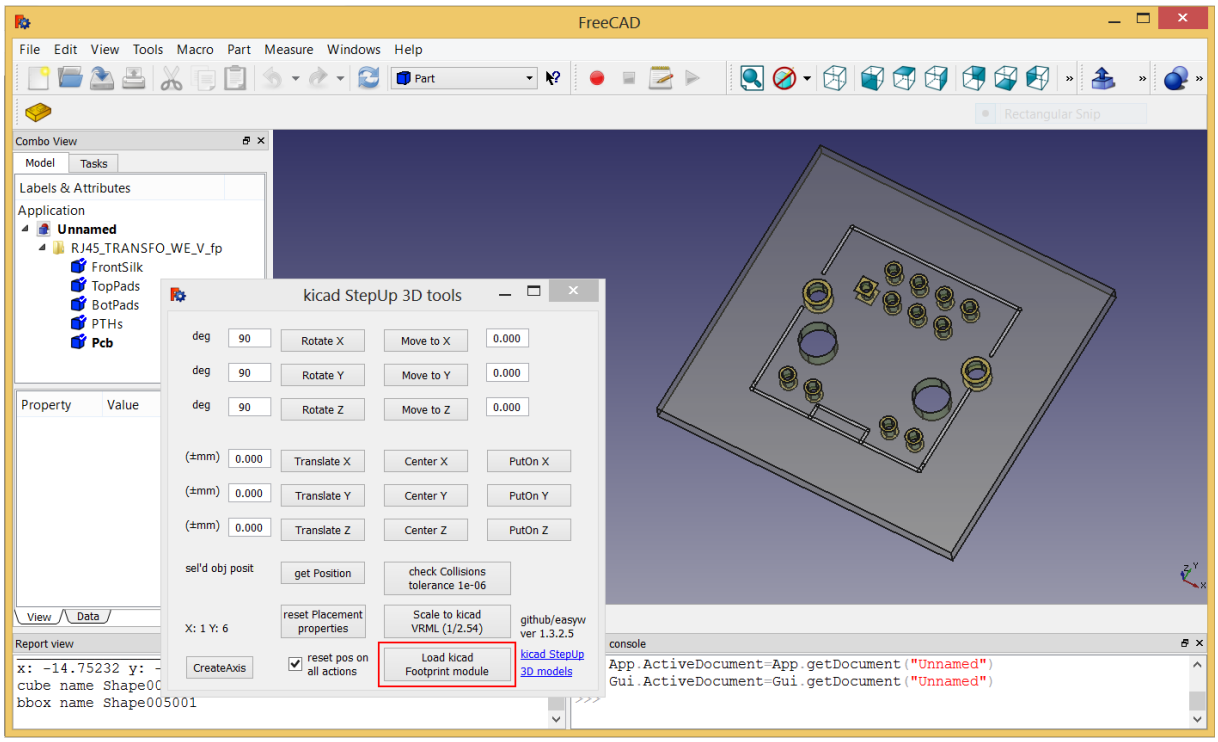


Figure 7. kicad StepUp tools: Load Footprint

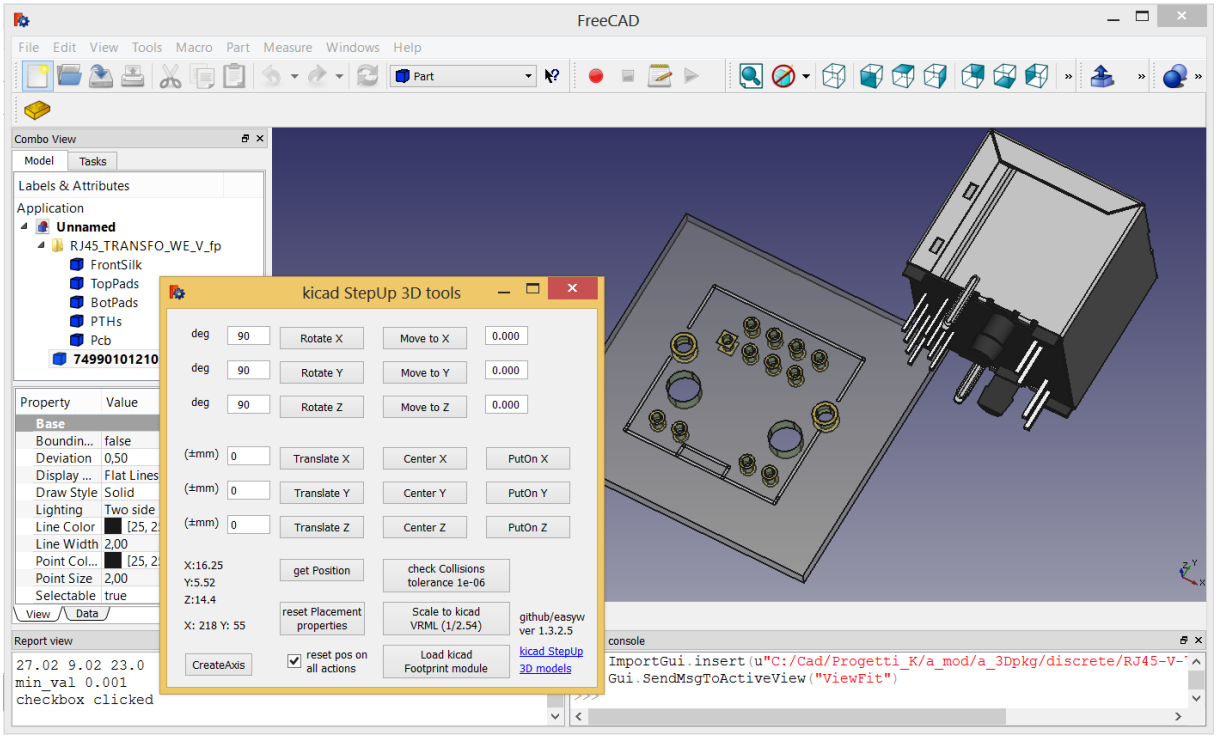


Figure 8. kicad StepUp tools: Align 3D model to footprint

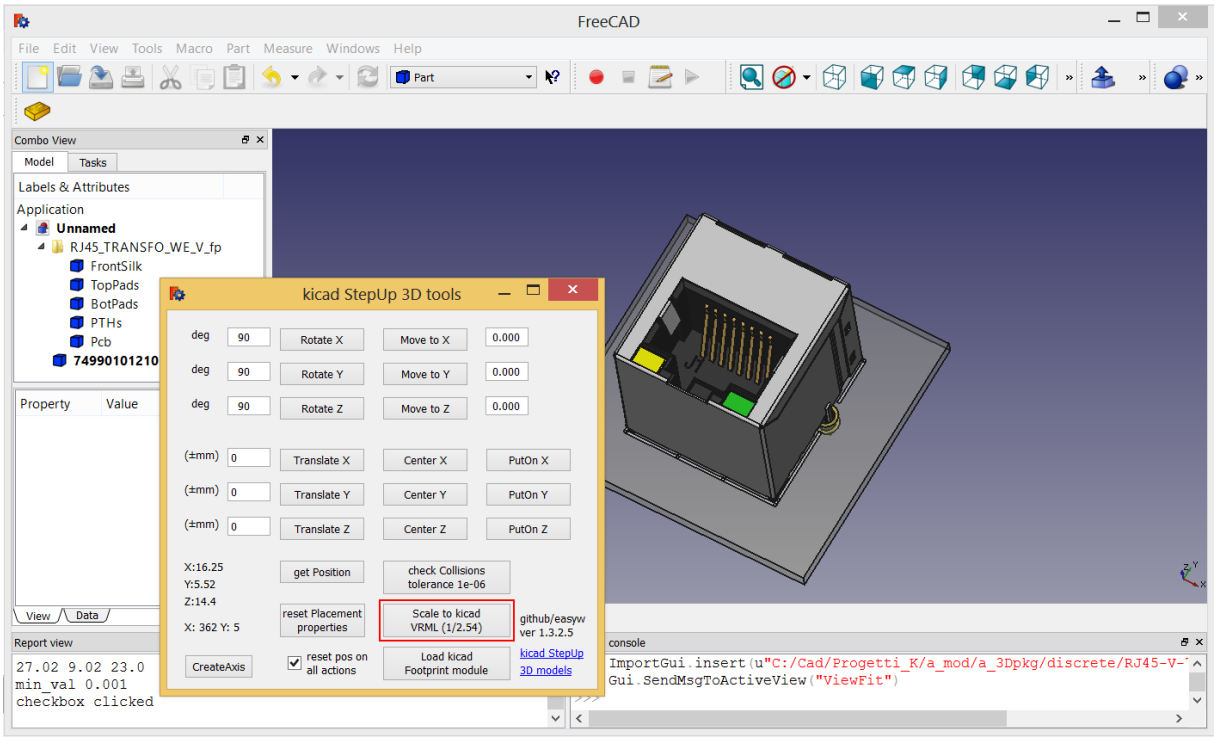


Figure 9. kicad StepUp tools: 3D STEP model aligned

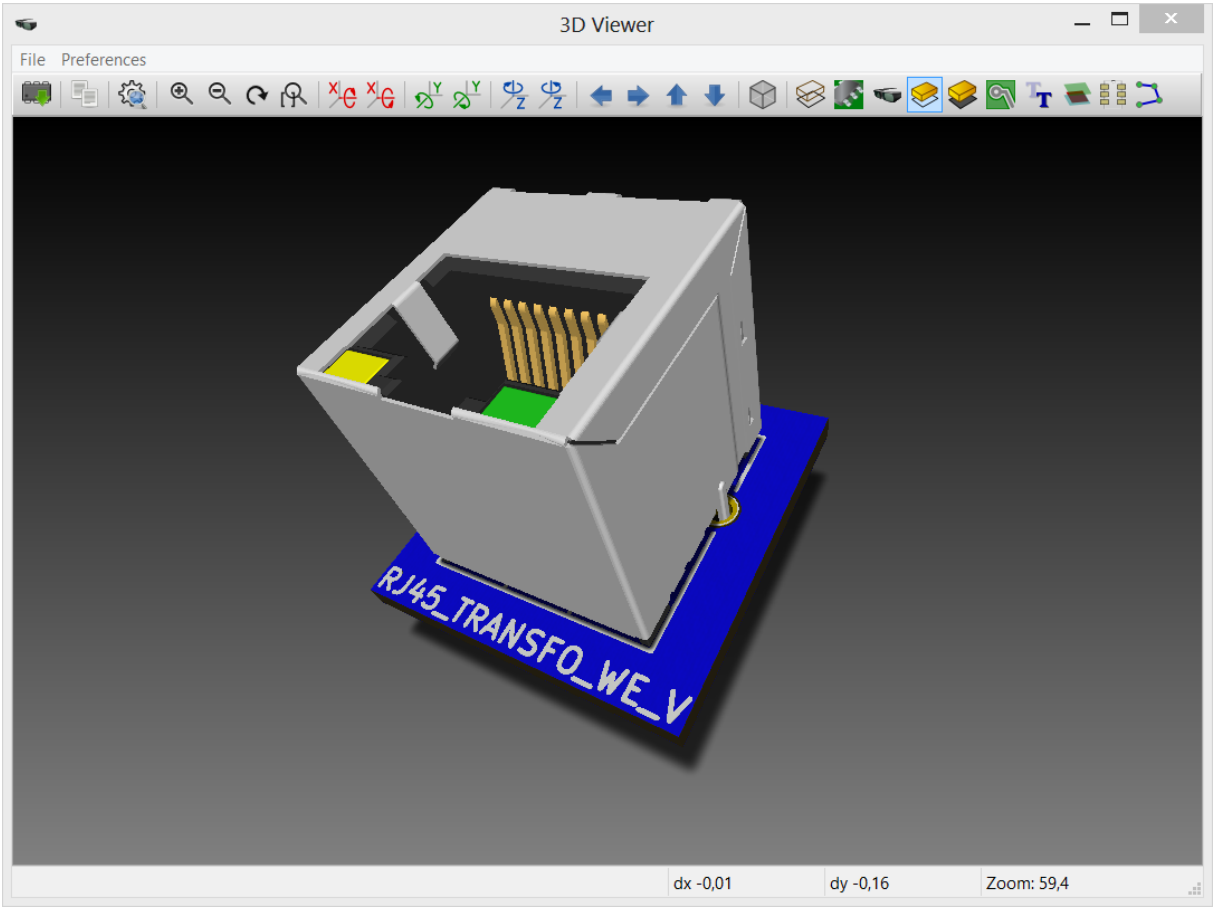


Figure 10. kicad StepUp tools: 3D VRML model aligned

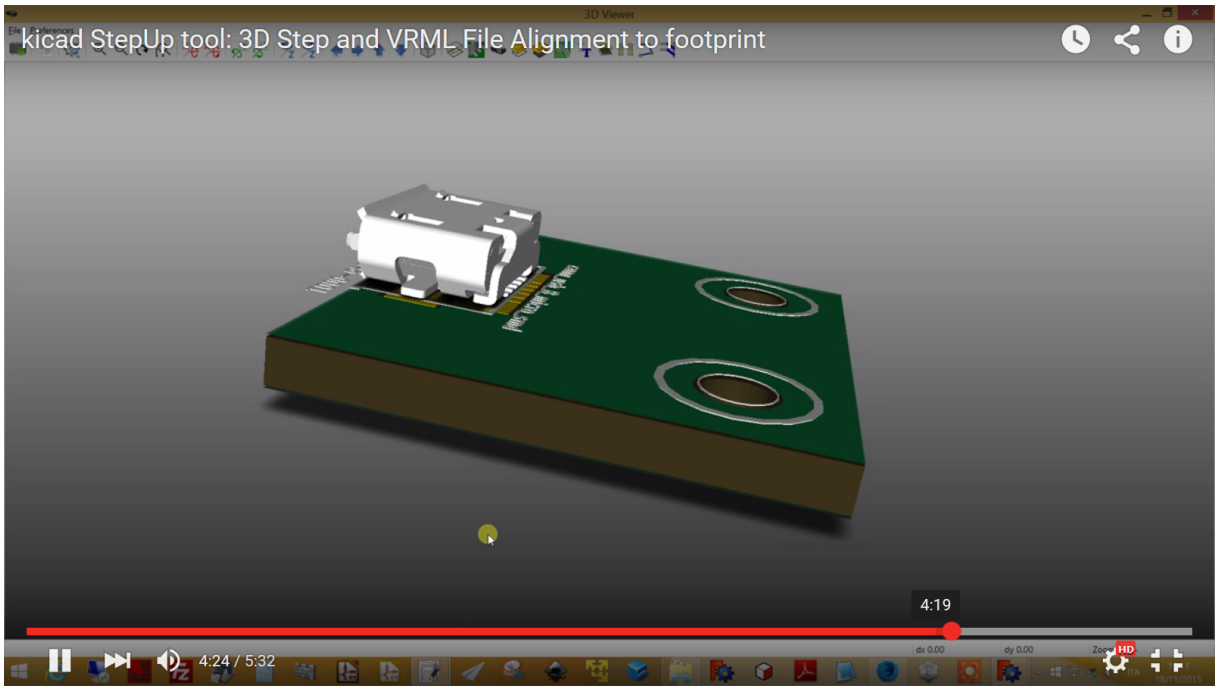


Figure 11. kicad StepUp tools: align 3D STEP and VRML to footprint - video tutorial

YouTube Kicad StepUp tool: Align 3D Step model to pcbnew footprint video[16]

[16] https://youtu.be/O6vr8QFnYGw

13. Generating smaller 3D model with bounding boxes

Sometimes the need would be just a 3D MCAD model for analysis or simple space constraints, so a nice detailed component models in MCAD system may be not required or desired;
in that case it is possible to configure the exporter to:

- skip 3D models by name
- skip models with a volume less than an assigned value
- skip models with a height less than an assigned value
- convert the remaining parts, or all but edge connectors, to bounding boxes

The result 3D MCAD model will have the accuracy of the pcb and assemblies only when needed, maintaining the model light as required.

