# PCB Calculator

**November 17, 2019**

# Contents

*Reference manual*



**Contributors**

Heitor de Bittencourt. Mathias Neumann

**Feedback**

Please direct any bug reports, suggestions or new versions to here:

- 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

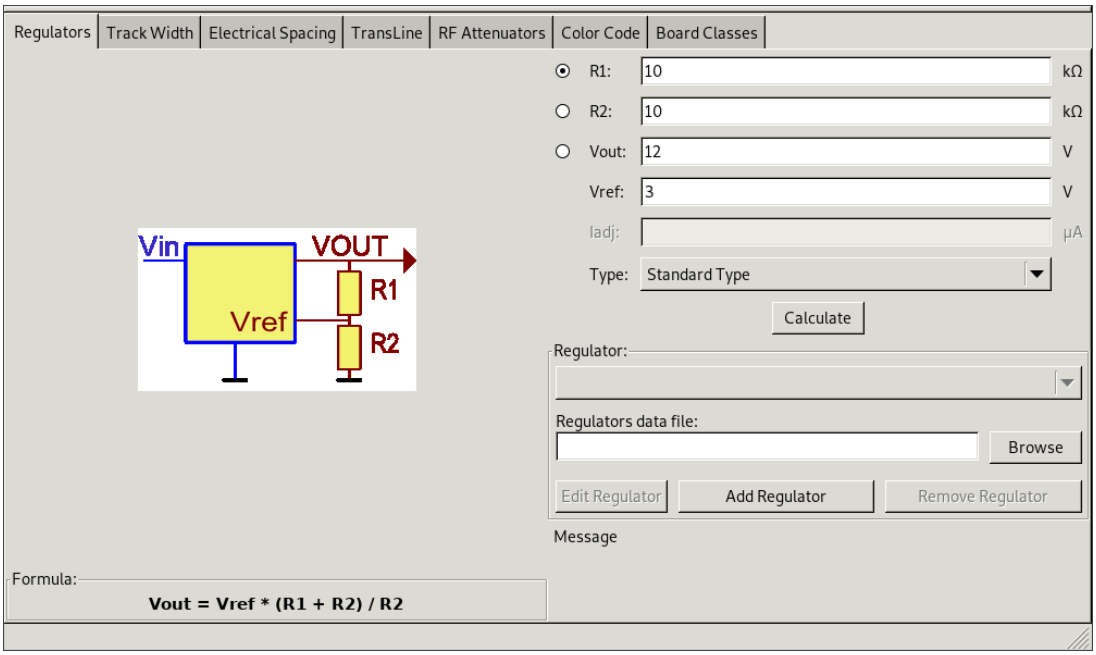
The KiCad PCB Calculator is a set of utilities to help you find the values of components or other paremeters of a layout. The Calculator has the following tools:

- 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:

