

LibrePCB

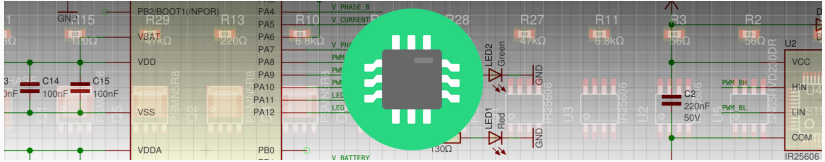
A new, powerful and intuitive EDA tool for everyone

Danilo Bargaen, Raphael Nestler

June 15, 2019

CoSin 2019

Goals For Today



Goals

- Intro to LibrePCB
- Library Concepts
- Install LibrePCB
- Create a LED PCB

Getting Started

https://download.librepcb.org/nightly_builds/master/

Linux

librepcb-nightly-linux-x86_64.AppImage

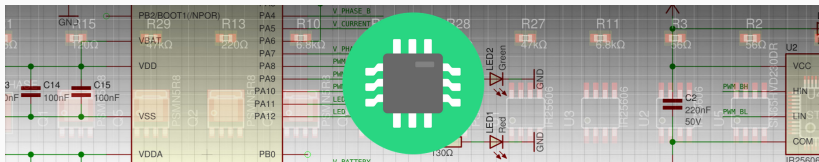
macOS

librepcb-nightly-mac-x86_64.dmg

Windows

librepcb-installer-nightly-windows-x86.exe

About LibrePCB



Free/OpenSource EDA Suite

- Multiplatform   
- Written from scratch in C++11/Qt5
- Development started in 2013, first stable release in late 2018
- Website: <https://librepcb.org/>
- GitHub: <https://github.com/LibrePCB/LibrePCB>

Frustration about existing EDA tools

- Library system
- File format
- Usability

Problem

- Different library types (e.g. *.lib, *.pretty, *.3dshapes)
- Tools do not (completely) handle library management
 - No integrated tool to install and update libraries
 - No dependency management
 - Complicated project library management

Library Management

Problem

- Different library types (e.g. *.lib, *.pretty, *.3dshapes)
- Tools do not (completely) handle library management
 - No integrated tool to install and update libraries
 - No dependency management
 - Complicated project library management

Result

- It's up to the user to manage his libraries (which is a pain)

Libraries

Access the largest collection of free and open source component libraries.

Sort by [Downloads](#) | [Likes](#) | [Date](#)

si5317_10.lbr by samuell

SI5317 jitter filter from Silicon Labs. This is a filter specially designed for clock signals. The SI5317 is fully configurable, allowing both the work frequency and loop bandwidth to be set. It admits different types of clocks (CML, CMOS, LVDS or LVPECL), being capable of producing such levels too. Based on Silicon Laboratories' 3rd-generation DSPLL technology, the SI5317 outputs a clock signal having a typical jitter of 300fs.

3951 Downloads | 396 Likes | 05.17.2016

sxx8xsx_10.lbr by samuell

SxX8xSx SCRs (silicon controlled rectifiers) from Littelfuse (Teccor). These thyristors can control currents up to 0.51A (or 0.8A average), having a maximum voltage drop of 1.7V.

2471 Downloads | 257 Likes | 05.17.2016

polyfuse-smd_20.lbr by samuell

Littelfuse Polyfuse devices. This new version of the library contains the most recent surface mount

Library Management



EAGLE Overview Features Free Download Subscribe System Requirements [Support & Learn](#)

Libraries

Access the largest collection of libraries

Search for Libraries

si5317_10.lbr by sa

Si5317 jitter filter from
fully configurable, all
types of clocks (CML,
Silicon Laboratories)
typical jitter of 300fs.

Download Like

sxx8xSx_10.lbr by

SxX8xSx SCRs (silicon
currents up to 0.51A (

Download Like

polyfuse-smd_20.lbr

Littelfuse Polyfuse de

Project '/home/user/test/test.pro'

Component library files

power
device
transistors
conn
linear
regul
74xx
cmos4000
adc-dac
memory
xilinx

Add

Insert

Remove

Up

Down

User defined search path

Add

Insert

Remove

Current search path list

/home/user/test
/snap/kicad-snap/2/usr/share/kicad/library
/snap/kicad-snap/2/usr/share/kicad/template
/usr/local/share

Check for cache/library conflicts when loading schematic

Cancel

OK

Library Management



EAGLE Overview Features Free Download Subscribe System Requirements Support & Learn

Libraries

Access the largest collection of libraries

Search for Libraries

si5317_10.lbr by sa

SI5317 jitter filter from fully configurable, all types of clocks (CML, Silicon Laboratories) typical jitter of 300fs.