The config file *ksu-config.cfg* let you configure the following parameters:

1. 3D path prefix
   your KISYS3DMOD path (see kicad for help) or 3D model path prefix
   ${KIPRJMOD}, ${KIPRJMOD}, :ALIAS:, ${ENV} vars are supported
2. blacklist of 3D models
   none=all 3D models will be parsed;
   volume=1 means all models with a volume < 1mm3 will not be included
   height=1 means all models with a height < 1mm will not be included
3. pcb color r,g,b
   e.g. 0.0,0.5,0.0,light green
4. bounding box option
   LIST list of modules, separated by a comma, not converted to bbox
   ALL or off
5. placement options of board and parts
   useAuxOrigin, useBaseOrigin, useBasePoint;x;y, usedefault, +AutoAdjust
6. virtual modules to be or not added to board
   if a module has vitual attribute in kicad pcbnew, can be selectively parsed
7. fuse modules to board and make a single object of pcb and parts
   fuseAll, nofuse

Note: be careful … fusion can be heavy or generate FC crash with a lot of objects please consider to use bbox or blacklist small objs in case of *fuseAll* option

8. allow compound for STEP models
   allow compound if you want to allow multi-part STEP models
9. turntable spin after loading
   enable or disable spinning after loading the board
10. font size for ksu widget

14. Skipping small parts and using Bounding Boxes

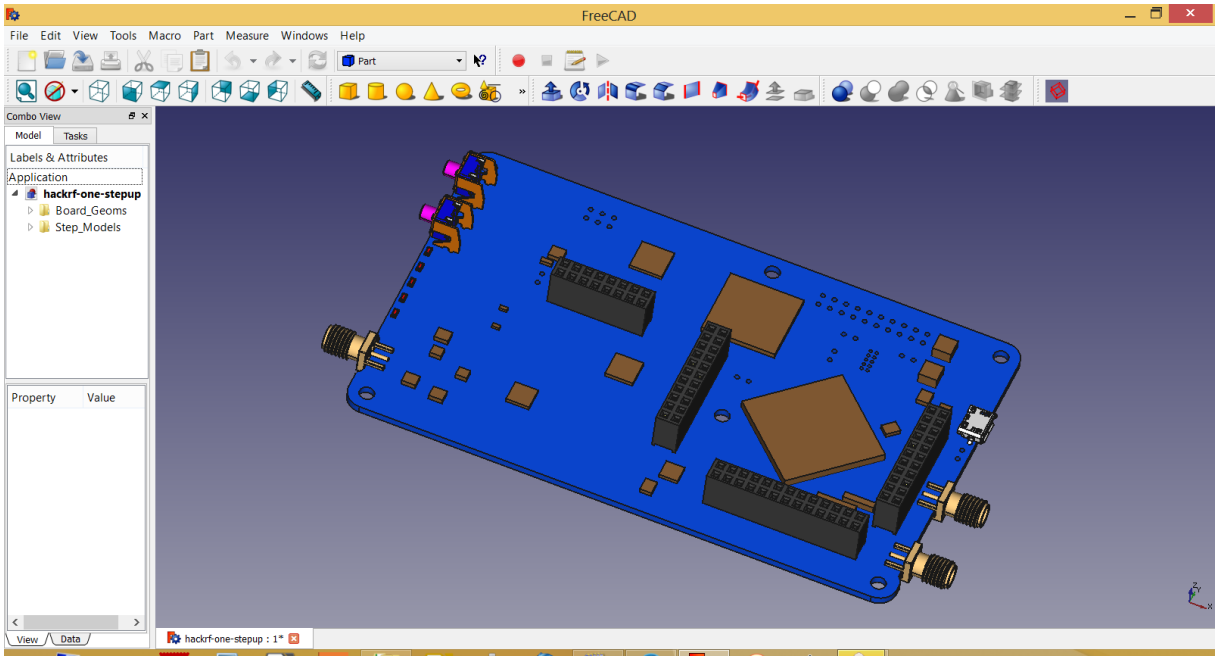


Figure 12. kicad StepUp: using bounding boxes for all but connectors and skipping small parts

15. Check for Collisions and mechanical constrains

With ***kicad-SteUp-tools Macro*** it is also possible to **detect collisions** and **check mechanical constrains**

- detect collisions among part pins and drills
- detect collisions for enclosure clearance

(between pcb with connectors and enclosure)