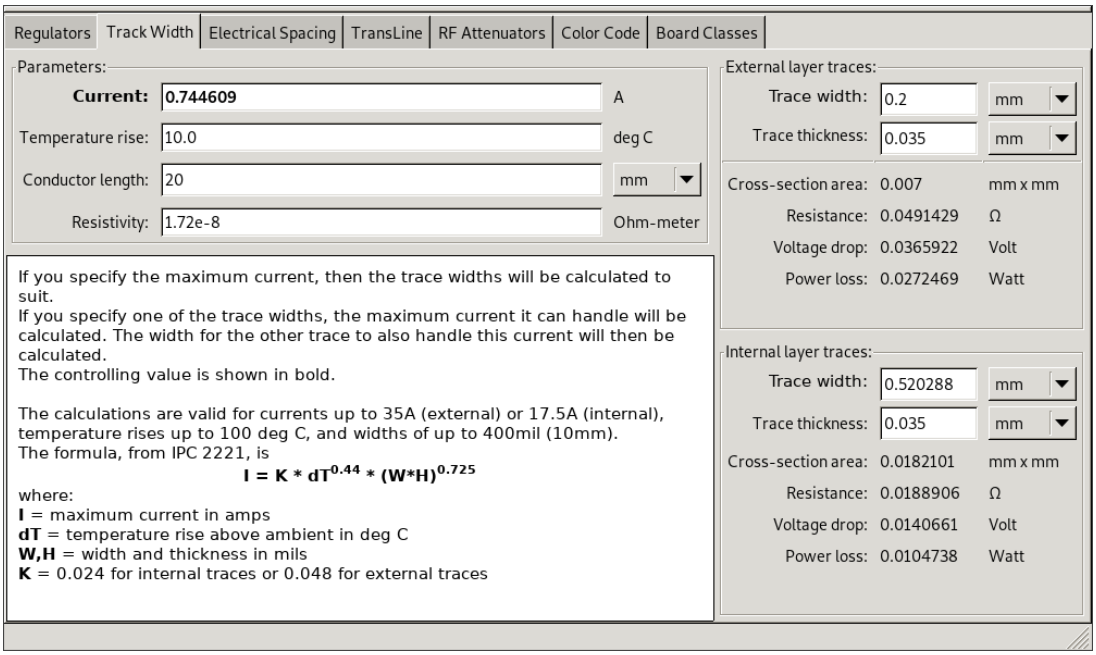
$$Vout = Vref \cdot \left( \frac{R1 + R2}{R1} \right) + Iadj \cdot R2$$

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

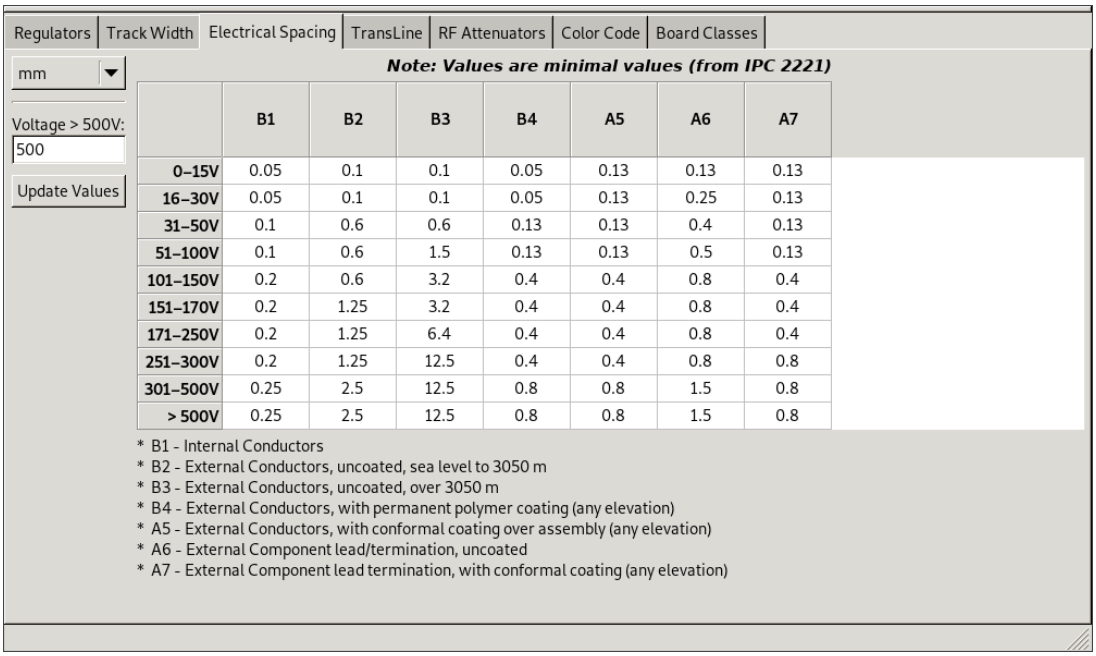
The Track Width tool calculates the trace width for printed circuit board conductors for a given current and temperature rise. It uses formulas from IPC-2221 (formerly IPC-D-275).