Download Like

sxx8xsx_10.lbr by

SxXbXsX SCRs (silicon currents up to 0.51A (

Download Like

polyfuse-smd_20.l

Littelfuse Polyfuse de

Project '/home/user/test/test.pro'

Component library files

power
device
transistors
conn
linear
regul
74xx
cmos4000
adc-dac
memory
xilinx

User defined search path

Current search path list

/home/user/test
/snap/kicad-snap/2/usr/s
/snap/kicad-snap/2/usr/s
/usr/local/share

PCB Library Tables

Library Tables by Scope

Table: /home/user/snap/kicad-snap/common/.config/kicad/fp-lib-table

	Nickname	Library Path
15	CONNECTORS_JAE	\${KISYSMOD}/connectors_JAE.pretty
16	Connectors_JST	\${KISYSMOD}/Connectors_JST.pretty
17	Connectors_Molex	\${KISYSMOD}/Connectors_Molex.pretty
18	Connectors_Multicomp	\${KISYSMOD}/Connectors_Multicomp.pretty

Global Libraries Project Specific Libraries

Append with Wizard Append Library Remove Library Move Up Move Down

Path Substitutions

	Environment Variable	Path Segment
1	KIPRJMOD	/home/user/test
2	KISYS3DMOD	\$\$SNAP/usr/share/kicad/modules/packages3d/
3	KISYSMOD	\$\$SNAP/usr/share/kicad/modules/

Cancel

OK

Check for cache/library conflicts when loading schematic

Cancel

OK

Library Management



EAGLE Overview Features Free Download Subscribe System Requirements Support & Learn

Libraries

Access the largest collection of libraries

Search for Libraries

si5317_10.lbr by sa

SI5317 jitter filter from fully configurable, all types of clocks (CML, Silicon Laboratories) typical jitter of 300fs.

Download Like

sxx8xsx_10.lbr by

SxXbSx SCR (silicon currents up to 0.51A (

Download Like

polyfuse-sm-d_20.l

Littelfuse Polyfuse de

Project '/home/user/test/test.pro'

Component library files

power
device
transistors
conn
linear
regul
74xx
cmos4000
adc-dac
memory
xilinx

User defined search path

Current search path list

/home/user/test
/snap/kicad-snap/2/usr/s
/snap/kicad-snap/2/usr/s
/usr/local/share

PCB Library Tables

Library Tables by Scope

Table: /home/user/snap/kicad-snap/common/.config/kicad/fp-lib-table

Symbol Name	Library Path
Connectors_JST.pretty	\$(KISYSMOD)/connectors_JST.pretty
Connectors_Molex.pretty	\$(KISYSMOD)/Connectors_Molex.pretty
Connectors_Multicomp.pretty	\$(KISYSMOD)/Connectors_Multicomp.pretty

Global Project Specific Libraries

Append Wizard Append Library Remove Library Move Up Move Down

Path Segments

Order	Environment Variable	Path Segment
1	KIPROJMOD	/home/user/test
2	KISYS3DMOD	\$\$SNAP/usr/share/kicad/modules/packages3d/
3	KISYSMOD	\$\$SNAP/usr/share/kicad/modules/

Cancel

OK

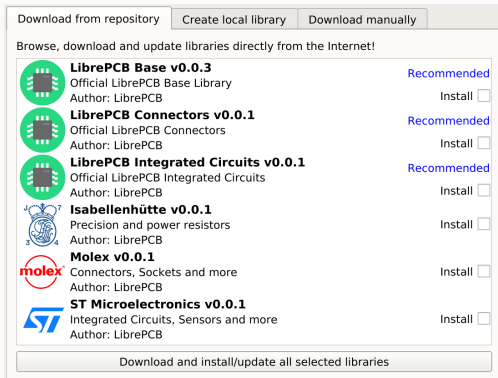
Check for cache/library conflicts when loading schematic

Cancel

OK

Solution

- Integrated library manager with dependency management
- Libraries can contain any entity type (symbols, footprint, ...)
- The application handles basically **everything** for you



Problem

- Everything is referenced by name
- References across libraries not possible in some tools

Library References

Problem

- Everything is referenced by name
- References across libraries not possible in some tools

Result

- Broken references after changing names
- Name conflicts because they are not unique
- Many duplicates accross different libraries

Library References

Problem

- Everything is referenced by name
- References across libraries not possible in some tools

Result

- Broken references after changing names
- Name conflicts because they are not unique
- Many duplicates accross different libraries

Solution

- Every entity is identified by a random UUID
- References always by UUID, never by name
- Entities can be referenced across different libraries


Library References

```
(librepcb_symbol
 (uuid f0061936-5169-49c9-bfa5-4efc8108cd1c )
 (name "Connector 1x4")
 ...
 (pin 169d6728-7108-4600-aa48-765711db01bc (name "1")
 (pos -20.32 40.64) (rot 0.0) (length 5.08)
 )
 (pin 1c49822e-fd83-452a-a7a6-f4ae1357a0c7 (name "2")
 (pos 20.32 -40.64) (rot 180.0) (length 5.08)
 )
 (pin 208bd2b9-ed07-4df5-b5ab-a89fb03378d5 (name "3")
 (pos 20.32 -38.1) (rot 180.0) (length 5.08)
 )
 (pin 2684075c-566e-43fb-b025-17cf43badaf4 (name "4")
 (pos 20.32 -12.7) (rot 180.0) (length 5.08)
 )
 )
 )
```


Symbol Variants


Problem

- Impossible to have different symbols for the same component

e.g. Resistor: 

Symbol Variants

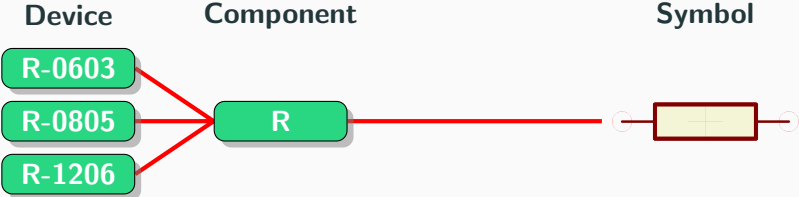
Problem

- Impossible to have different symbols for the same component
e.g. Resistor: 