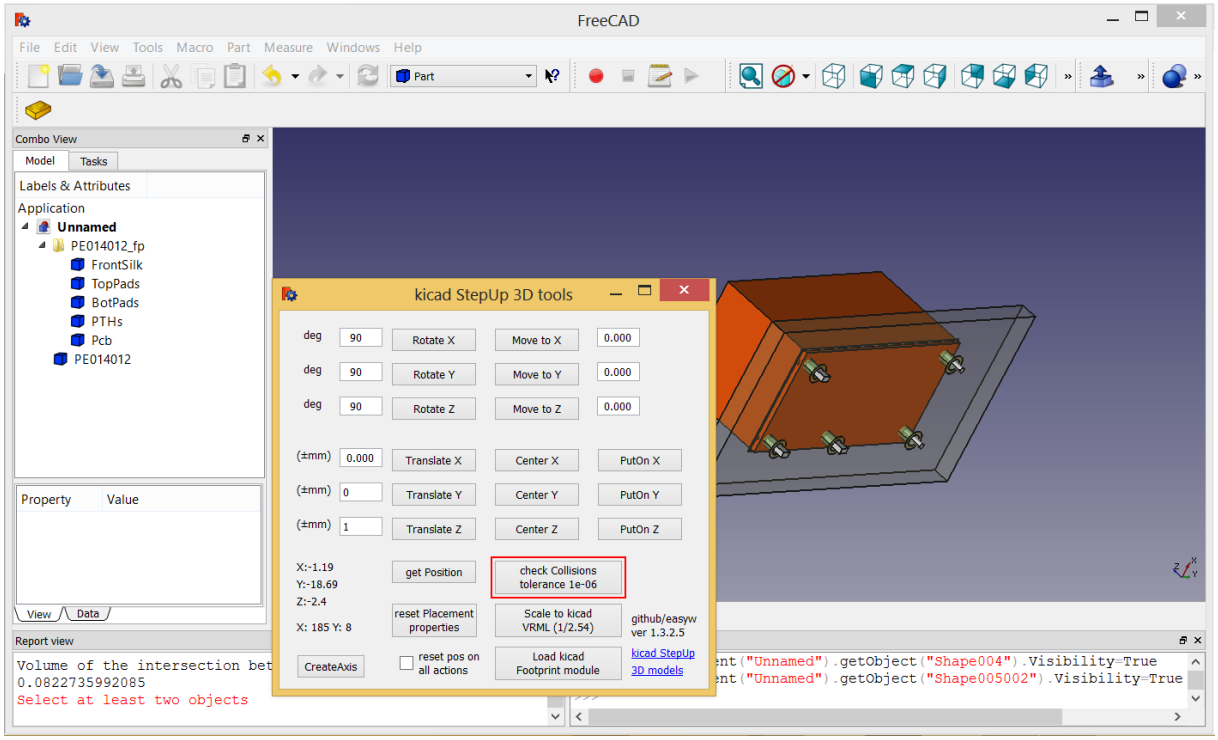


Figure 13. kicad StepUp tools: collisions check for 3D part module and footprint

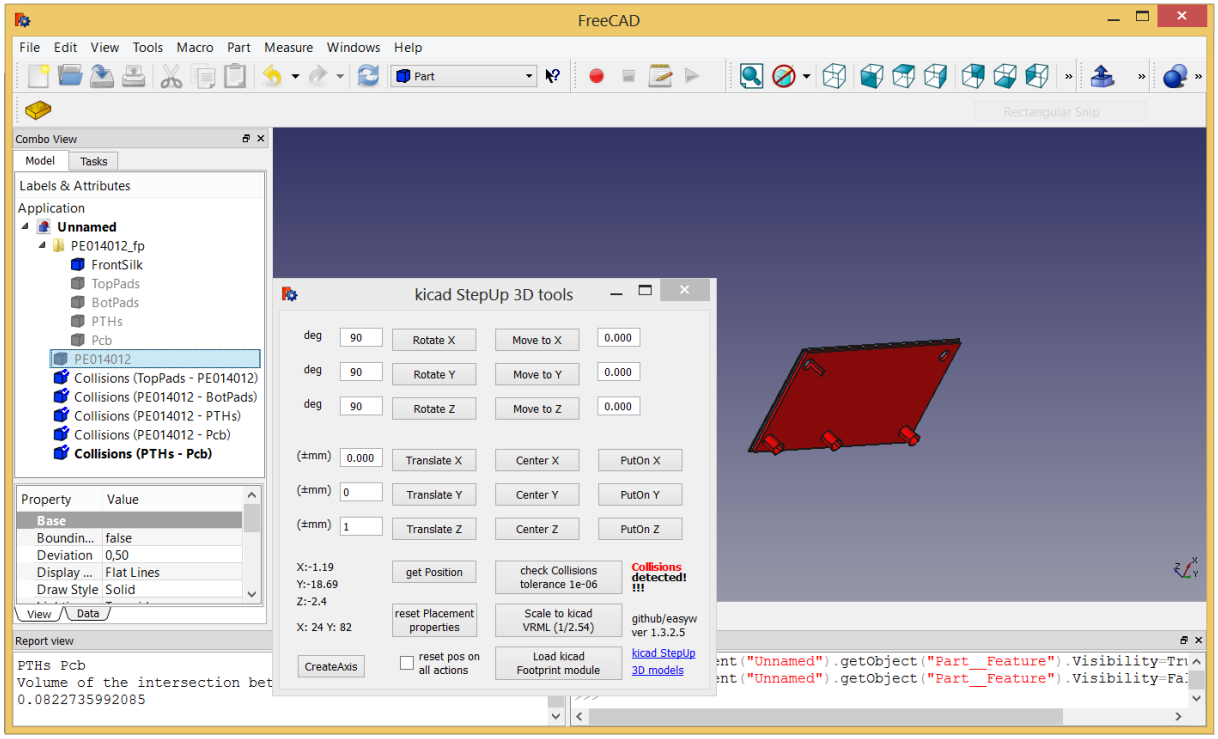


Figure 14. kicad StepUp tools: collisions found for 3D part module and footprint

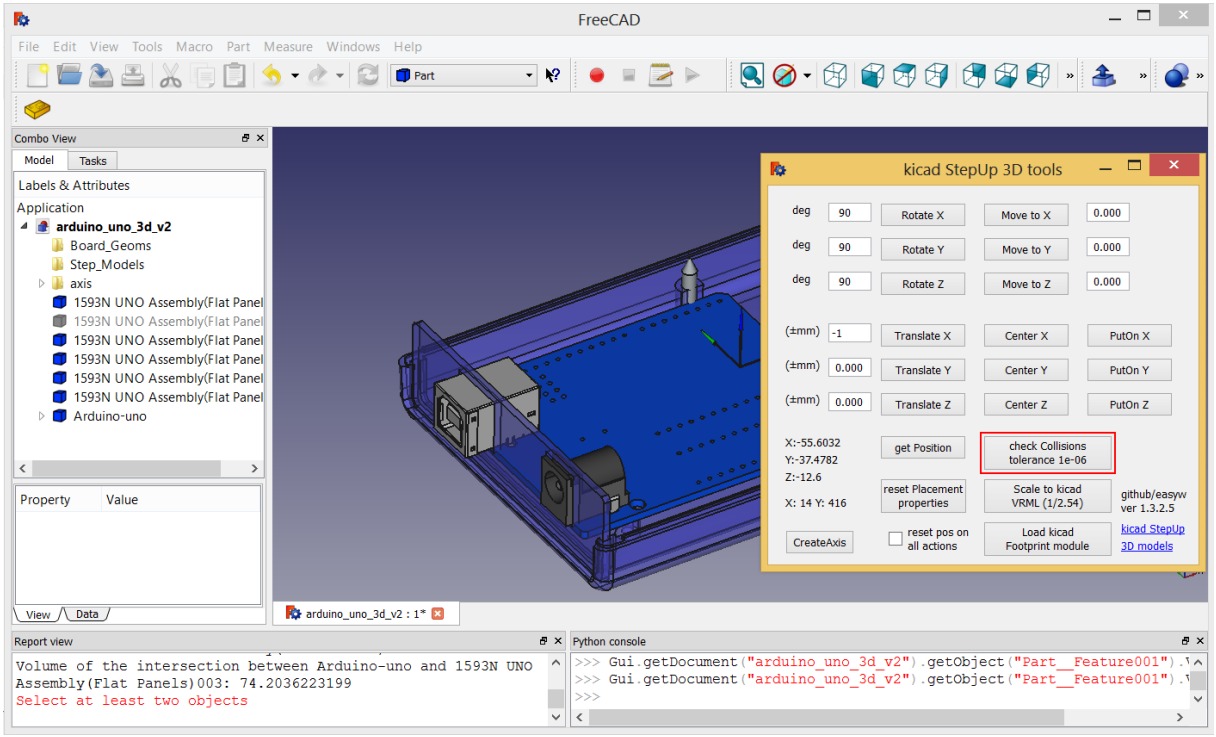


Figure 15. kicad StepUp tools: collisions check for 3D pcb and connectors with Arduino-uno-enclosure

