PCB Calculator

May 15, 2020

Contents

Reference manual

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Publication date and software version

March 05 2020

1 Introduction

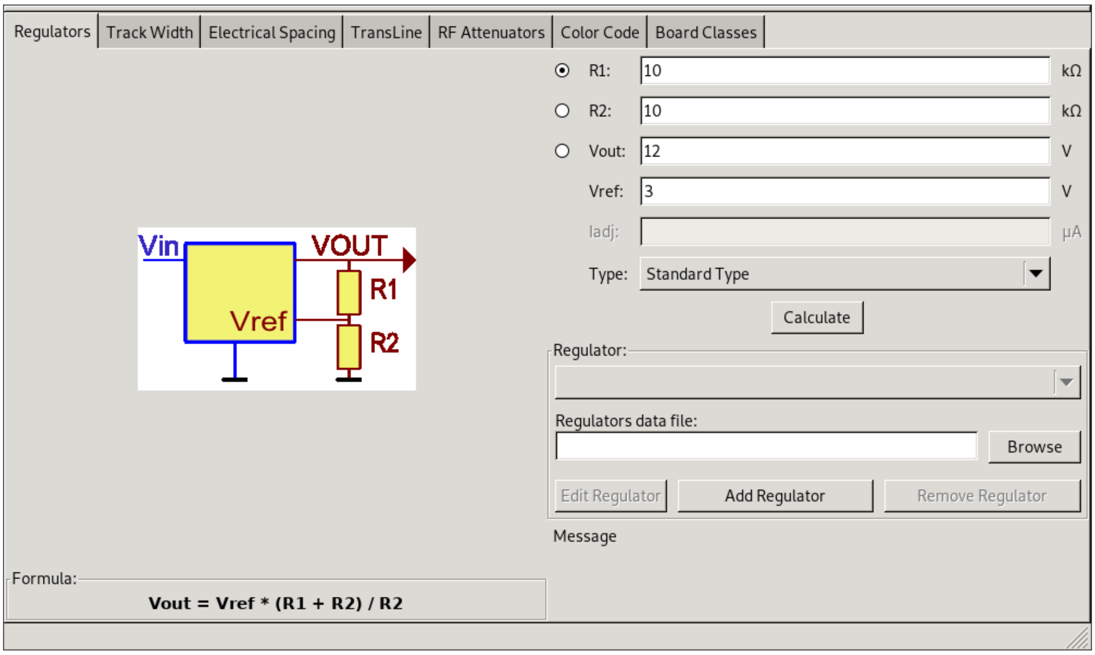
The KiCad PCB Calculator is a set of utilities to help you find the values of components or other parameters of a layout. The Calculator has the following tools:

- 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:

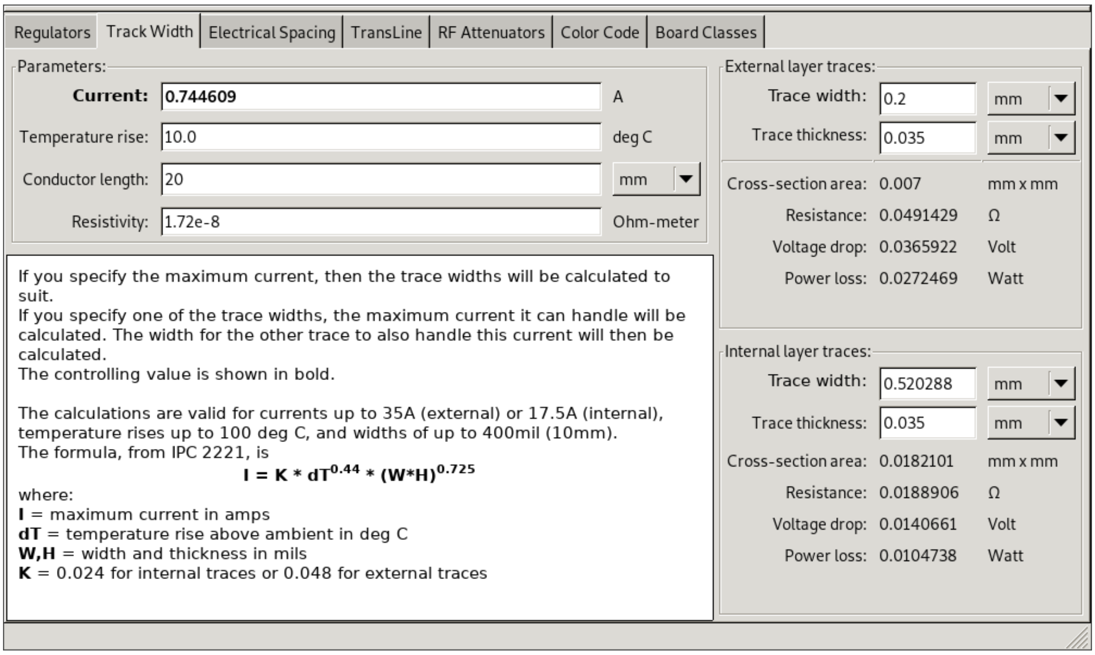
$$Vout = Vref \cdot \left(\frac{R1 + R2}{R1}\right) + Iadj \cdot R2$$