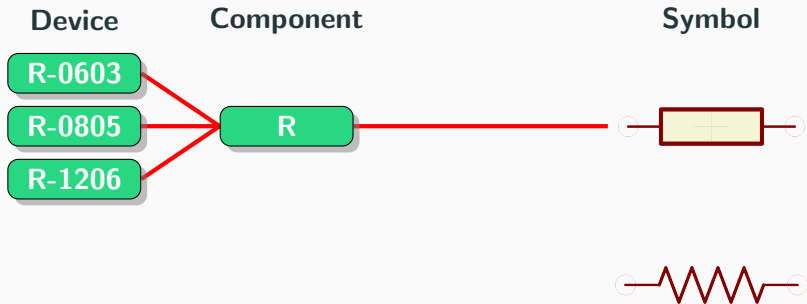
Result

- Duplicate components (same functionality, different symbol)

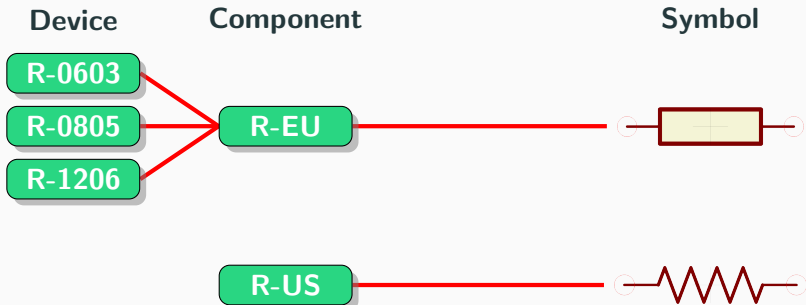
Symbol Variants



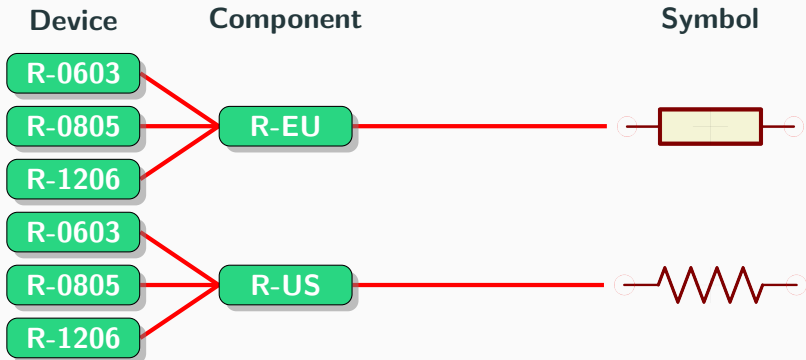
Symbol Variants



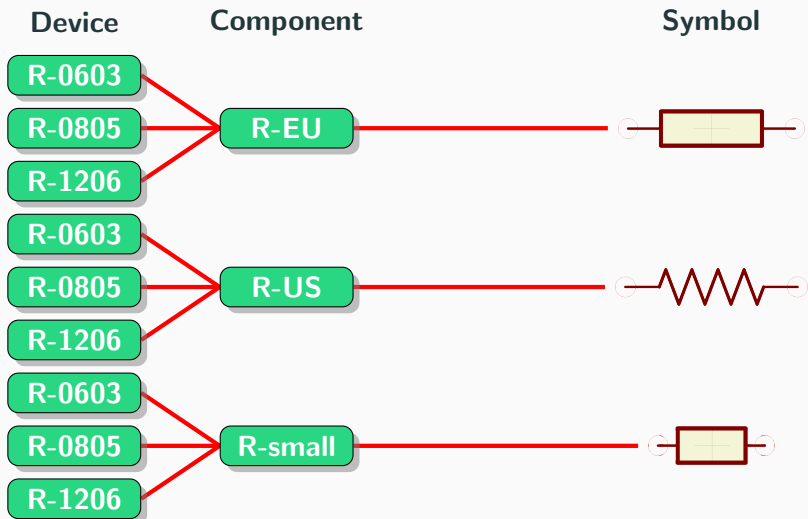
Symbol Variants



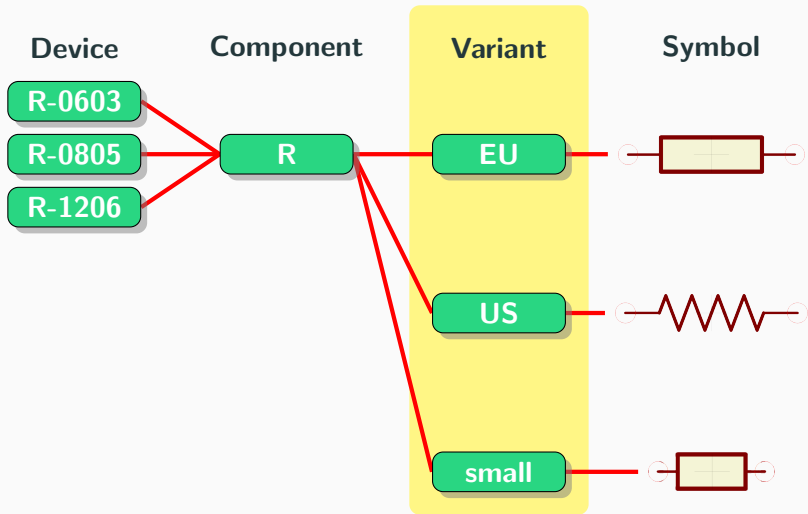
Symbol Variants



Symbol Variants



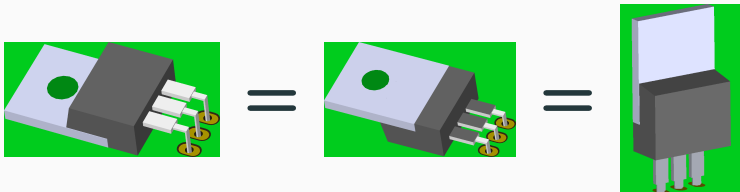
Symbol Variants



Footprint Variants

Problem

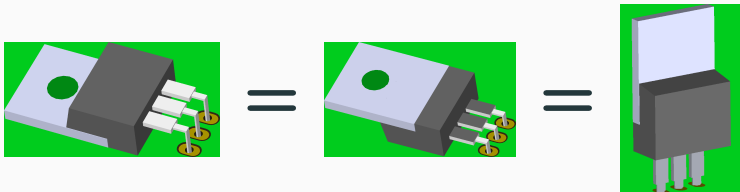
- Libraries do not provide an abstraction layer for **packages**



Footprint Variants

Problem

- Libraries do not provide an abstraction layer for **packages**



Result

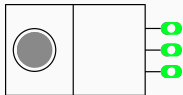
- Devices need to know every footprint variant of their package