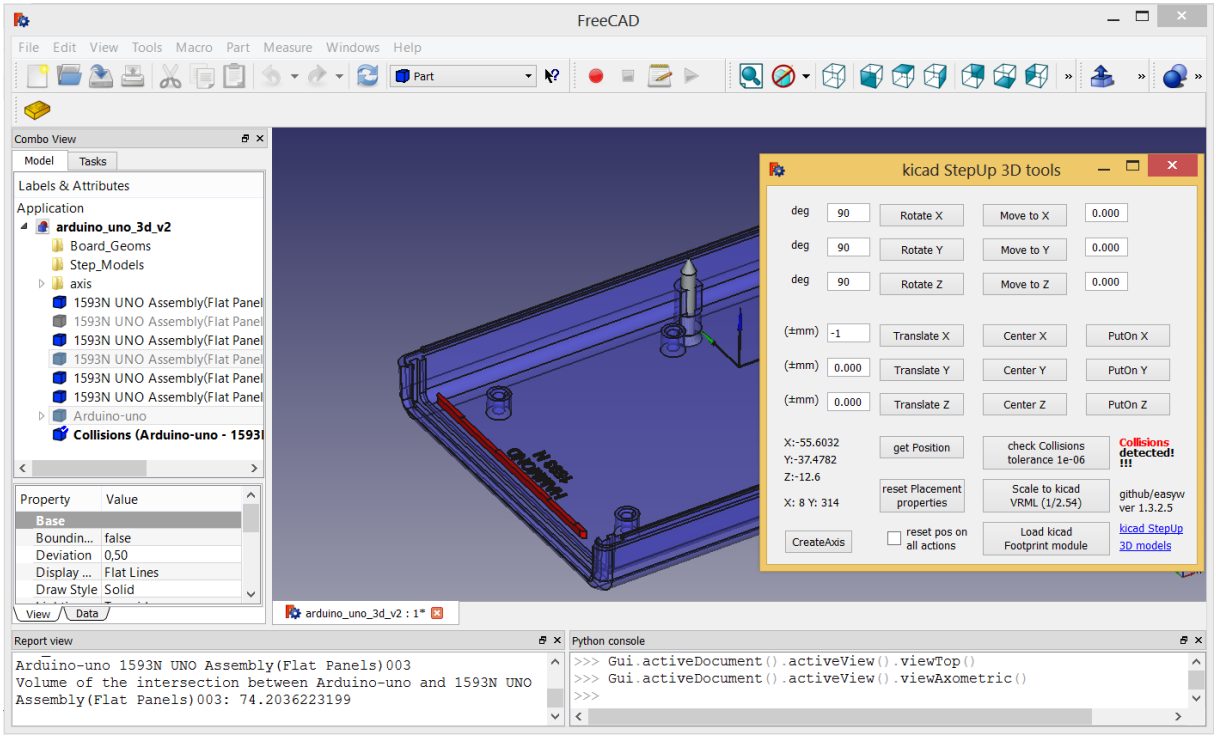


Figure 16. kicad StepUp tools: collisions found for 3D pcb and connectors with Arduino-uno-enclosure

16. STEP AP214 and VRML FreeCAD scripted repository ready to kicad StepUp

repository of 3D STEP models:[17]

me and HyOzd have done a repository of many electronic components **STEP AP214** and **VRML** models, with some nice scripts to build parametric models for *SOIC, SSOP, TSSOP, SOT, QFP, QFN* ICs, *DIP* ICs, *Chip Resistors, Chip Capacitors, Pin Headers*

just compiling a parametric text file with dimensions from component data sheet

3D-script-generator and 3D models[18]

more is coming …

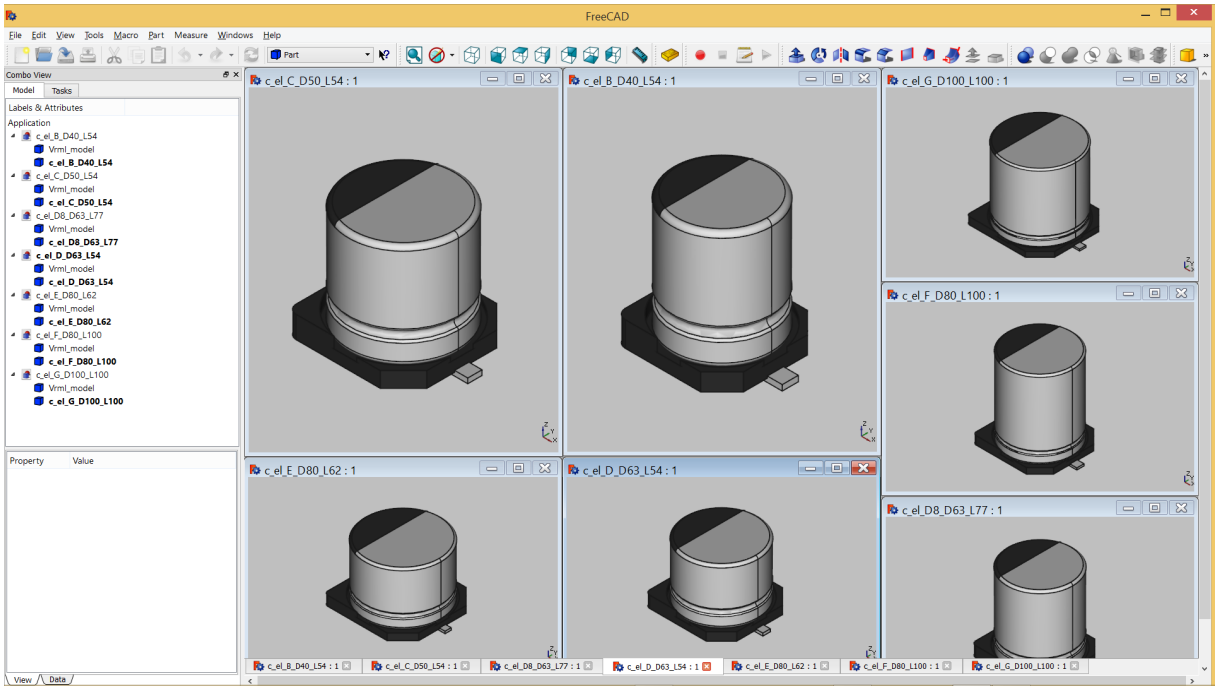


Figure 17. kicad StepUp: parametric STEP & VRML library

[17] https://github.com/easyw/kicad-3d-models-in-freecad

[18] https://github.com/easyw/kicad-3d-models-in-freecad/tree/master/cadquery/FCAD_script_generator