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

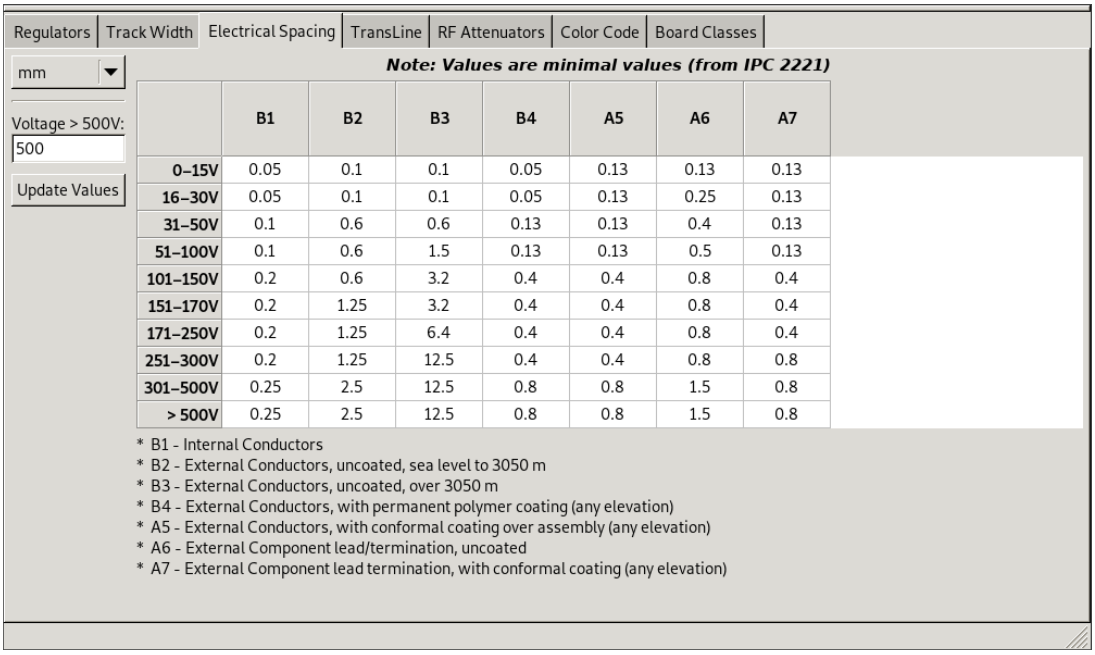
The Track Width tool calculates the trace width for printed circuit board conductors for a given current and temperature rise. It uses formulas from IPC-2221 (formerly IPC-D-275).



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*.