Footprint Variants

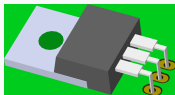
Device



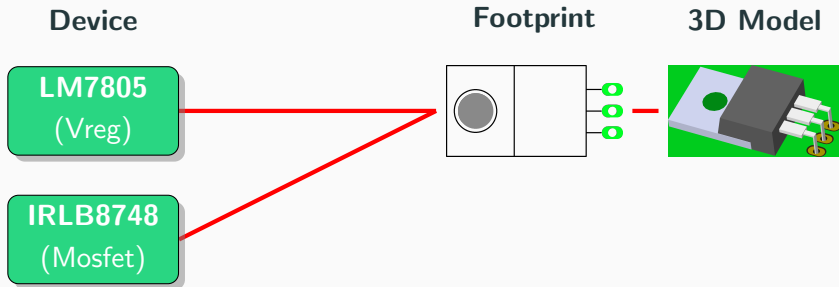
Footprint



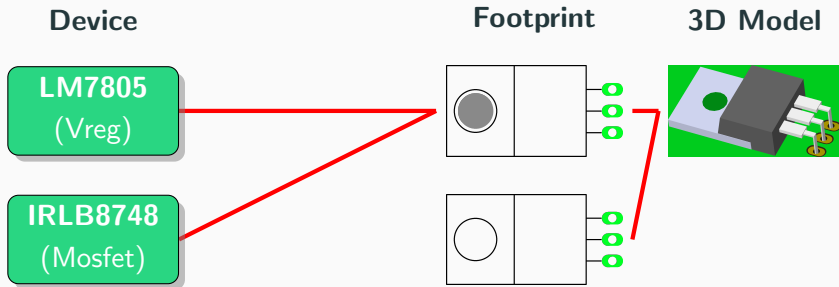
3D Model



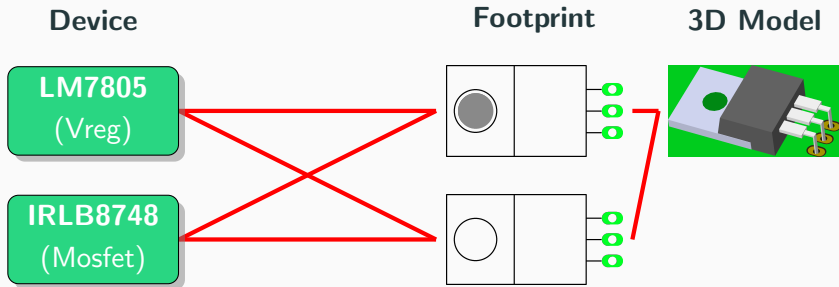
Footprint Variants



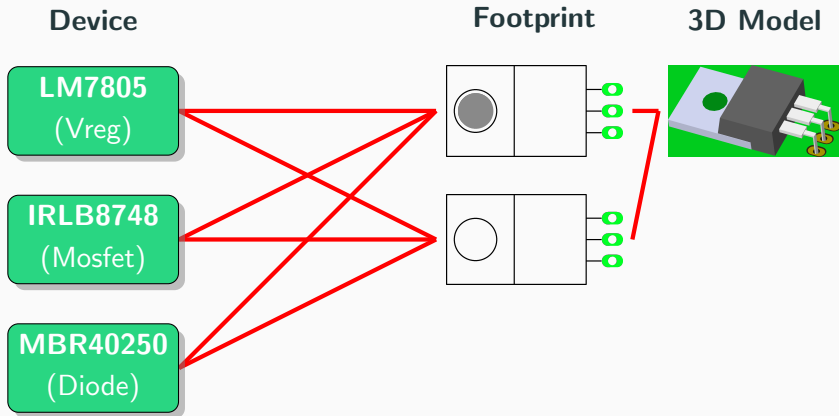
Footprint Variants



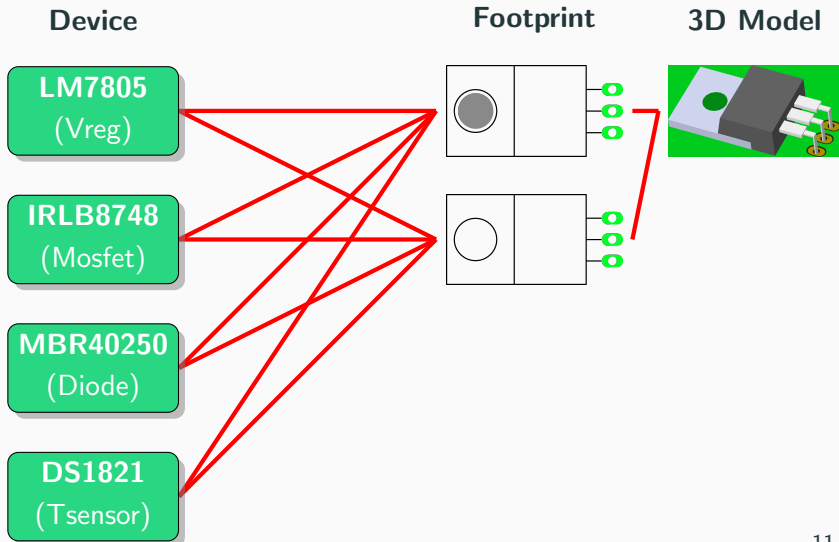
Footprint Variants



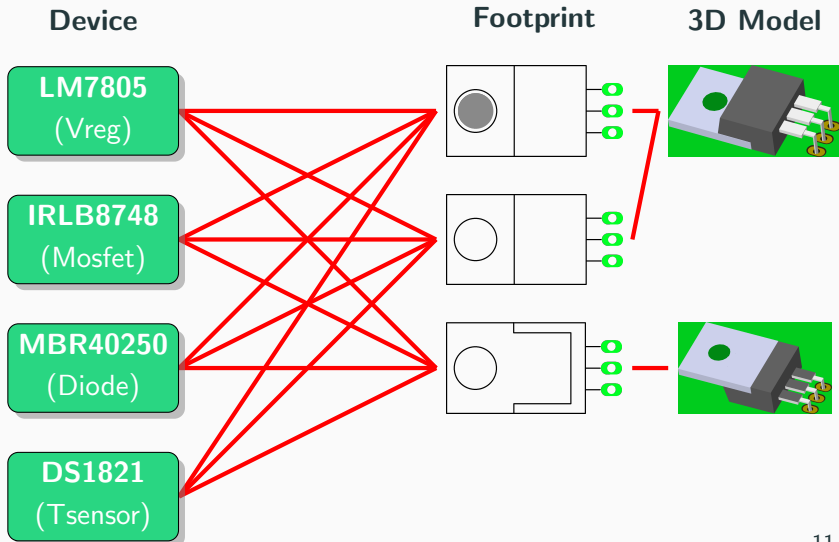
Footprint Variants



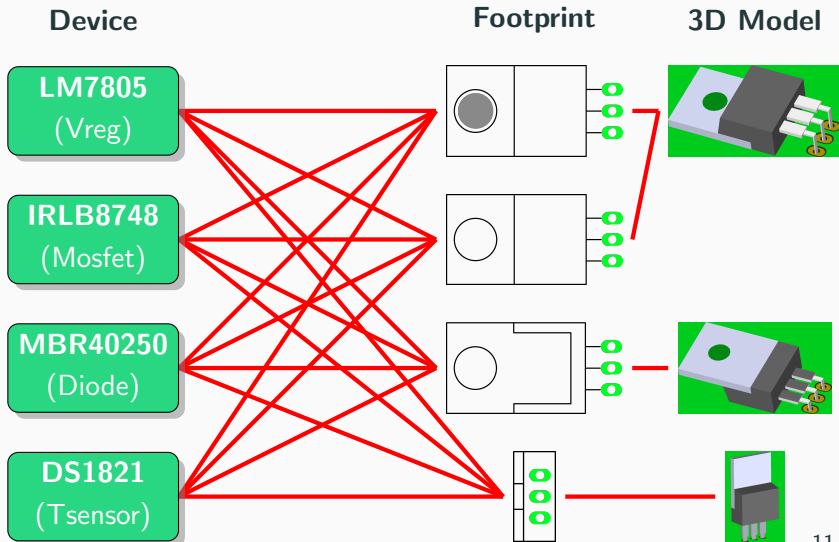
Footprint Variants



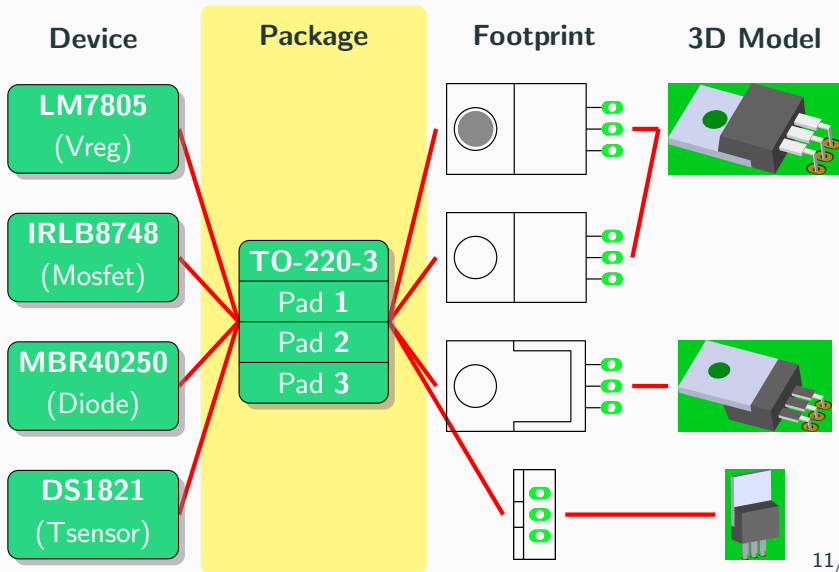
Footprint Variants



Footprint Variants



Footprint Variants



Problem

- Entities are organized by their containing library
- No way to assign categories and/or keywords to library entities

Problem

- Entities are organized by their containing library
- No way to assign categories and/or keywords to library entities

Result

- Users need to carry about (absolutely irrelevant) library names
- Entities are very hard to find in the library browser

Library Browser

Name	Beschreibung
special	Special Devices
special-drill	Special drills
st-microelectronics	ST Microelectronics Devices
stm	ARM 32-bit Cortex™ MCUs
stm32_lqfp144	STM32F101Zx and STM32F103Zx. L...
stm32f	?
stm_v2	ARM 32-bit Cortex™ MCUs
stm_v3	ARM 32-bit Cortex™ MCUs
supertex	Supertex Inc.
supply1	Supply Symbols