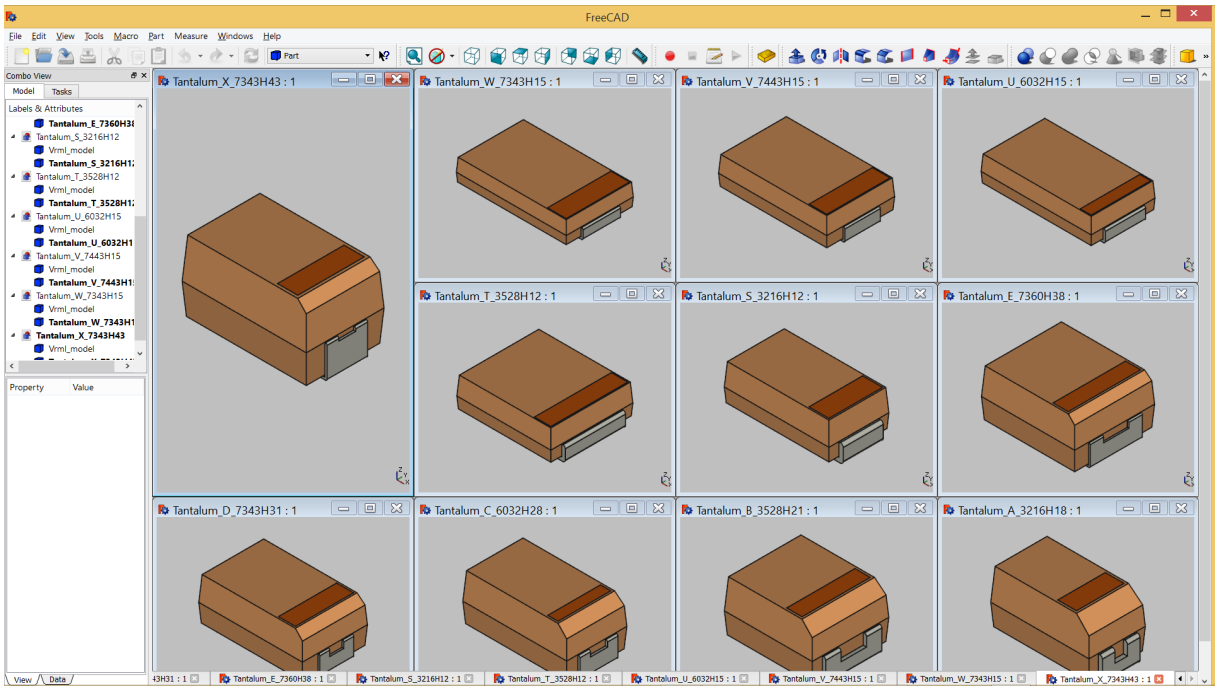


Figure 18. kicad StepUp: parametric STEP & VRML library

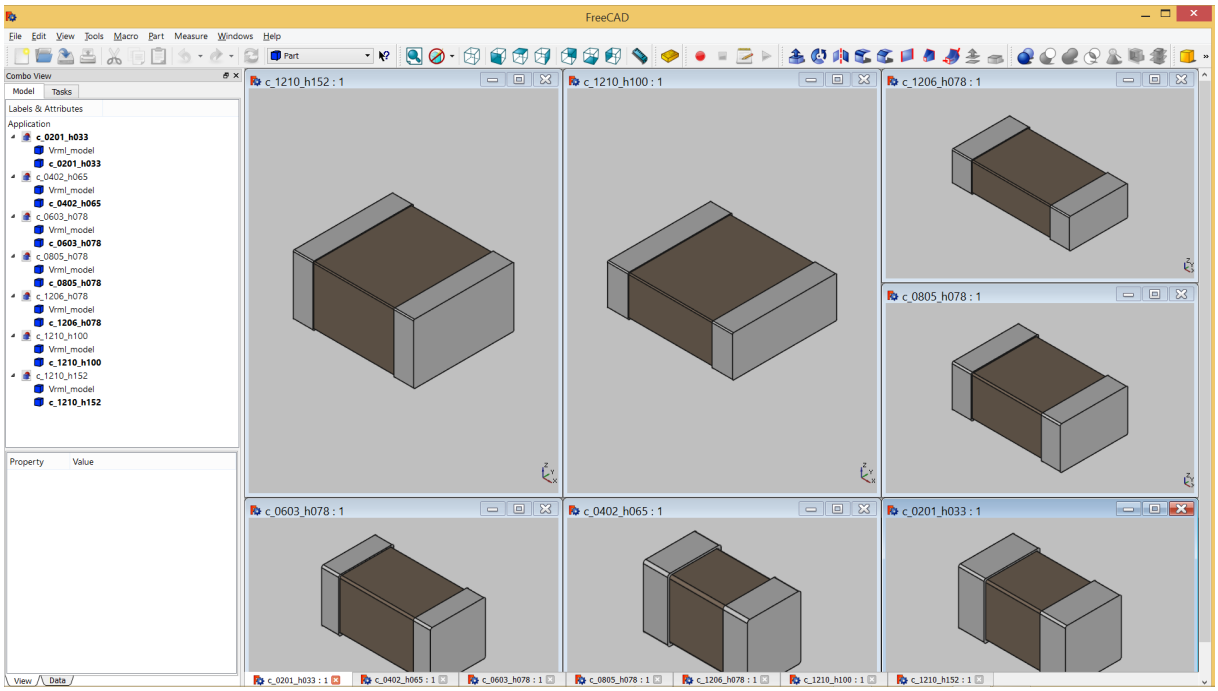


Figure 19. kicad StepUp: parametric STEP & VRML library

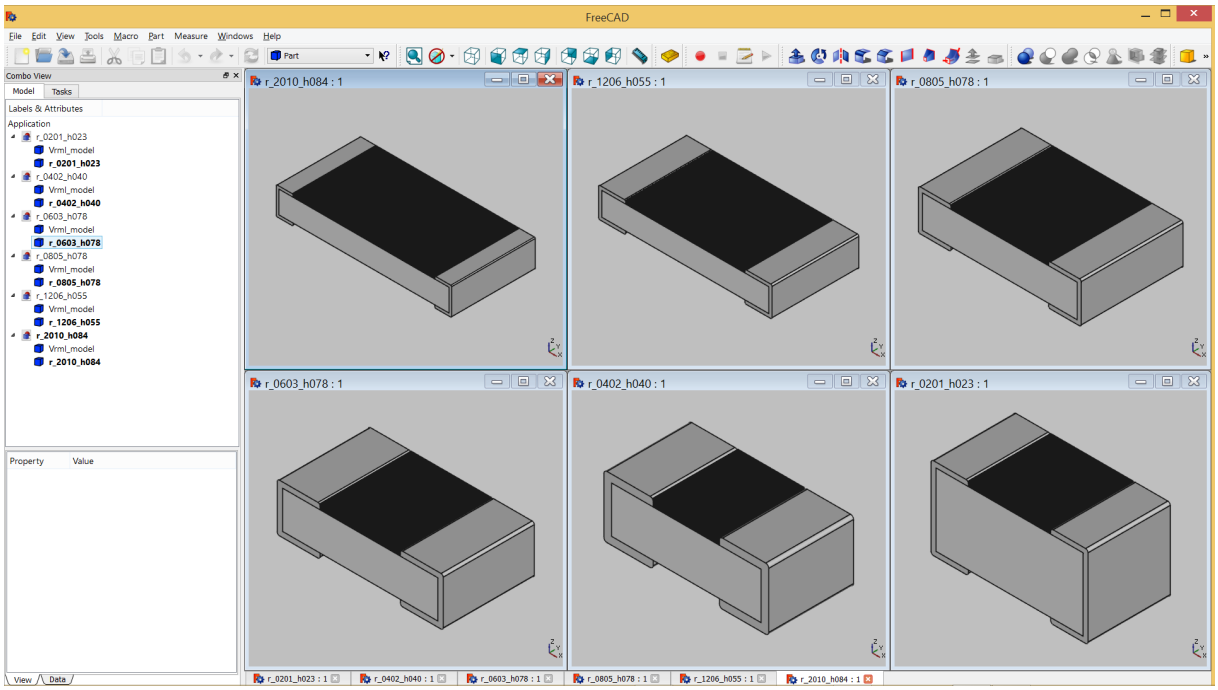


Figure 20. kicad StepUp: parametric STEP & VRML library

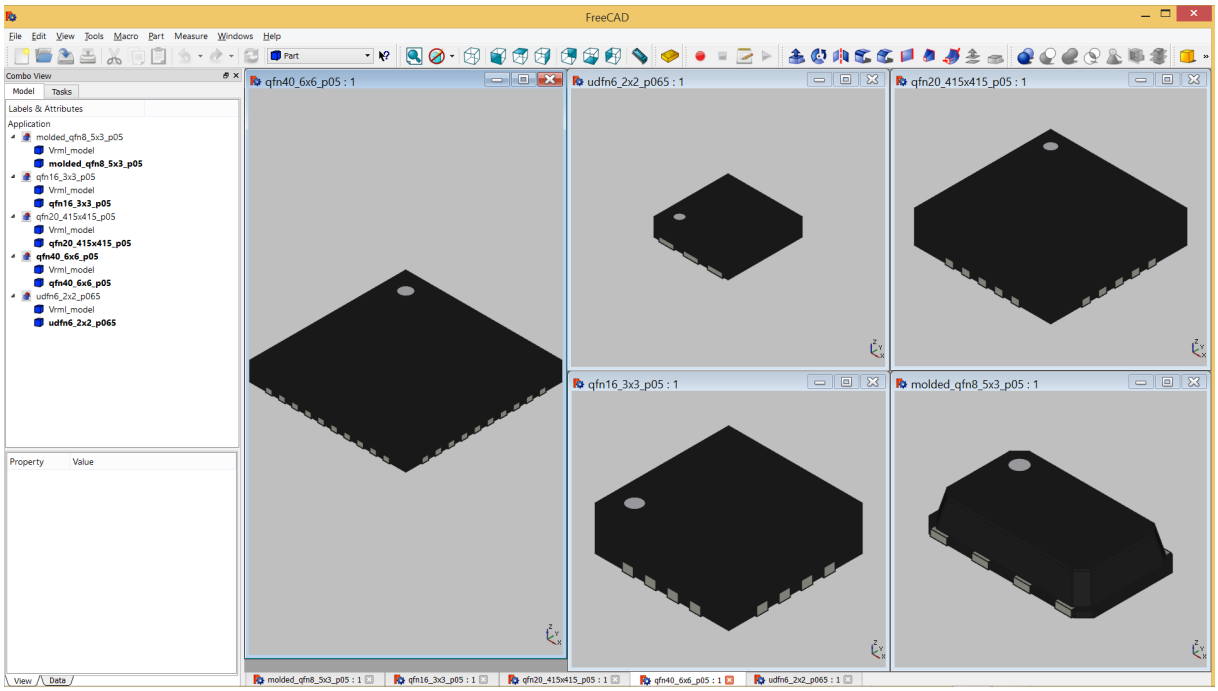


Figure 21. kicad StepUp: parametric STEP & VRML library

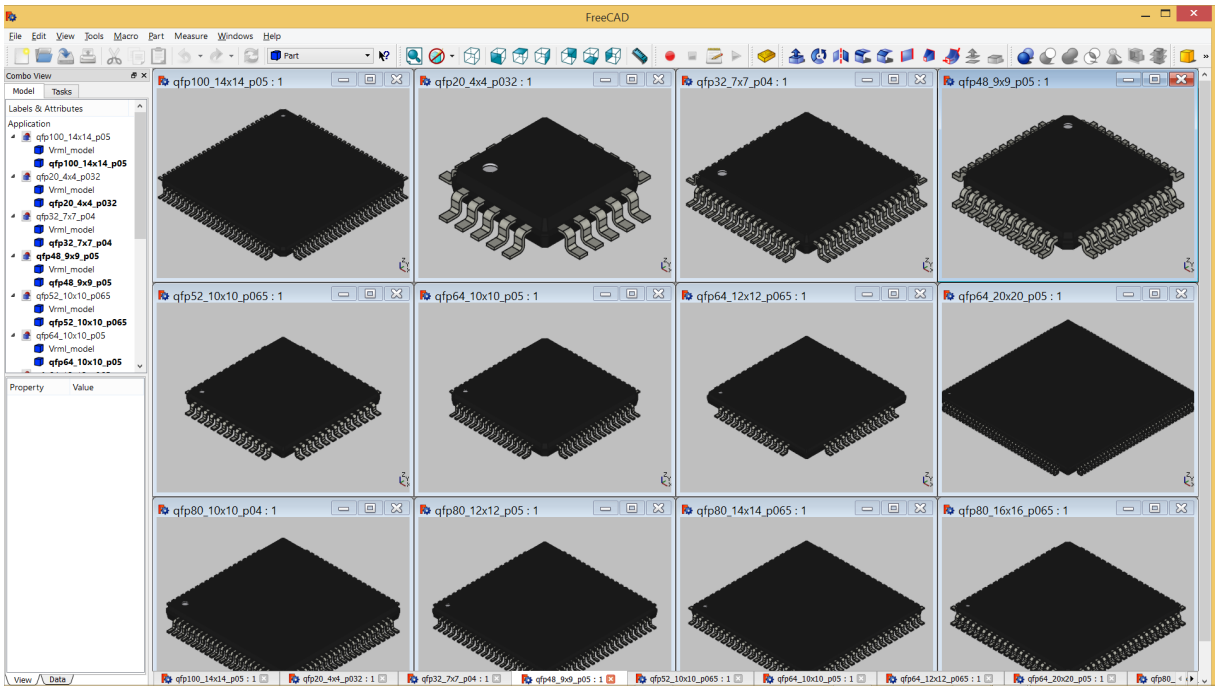


Figure 22. kicad StepUp: parametric STEP & VRML library

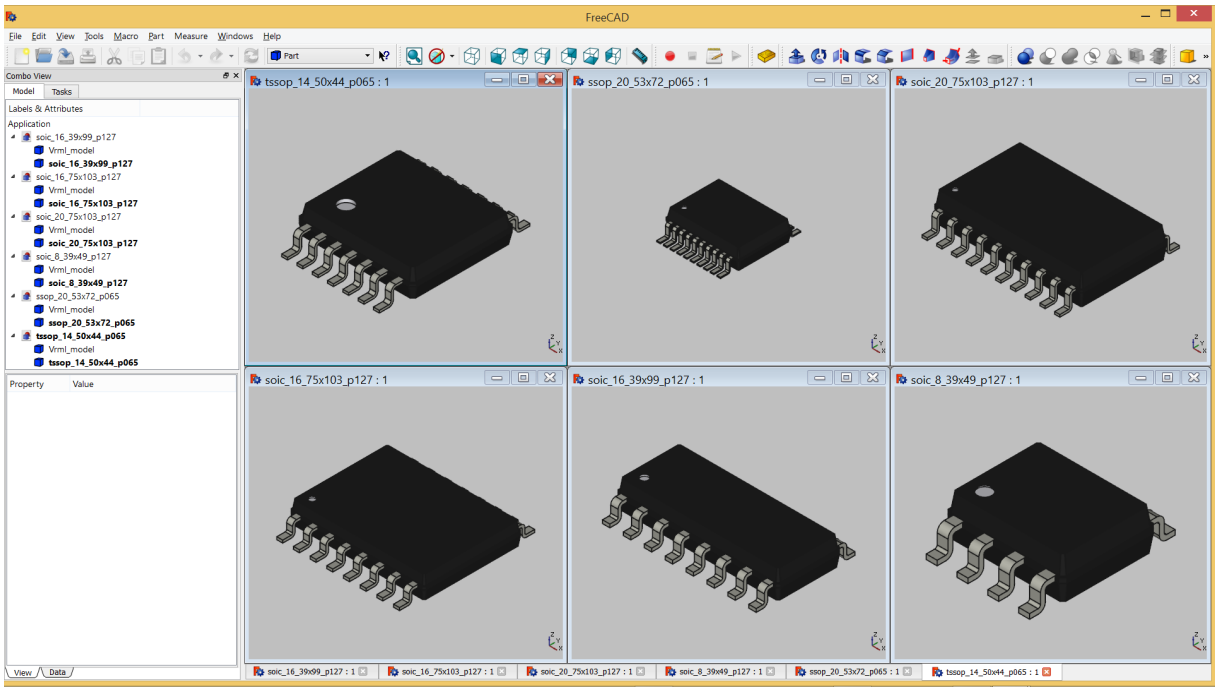


Figure 23. kicad StepUp: parametric STEP & VRML library

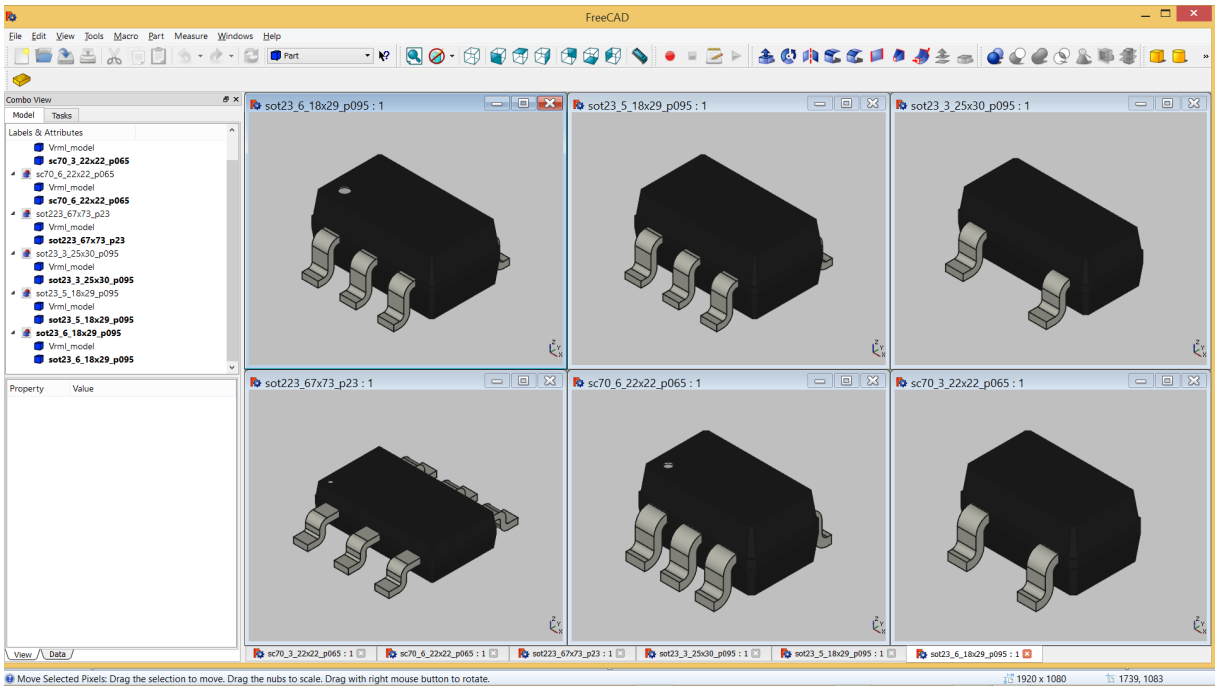


Figure 24. kicad StepUp: parametric STEP & VRML library

17. Create boxes or cylinders using dimensions as in scale values of wrl model

This feature will be triggered only if the wrl models have the following names:

- box_mcad.wrl
- cylV_mcad.wrl
- cylH_mcad.wrl

When kicad StepUp tools will parse these special names, correspondent models will be generated in FreeCAD using the dimensions as per the scale values indicated in the kicad_pcb file. the **3 special wrl models are in the "shapes" folder of the demo project**