	B1	B2	B3	B4	A5	A6	A7
0–15V	0.05	0.1	0.1	0.05	0.13	0.13	0.13
16–30V	0.05	0.1	0.1	0.05	0.13	0.25	0.13
31–50V	0.1	0.6	0.6	0.13	0.13	0.4	0.13
51–100V	0.1	0.6	1.5	0.13	0.13	0.5	0.13
101–150V	0.2	0.6	3.2	0.4	0.4	0.8	0.4
151–170V	0.2	1.25	3.2	0.4	0.4	0.8	0.4
171–250V	0.2	1.25	6.4	0.4	0.4	0.8	0.4
251–300V	0.2	1.25	12.5	0.4	0.4	0.8	0.8
301–500V	0.25	2.5	12.5	0.8	0.8	1.5	0.8
> 500V	0.25	2.5	12.5	0.8	0.8	1.5	0.8

2.4 TransLine

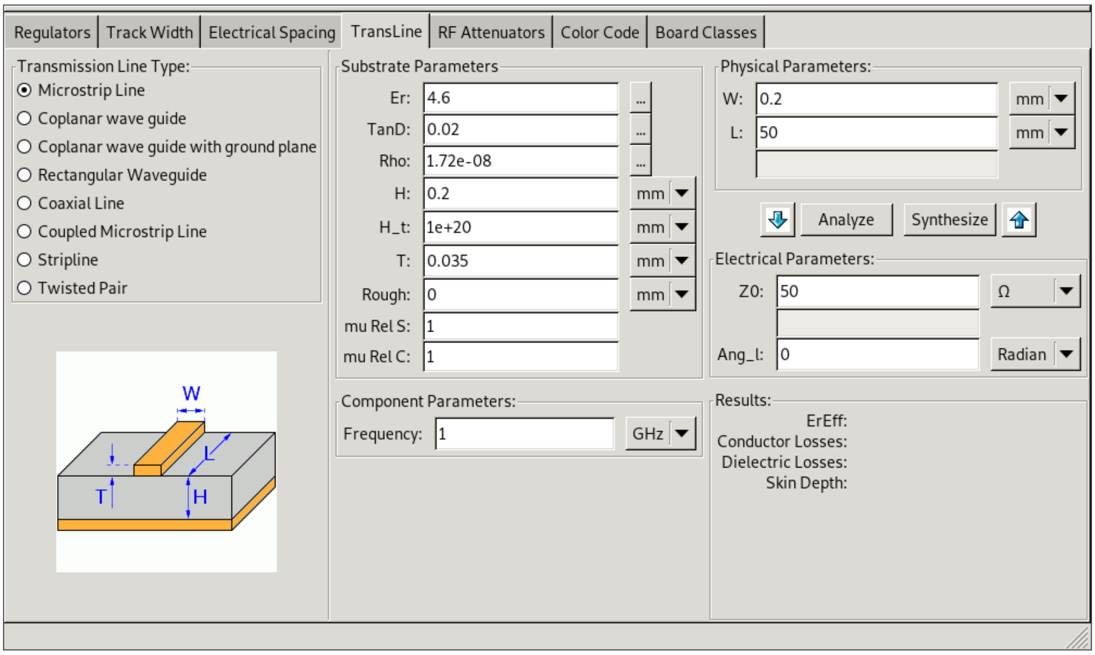
Transmission line theory is a cornerstone in the teaching of RF and microwave engineering.

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.

