PCB Calculator
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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 $V_{out}$ as a function of the reference voltage $V_{ref}$ and resistors $R_1$ and $R_2$ is given by:

$$V_{out} = V_{ref} \cdot \left( \frac{R_1 + R_2}{R_1} \right)$$

For the *3 terminal type*, there is a correction factor due to the quiescent current $I_{adj}$ flowing from the adjust pin:

$$V_{out} = V_{ref} \cdot \left( \frac{R_1 + R_2}{R_1} \right) + I_{adj} \cdot R_2$$

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

To use this calculator, enter the parameters of the regulator *Type*, $V_{ref}$ and, if needed, $I_{adj}$, 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 recommended 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**.

<table>
<thead>
<tr>
<th>Voltage</th>
<th>B1</th>
<th>B2</th>
<th>B3</th>
<th>B4</th>
<th>A5</th>
<th>A6</th>
<th>A7</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–15V</td>
<td>0.05</td>
<td>0.1</td>
<td>0.1</td>
<td>0.05</td>
<td>0.13</td>
<td>0.13</td>
<td>0.13</td>
</tr>
<tr>
<td>16–30V</td>
<td>0.05</td>
<td>0.1</td>
<td>0.1</td>
<td>0.05</td>
<td>0.13</td>
<td>0.25</td>
<td>0.13</td>
</tr>
<tr>
<td>31–50V</td>
<td>0.1</td>
<td>0.6</td>
<td>0.6</td>
<td>0.13</td>
<td>0.13</td>
<td>0.4</td>
<td>0.13</td>
</tr>
<tr>
<td>51–100V</td>
<td>0.1</td>
<td>0.6</td>
<td>1.5</td>
<td>0.13</td>
<td>0.13</td>
<td>0.5</td>
<td>0.13</td>
</tr>
<tr>
<td>101–150V</td>
<td>0.2</td>
<td>0.6</td>
<td>3.2</td>
<td>0.4</td>
<td>0.4</td>
<td>0.8</td>
<td>0.4</td>
</tr>
<tr>
<td>151–200V</td>
<td>0.2</td>
<td>1.25</td>
<td>3.2</td>
<td>0.4</td>
<td>0.8</td>
<td>0.8</td>
<td>0.4</td>
</tr>
<tr>
<td>201–250V</td>
<td>0.2</td>
<td>1.25</td>
<td>6.4</td>
<td>0.4</td>
<td>0.8</td>
<td>0.8</td>
<td>0.4</td>
</tr>
<tr>
<td>251–300V</td>
<td>0.2</td>
<td>1.25</td>
<td>12.5</td>
<td>0.4</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
</tr>
<tr>
<td>301–500V</td>
<td>0.25</td>
<td>2.5</td>
<td>12.5</td>
<td>0.8</td>
<td>0.8</td>
<td>1.5</td>
<td>0.8</td>
</tr>
<tr>
<td>&gt;500V</td>
<td>0.25</td>
<td>2.5</td>
<td>12.5</td>
<td>0.8</td>
<td>0.8</td>
<td>1.5</td>
<td>0.8</td>
</tr>
</tbody>
</table>

**Note:** Values are minimal values (from IPC 2221)

- **B1** - Internal Conductors
- **B2** - External Conductors, uncoated, sea level to 3050 m
- **B3** - External Conductors, coated, sea level to 3050 m
- **B4** - External Conductors, with permanent polymer coating (any elevation)
- **A5** - Internal Conductors, with conformal coating over assembly (any elevation)
- **A6** - External Component lead termination, uncoated
- **A7** - External Component lead termination, with conformal coating (any elevation)

### 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:

- Coplanar waveguide.

- Coplanar waveguide with ground plane.

- Rectangular waveguide:

- Coaxial line.

- Coupled microstrip line:

- 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).

---

**Formula**

\[
Z_{in} \text{ desired input impedance in } \Omega \\
Z_{out} \text{ desired output impedance in } \Omega \\
a \text{ attenuation in } \text{dB}
\]

\[
L = 10^{a/10} \text{ (the loss)} \\
A = (L + 1)/(L - 1)
\]

**Pi attenuator**

\[
R2 = (L - 1)/2 \times \sqrt{(Z_{in} \times Z_{out})/L} \\
R1 = 1/(A/Z_{in} - 1/R2) \\
R3 = 1/(A/Z_{out} - 1/R2)
\]
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: 47 x 100 ± 5% = 4700 Ohm, 5% tolerance
- 1kOhm, 1% tolerance: Brown Black Black Brown Brown

<table>
<thead>
<tr>
<th>Tolerance</th>
<th>10% / 5%</th>
<th>&lt;= 2%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Brown</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Red</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Orange</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Yellow</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Green</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Blue</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Violet</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Grey</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>White</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Gold</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Silver</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2.7 Board-Classes

<table>
<thead>
<tr>
<th>Regulators</th>
<th>Track Width</th>
<th>Electrical Spacing</th>
<th>TransLine</th>
<th>RF Attenuators</th>
<th>Color Code</th>
<th>Board Classes</th>
</tr>
</thead>
<tbody>
<tr>
<td>mm</td>
<td>Class 1</td>
<td>Class 2</td>
<td>Class 3</td>
<td>Class 4</td>
<td>Class 5</td>
<td>Class 6</td>
</tr>
<tr>
<td>Lines width</td>
<td>0.8</td>
<td>0.5</td>
<td>0.31</td>
<td>0.21</td>
<td>0.15</td>
<td>0.12</td>
</tr>
<tr>
<td>Min clearance</td>
<td>0.68</td>
<td>0.5</td>
<td>0.31</td>
<td>0.21</td>
<td>0.15</td>
<td>0.12</td>
</tr>
<tr>
<td>Via (diam - drill)</td>
<td>--</td>
<td>--</td>
<td>0.45</td>
<td>0.34</td>
<td>0.24</td>
<td>0.2</td>
</tr>
<tr>
<td>Plated Pad (diam - drill)</td>
<td>1.19</td>
<td>0.78</td>
<td>0.6</td>
<td>0.49</td>
<td>0.39</td>
<td>0.35</td>
</tr>
<tr>
<td>NP Pad (diam - drill)</td>
<td>1.57</td>
<td>1.13</td>
<td>0.9</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

*Note: Values are minimal values*