So it is possible to use simple generic shapes to generate bounding box like ECAD and MCAD models…

18. Blender compatibility for FreeCAD generated VRML files

kicad StepUp rendered with Blender[19]

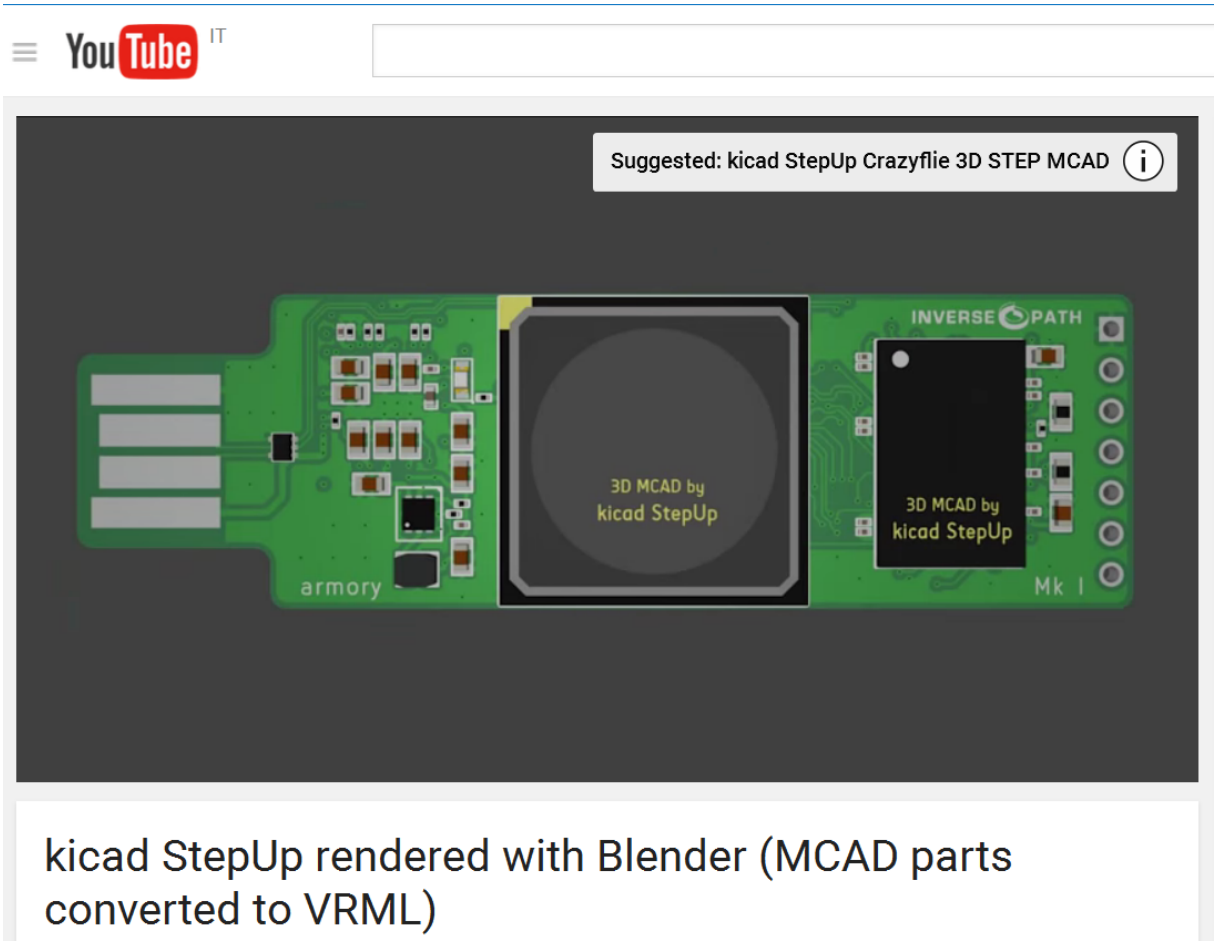


Figure 25. kicad StepUp: video rendered with Blender

kicad-SteUp-tools.FCMacro now have an exporting function that will create VRML smaller in file size and **fully compatible with Kicad and Blender**

[19] https://youtu.be/oq-w532Qmlo

19. Config File

NB the new config file is in home user dir
Linux and OSX:
~/ which is *$HOME*
Windows:
%HOMEPATH%
Click kicad-StepUp-tools.FCMacro Config Button to display the **ksu-config.ini** file and Help button for a quick Help

In case of any problem, just **delete ksu-config.ini file** and restart the kicad StepUp tools… a new ini file will be generated
edit your 3D prefix and re-run the tools

20. List of files

kicad_StepUp-Tools.FCMacro = Load kicad Board, Load Footprint, Move, Rotate, Scale, export wrl, check Collisions; GUI Macro to easily manage ALL MCAD conversion for board and manufacturers STEP modules and kicad VRML
kicadStepUp-starter-Guide.pdf = *kicad StepUp* starter Guide kicad_StepUp.FCMacro = OLD *kicad StepUp* 3D MCAD exporter script/plugin
ksu-config.cfg = OLD configuration file
kicad_StepUp_vrml_export.FCMacro = OLD STEP to scaled VRML script

21. credits

kicad StepUp script author is Maurice easyw@launchpad[20]
Guide Doc Version is 2.1.0

kicad EDA[21]
- IDF export for kicad (Cirilo Bernardo)

FreeCAD[22]

IDF import for FreeCAD
- Milos Koutny (milos.koutny@gmail.com[23])

CadQuery module[24]
- CadQuery FreeCAD module

hyOzd freecad macros[25]
- hyOzd parametric script

FreeCAD-PCB
- marmni <marmni@onet.eu[26]>

[20] https://launchpad.net/~easyw/
[21] http://kicad-pcb.org/
[22] http://freecadweb.org/
[23] mailto:milos.koutny@gmail.com
[24] https://github.com/jmwright/cadquery-freecad-module/archive/master.zip/
[25] https://bitbucket.org/hyOzd/freecad-macros
[26] mailto:marmni@onet.eu

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23. Risk disclaimer

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