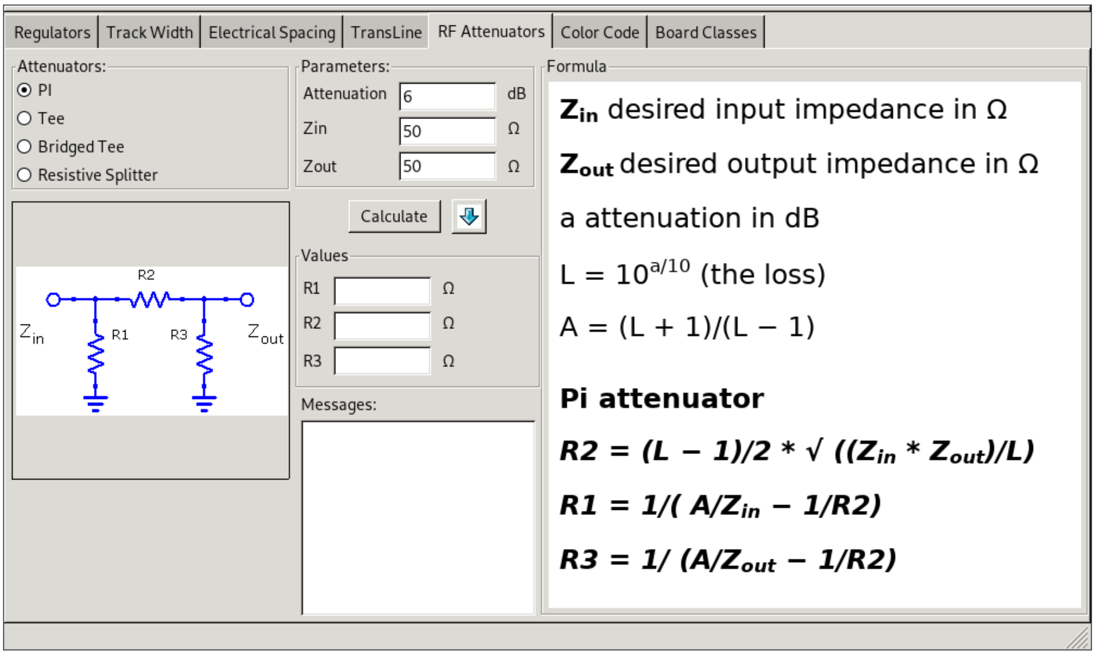


2.5 RF-Attenuators

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

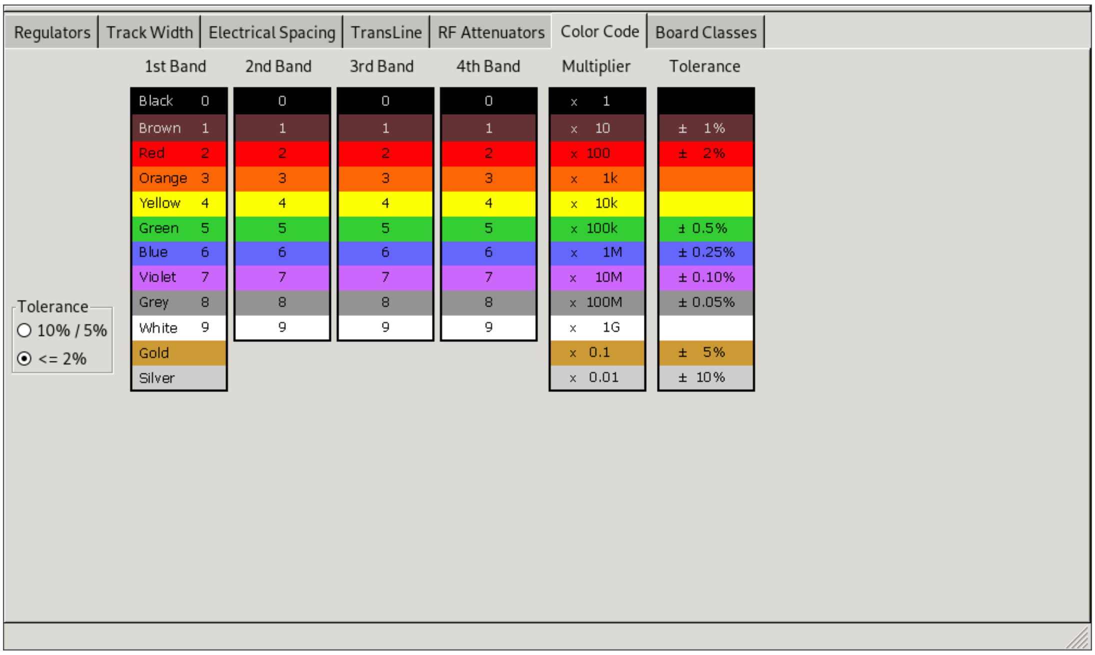
To use this tool, first select the type of attenuator you need, then enter the desired attenuation (in dB) and input/output impedances (in Ohms).