## 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

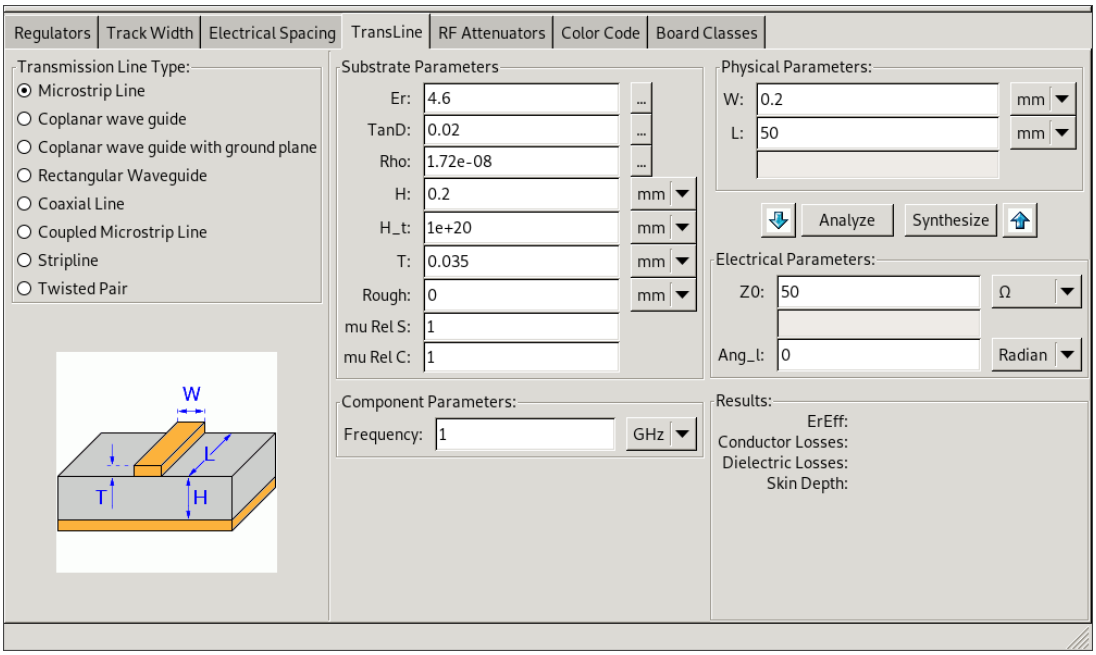
Transmission line theory is a cornerstone in the teaching of RF and microwave engineering.

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 heavilly 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.