supply2	Supply Symbols
switch	Switches
switch-als	AI PS Switch from Markus Faust & mfa

Pads SmDs Beschreibung Vorschau

Suchen:

Attribute:

OK Aus Liste entfernen Abbrechen

Choose Component (2534 items loaded)

Filter:

- opto
- philips
- power
- regul
- siliconi
- texas
 - IS07320C [Low Power Dual-Channel 2/0 Digital Isolator, 25Mb
 - IS07320FC [Low Power Dual-Channel 2/0 Digital Isolator, 25Mb
 - IS07321C [Low Power Dual-Channel 1/1 Digital Isolator, 25Mb
 - IS07321FC [Low Power Dual-Channel 1/1 Digital Isolator, 25Mb
 - IS07340C [Low Power Quad-Channel 4/0 Digital Isolator, 25Mb
 - IS07340FC [Low Power Quad-Channel 4/0 Digital Isolator, 25Mb
 - IS07341C [Low Power Quad-Channel 3/1 Digital Isolator, 25Mb
 - IS07341FC [Low Power Quad-Channel 3/1 Digital Isolator, 25Mb
 - IS07342C [Low Power Quad-Channel 2/2 Digital Isolator, 25Mb
 - IS07342FC [Low Power Quad-Channel 2/2 Digital Isolator, 25Mb
 - LM356911-EQCS0 [TI Stellaris ARM-M3 MCU Ethernet PHY, LQFP100]
 - LM356911-IQC50 [TI Stellaris ARM-M3 MCU Ethernet PHY, Industrial
 - LM4F110B2QR [Replaced by TM4C1231C3PM, LQFP64]
 - LM4F110C40R [Replaced by TM4C1231D5PM, LQFP64]

LM356911-EQCS0

Description
TI Stellaris ARM-M3 MCU Ethernet PHY, LQFP100

Keywords
MCU ARM M3 Stellaris PHY ETH NRND

Cancel OK

Solution

- Libraries can contain **categories**