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

2.7.1 Performance Classes

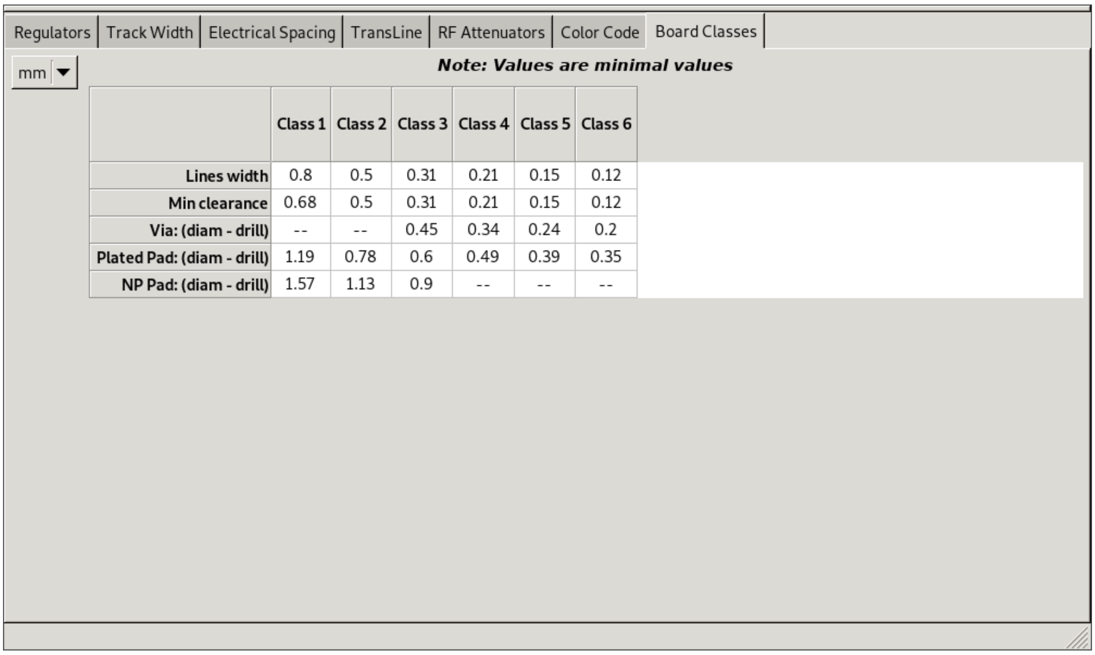
In IPC-6011 have been three performance classes established

- Class 1 General Electronic Products Includes consumer products, some computer and computer peripherals suitable for applications where cosmetic imperfections are not important and the major requirement is function of the completed printed board.
- Class 2 Dedicated Service Electronic Products Includes communications equipment, sophisticated business machines, instruments where high performance and extended life is required and for which uninterrupted service is desired but not critical. Certain cosmetic imperfections are allowed.
- Class 3 High Reliability Electronic Products Includes the equipment and products where continued performance or performance on demand is critical. Equipment downtime cannot be tolerated and must function when required suchas in life support items or flight control systems. Printed boards in this class are suitable for applications where high levels of assurance are required and service is essential.

2.7.2 PCB Types

In IPC-6012B there are also 6 Types of PCB defined:

- Printed Boards without plated through holes (1)
  - 1 Single-Sided Board
- And Boards with plated through holes (2-6)
  - 2 Double-Sided Board
  - 3 Multilayer board without blind or buried vias
  - 4 Multilayer board with blind and/or buried vias
  - 5 Multilayer metal core board without blind orburied vias
  - 6 Multilayer metal core board with blind and/orburied vias



	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	--	--	--