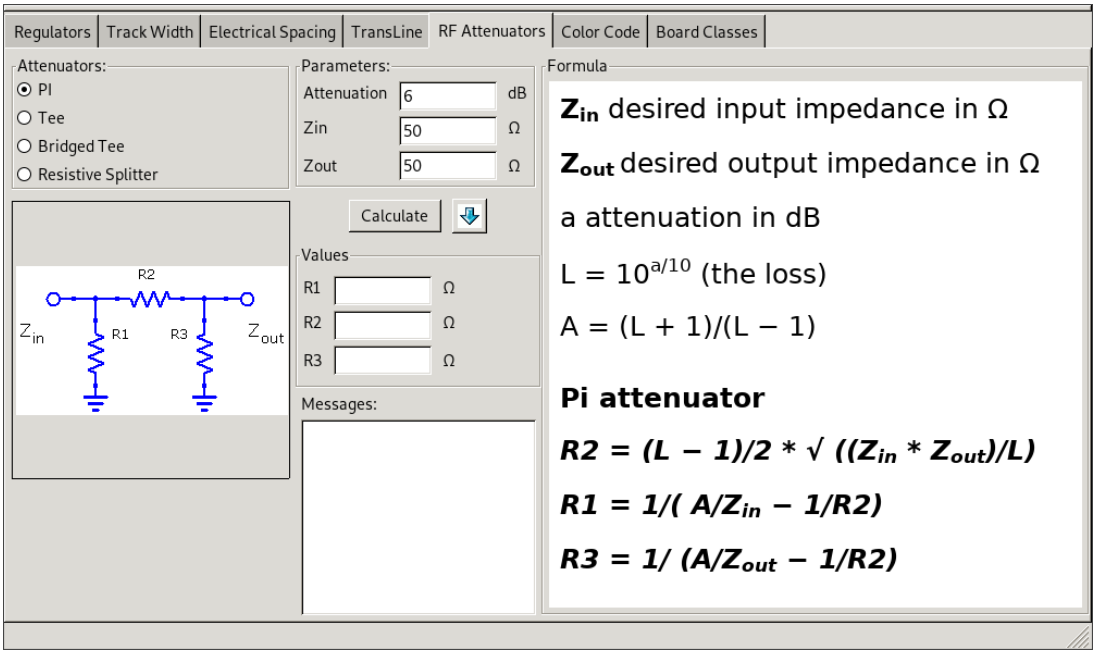



## 2.5 RF-Attenuators

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

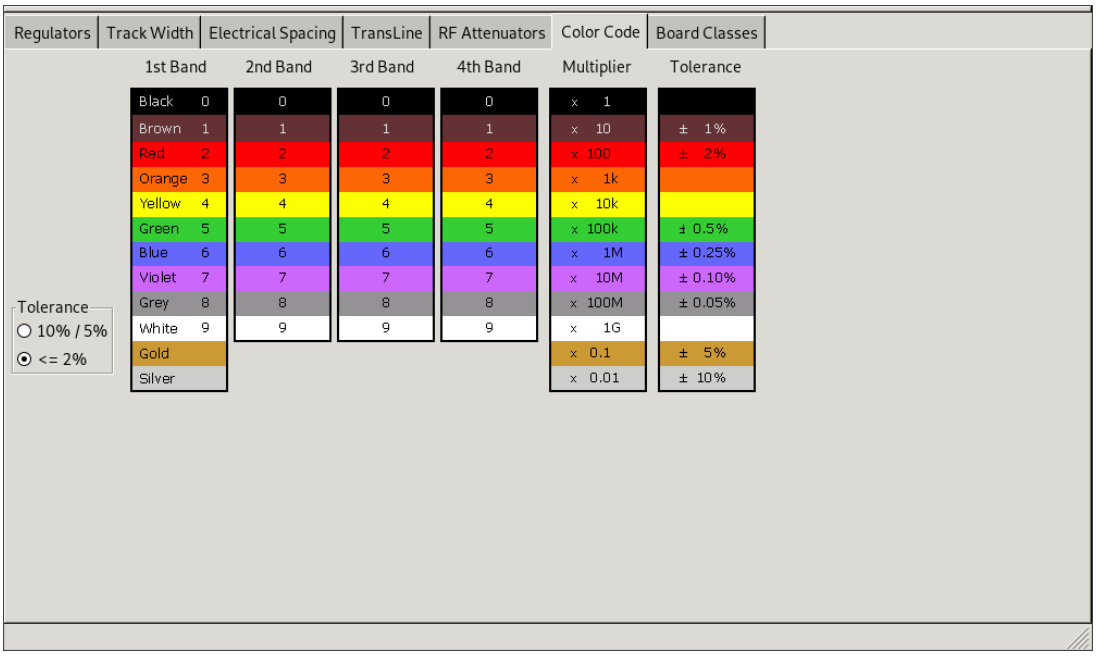
To use this tool, first select the type of attenuator you need, then enter the desired attenuation (in dB) and input/output impedances (in Ohms).



## 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




## 2.7 Board-Classes