- Entities can be assigned to these categories
- Entities can have keywords

Name:	<input type="text" value="STM32F103C"/>
Description:	<input type="text"/>
Keywords:	<input type="text" value="arm,cortex,m3,microcontroller"/>
Author:	<input type="text" value="LibrePCB"/>
Version:	<input type="text" value="0.1"/>
Deprecated:	<input type="checkbox"/> Component should no longer be used.
Categories:	<input type="text" value="Root category
↳ Microcontrollers
↳ STM32"/>
	<input type="button" value="Add category"/> <input type="button" value="Remove selected"/>

Library Browser

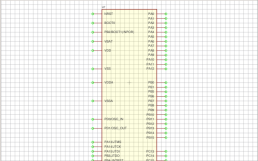
Add Component

What are you looking for?

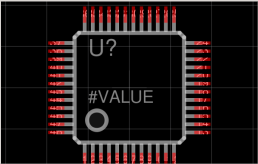
- Capacitors
- Connectors
 - Board-to-Board
 - D-Sub
 - IC Sockets
 - Solder Pad
 - Terminal Blocks
 - Wire-to-Board
- Crystals / Oscillators / Resonators
- Diodes
- Filters
- Inductors / Coils
- Integrated Circuits
 - MOSFET Drivers
 - Transceivers
 - Voltage Regulators
- LEDs
- Microcontrollers
 - Microchip
 - STM32**
- Resistors
- Schematic Frames
- Supply Symbols
- Transistors / FETs / Diacs / Triacs (Without Category)

▼ STM32F103C [1] STM32F103C

STM32F103C_LQFP48 LQFP48



STM32F103C_LQFP48 [LQFP48]



Cancel OK

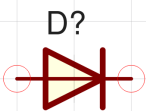
Library Browser

What are you looking for?

