PCB Calculator

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Contents

Reference manual

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- About KiCad document: https://github.com/KiCad/kicad-doc/issues

- About KiCad software: https://bugs.launchpad.net/kicad

- About KiCad software i18n: https://github.com/KiCad/kicad-i18n/issues

Publication date and software version
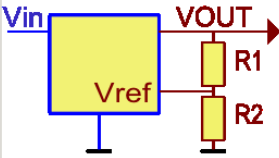
july 17, 2019

1 Introduction

The KiCad PCB Calculator is a set of utilities to help you find the values of components or other paremeters of a layout. The Calculator has the following tools:

- Regulators

- Track Width

- Electrical Spacing

- Trans Line

- RF Attenuators

- Color Code

- Board Classes

2 Calculators

2.1 Regulators

This calculator helps with the task of finding the values of the resistors needed for linear and low-dropout voltage regulators.

For the *Standard Type*, the output voltage Vout as a function of the reference voltage Vref and resistors R1 and R2 is given by:

$$Vout = Vref \cdot \left(\frac{R1 + R2}{R1} \right)$$

For the *3 terminal type*, there is a correction factor due to the quiescent current Iadj flowing from the adjust pin:

$$Vout = Vref \cdot \left(\frac{R1 + R2}{R1} \right) + Iadj \cdot R2$$

This current is typically below 100 uA and can be neglected with caution.

To use this calculator, enter the parameters of the regulator *Type*, *Vref* and, if needed, *Iadj*, select the field you want to calculate (one of the resistors or the output voltage) and enter the other two values.

2.2 Track-Width

The Track Width tool calculates the trace width for printed circuit board conductors for a given current and temperature rise. It uses formulas from IPC-2221 (formerly IPC-D-275).

2.3 Electrical-Spacing

This table helps finding the minimum clearance between conductors.

Each line of the table has a minimum recomended distance between conductors for a given voltage (DC or AC peaks) range. If you need the values for voltages higher than 500V, enter the value in the box in the left corner and press *Update Values*.
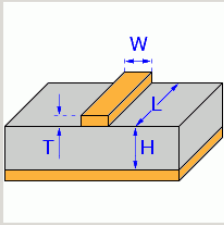

2.4 TransLine

Transmission line theory is a cornerstone in the teaching of RF and microwave engineering.

In the calculator you can choose different sorts of Line Types and their special parameters. The models implemented are frequency-dependent, so they disagree with simpler models at high *enough* frequencies.

This calculator is heavily based on Transcalc.

The transmission line types and the reference of their mathematical models are listed below:

- Microstrip line:

  - H. A. Atwater, "Simplified Design Equations for Microstrip Line Parameters", Microwave Journal, pp. 109-115, November 1989.

- Coplanar wave guide.

- Coplanar wave guide with ground plane.

- Rectangular waveguide:

  - S. Ramo, J. R. Whinnery and T. van Duzer, "Fields and Waves in Communication Electronics", Wiley-India, 2008, ISBN: 9788126515257.

- Coaxial line.

- Coupled microstrip line:

  - H. A. Atwater, "Simplified Design Equations for Microstrip Line Parameters", Microwave Journal, pp. 109-115, November 1989.

  - M. Kirschning and R. H. Jansen, "Accurate Wide-Range Design Equations for the Frequency-Dependent Characteristic of Parallel Coupled Microstrip Lines," in IEEE Transactions on Microwave Theory and Techniques, vol. 32, no. 1, pp. 83-90, Jan. 1984. doi: 10.1109/TMTT.1984.1132616.

  - Rolf Jansen, "High-Speed Computation of Single and Coupled Microstrip Parameters Including Dispersion, High-Order Modes, Loss and Finite Strip Thickness", IEEE Trans. MTT, vol. 26, no. 2, pp. 75-82, Feb. 1978.

  - S. March, "Microstrip Packaging: Watch the Last Step", Microwaves, vol. 20, no. 13, pp. 83.94, Dec. 1981.

- Stripline.

- Twisted pair.

2.5   RF-Attenuators

With the RF Attenuator utility you can calculate the values of the resistors needed for different types of attenuators:

- PI

- Tee

- Bridged Tee

- Resistive Splitter

To use this tool, first select the type of attenuator you need, then enter the desired attenuation (in dB) and input/output impedances (in Ohms).

2.6   Color-Code

This calculator helps translating the color bars from the resistor to its value. To use it, first select the *tolerance* of the resistor: 10%, 5% or equal or smaller than 2%. For example:

- Yellow Violet Red Gold: 4 7 x100 ±5% = 4700 Ohm, 5% tolerance

- 1kOhm, 1% tolerance: Brown Black Black Brown Brown

	1st Band	2nd Band	3rd Band	4th Band	Multiplier	Tolerance
	Black 0	0	0	0	x 1	
	Brown 1	1	1	1	x 10	± 1%
	Red 2	2	2	2	x 100	± 2%
	Orange 3	3	3	3	x 1k	
	Yellow 4	4	4	4	x 10k	
	Green 5	5	5	5	x 100k	± 0.5%
	Blue 6	6	6	6	x 1M	± 0.25%
	Violet 7	7	7	7	x 10M	± 0.10%
	Grey 8	8	8	8	x 100M	± 0.05%
	White 9	9	9	9	x 1G	
	Gold				x 0.1	± 5%
	Silver				x 0.01	± 10%

Tolerance
○ 10% / 5%
◉ <= 2%

2.7   Board-Classes

Note: Values are minimal values

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	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6
Lines width	0.8	0.5	0.31	0.21	0.15	0.12
Min clearance	0.68	0.5	0.31	0.21	0.15	0.12
Via: (diam - drill)	--	--	0.45	0.34	0.24	0.2
Plated Pad: (diam - drill)	1.19	0.78	0.6	0.49	0.39	0.35
NP Pad: (diam - drill)	1.57	1.13	0.9	--	--	--