- Capacitors
- Connectors
 - Board-to-Board
 - D-Sub
 - IC Sockets
 - Solder Pad
 - Terminal Blocks
 - Wire-to-Board
- Crystals / Oscillators / Resonators
- Diodes**
- Filters
- Inductors / Coils
- Integrated Circuits
 - MOSFET Drivers
 - Transceivers
 - Voltage Regulators
- LEDs
- Microcontrollers
 - Microchip
 - STM32
- Resistors
- Schematic Frames
- Supply Symbols
- Transistors / FETs / Diacs / Triacs (Without Category)

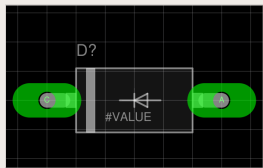
2x Schottky Diode in Series [1]
2x Schottky Diodes CA [1]
2x Schottky Diodes CC [1]
2x Standard Diodes CC [1]
2x Standard Diodes in Series [1]
Bidirectional Schottky Diode [1]
15KEXXC CB429-17 [1]
Capacity Diode [2]
Schottky Diode [14]
Standard Diode [1]
1N5400 DO201-15
Suppressor Diode [2]
Zener Diode [1]
1N4728 DO41Z10

Standard Diode



D?
#VALUE

1N5400 [DO201-15]



Cancel OK

Library Browser

The screenshot shows a software interface titled "Add Component". On the left, a search bar contains the text "cortex". Below it is a tree view of component categories:

- Capacitors
- Connectors
 - Board-to-Board
 - D-Sub
 - IC Sockets
 - Solder Pad
 - Terminal Blocks
 - Wire-to-Board
- Crystals / Oscillators / Resonators
- Diodes
- Filters
- Inductors / Coils
- Integrated Circuits
 - MOSFET Drivers
 - Transceivers
 - Voltage Regulators
- LEDs
- Microcontrollers
 - Microchip
 - STM32
- Resistors
- Schematic Frames
- Supply Symbols
- Transistors / FETs / Diacs / Triacs (Without Category)

In the center, a search results list shows "STM32F103C" selected, with a sub-entry "STM32F103C_LQFP48" highlighted in blue. To the right of this list, the text "[1] LQFP48" is visible.

On the right side of the window, a detailed view of the selected component is shown. It features a grid of pins and is titled "STM32F103C". Below this, the specific component name "STM32F103C_LQFP48 [LQFP48]" is displayed. At the bottom of this view is a schematic symbol for a microcontroller, showing a square package with pins on all sides, labeled with "U?" and "#VALUE".

At the bottom right of the window are "Cancel" and "OK" buttons.

Footprint Assignment

Problem

- Schematics contain "exact parts" (footprint known)

Footprint Assignment

Problem

- Schematics contain "exact parts" (footprint known)

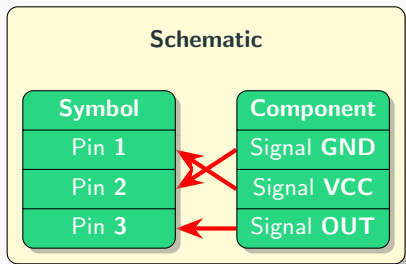
Result

- Wasting time for choosing (irrelevant) footprints in schematics
- Changing footprints afterwards requires to adjust schematics

Footprint Assignment

Solution

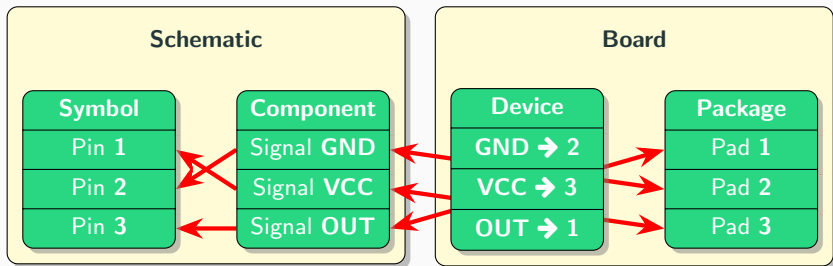
- Schematics contain "components" (footprint unknown)



Footprint Assignment

Solution

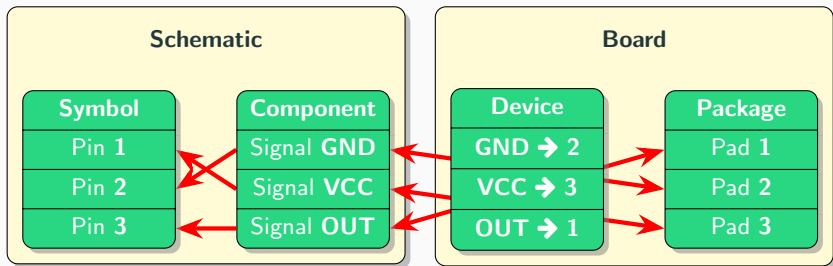
- Schematics contain "components" (footprint unknown)
- Boards contain "devices" (assign package to component)



Footprint Assignment

Solution

- Schematics contain "components" (footprint unknown)
- Boards contain "devices" (assign package to component)

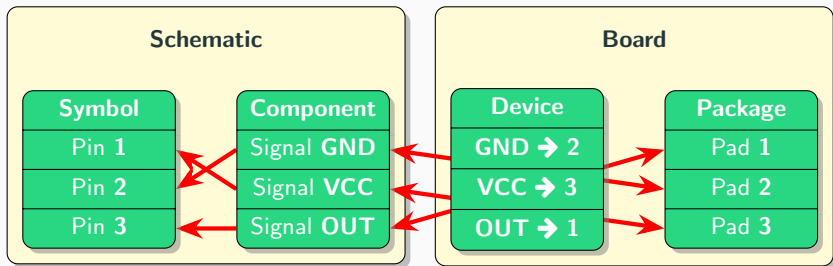


➔ Schematics can be drawn without worrying about footprints

Footprint Assignment

Solution

- Schematics contain "components" (footprint unknown)
- Boards contain "devices" (assign package to component)

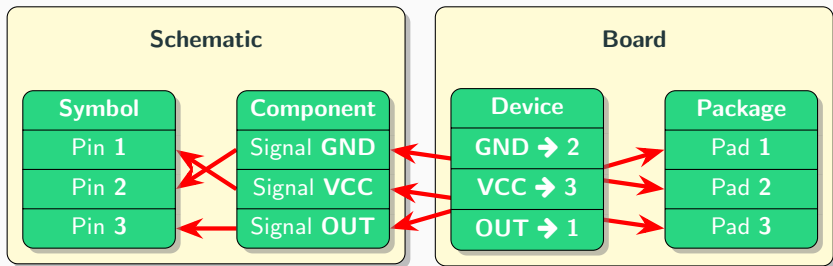


- ➔ Schematics can be drawn without worrying about footprints
- ➔ Footprints can easily be changed in boards

Footprint Assignment

Solution

- Schematics contain "components" (footprint unknown)
- Boards contain "devices" (assign package to component)



- ➔ Schematics can be drawn without worrying about footprints
- ➔ Footprints can easily be changed in boards
- ➔ Pin-to-pad mapping stored in library

Version Control Systems

Problem

- Important and unimportant data mixed
- Unclear which files to version control

Version Control Systems

Problem

- Important and unimportant data mixed
- Unclear which files to version control

Result

- Local changes even if nothing modified
- Very large and opaque diffs/commits
- Merging is basically impossible

Version Control Systems

Problem

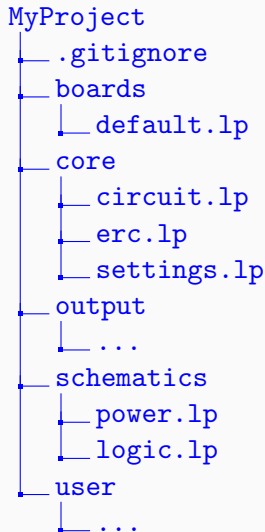
- Important and unimportant data mixed
- Unclear which files to version control

Result

- Local changes even if nothing modified
- Very large and opaque diffs/commits
- Merging is basically impossible

Solution

- Many small files for higher granularity
- Unimportant data strictly separated
- Automatic creation of `.gitignore`



Version Control Systems

```
--- a/test.kicad_pcb
+++ b/test.kicad_pcb
@@ -3,7 +3,7 @@
    (general
      (no_connects 0)
-     (area 41.834999 87.554999 233.755001 153.745001)
+     (area 20.171999 28.969758 233.755001 157.374234)
      (drawings 4)
@@ -21,7 +21,7 @@
      (36 B.SilkS user)
-     (37 F.SilkS user)
+     (37 F.SilkS user hide)
      (38 B.Mask user hide)
@@ -62,7 +62,7 @@
      (aux_axis_origin 0 0)
-     (visible_elements FFFC4601)
+     (visible_elements FFFC4609)
      (pcbplotparams
```

Problem

- Files are **not really** human readable

Version Control Systems

Problem

- Files are **not really** human readable

Result

- Diffs are very hard to understand
- Limited use of version control systems

Version Control Systems

Problem

- Files are **not really** human readable








Result

- Diffs are very hard to understand
- Limited use of version control systems

Solution

- Don't just consider text-based file formats as human readable!
- Control every tiny detail of the generated files
- Consider opaque parts of files as bugs and fix them

Project Status

Library Management		
Library Editor		
Schematic Editor		(except missing copy&paste)
Board Editor		(no DRC, some inconveniences)
Export (e.g. Gerber)		
Available Libraries		
File Format		Stable

Contributors welcome!

<https://github.com/LibrePCB/LibrePCB/blob/master/CONTRIBUTING.md>

IRC: #librepcb on Freenode

- Participate in issues
 - Open pull requests
 - Improve documentation
- Donate (Patreon or Bitcoin)

Getting Started

https://download.librepcb.org/nightly_builds/master/

Linux

librepcb-nightly-linux-x86_64.AppImage

macOS

librepcb-nightly-mac-x86_64.dmg

Windows

librepcb-installer-nightly-windows-x86.exe

Install the following libs:

- LibrePCB Base
- LibrePCB Connectors

Goals

To do:

- Create a PCB for the LED challenge in the tent outside
- Create missing library elements:
- Create a PCB
- If you want, manufacture it with the PCB mill

Library Elements

We need the following library elements:

- Connector for 12V wires, 1.6mm diameter holes (→ We need a new Package and Device)
- SMD 1206 resistor (→ From the standard lib)
- THT LED 5mm (→ We need a new Package and Device)
<https://katalog.we-online.de/led/datasheet/151053BS04500.pdf>
- Optional: Toggle button (no datasheet, ask Tony)

Thank you!

<http://librepcb.org>