

# Calculator Tools

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## *KiCad 10.0 Reference Manual*

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### フィードバック

The KiCad project welcomes feedback, bug reports, and suggestions related to the software or its documentation. For more information on how to submit feedback or report an issue, please see the instructions at <https://www.kicad.org/help/report-an-issue/>

### Software and Documentation Version

This user manual is based on KiCad 10.0.0. Functionality and appearance may be different in other versions of KiCad.

Documentation revision: 90e4b228.

## はじめに

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:

- レギュレーター
- 配線幅
- 導体間隔
- 伝送線路
- RF アッテネーター
- カラー コード
- ボード クラス

## レギュレーター

### レギュレーター

この計算機は、リニア定電圧レギュレーターと低損失定電圧レギュレーターで使用される抵抗の値を見つけるのに役立ちます。

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:

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

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

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

この電流は一般的に 100 uA 以下であり、気をつけながら無視することができます。

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.

## RF アッテネーター

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

- パイ型
- T型
- ブリッジT型
- 抵抗分割型

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).

## E-Series

This calculator helps to identify combinations of standard E-series resistors that meet a required resistance, optionally excluding several resistor values that are not available.

PCB Calculator

Regulators RF Attenuators **E-Series** Color Code TransLine Via Size Track Width Electrical Spacing Board Classes

Inputs  
Required resistance: 4.6 kΩ  
Exclude value 1: kΩ  
Exclude value 2: kΩ

E1  E3  E6  E12  E24

Solutions  
Simple solution: 4K7 | 220K0 Error: -0.04 %  
3R solution: 4K7 | ( 68K + 150K ) Error: -0.02 %  
4R solution: 100R + 100R + 2K2 + 2K2 Error: Exact %

Help  
E-series are defined in IEC 60063.  
Available values are approximately equally spaced in a logarithmic scale.

E24 (5%) :	1.0	1.1	1.2	1.3	1.5	1.6	1.8	2.0	2.2	2.4	2.7	3.0	3.3	3.6	3.9	4.3	4.7	5.1	5.6	6.2	6.8	7.5	8.2	9.1
E12 (10%) :	1.0	1.2	1.5	1.8	2.2	2.7	3.3	3.9	4.7	5.6	6.8	8.2												
E6 (20%) :	1.0	-	1.5	-	2.2	-	3.3	-	4.7	-	6.8	-												
E3 (50%) :	1.0	-	-	-	2.2	-	-	-	4.7	-	-	-												
E1 :	1.0	-	-	-	-	-	-	-	-	-	-	-												

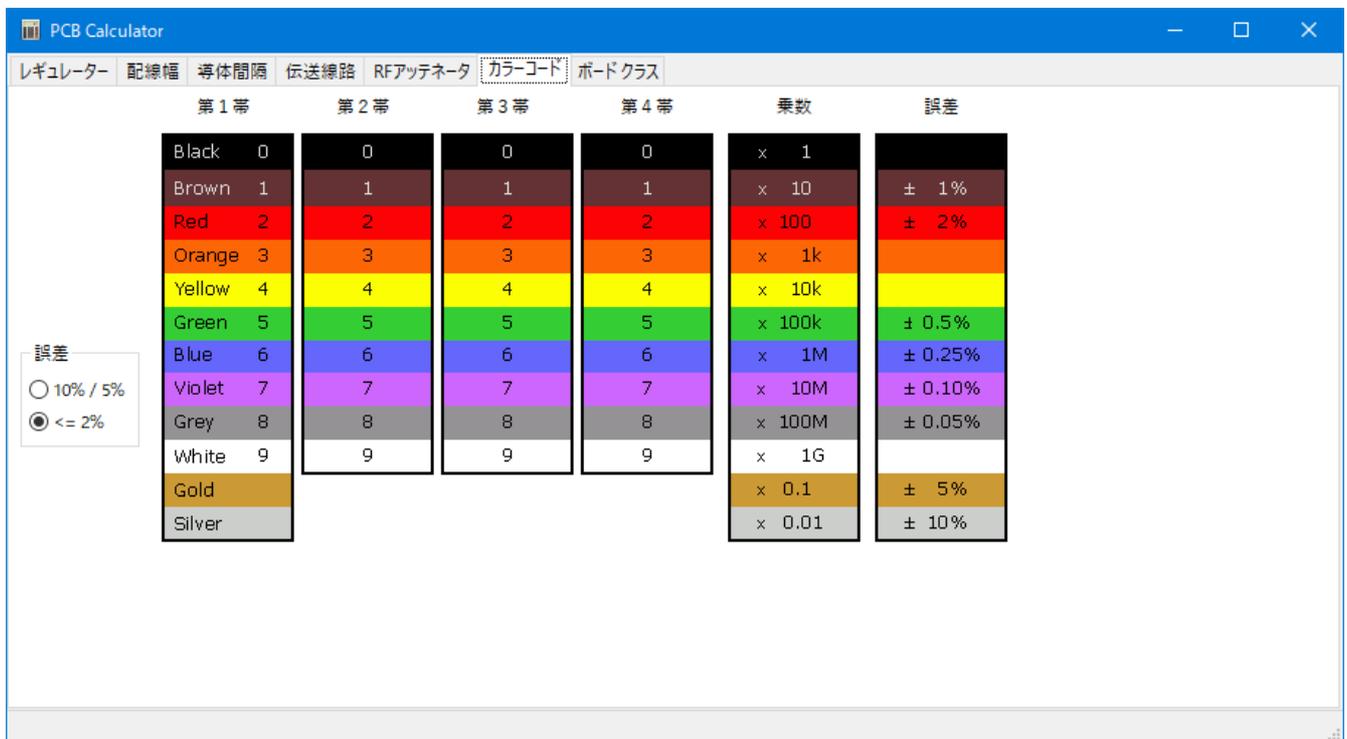
- ◆ This calculator finds combinations of standard E-series (between 10Ω and 1MΩ) to create arbitrary values.
- ◆ You can enter the required resistance from 0.0025 to 4000 kΩ.
- ◆ Solutions using up to 4 components are given.

The requested value is always excluded from the solution set.

## カラーコード

この計算機は、抵抗のカラーバーを抵抗値に翻訳するのを助けます。この機能を使うには、抵抗の許容誤差 (10%、5% または 2% 以下) を最初に選択します。例えば:

- 黄紫赤金:  $47 \times 100 \pm 5\% = 4700 \Omega$ , 許容誤差 5%
- 1 kΩ, 許容誤差 1%: 茶黒黒茶茶



## 伝送線路

伝送線路理論は、高周波とマイクロ波工学の授業における基本です。

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](#).

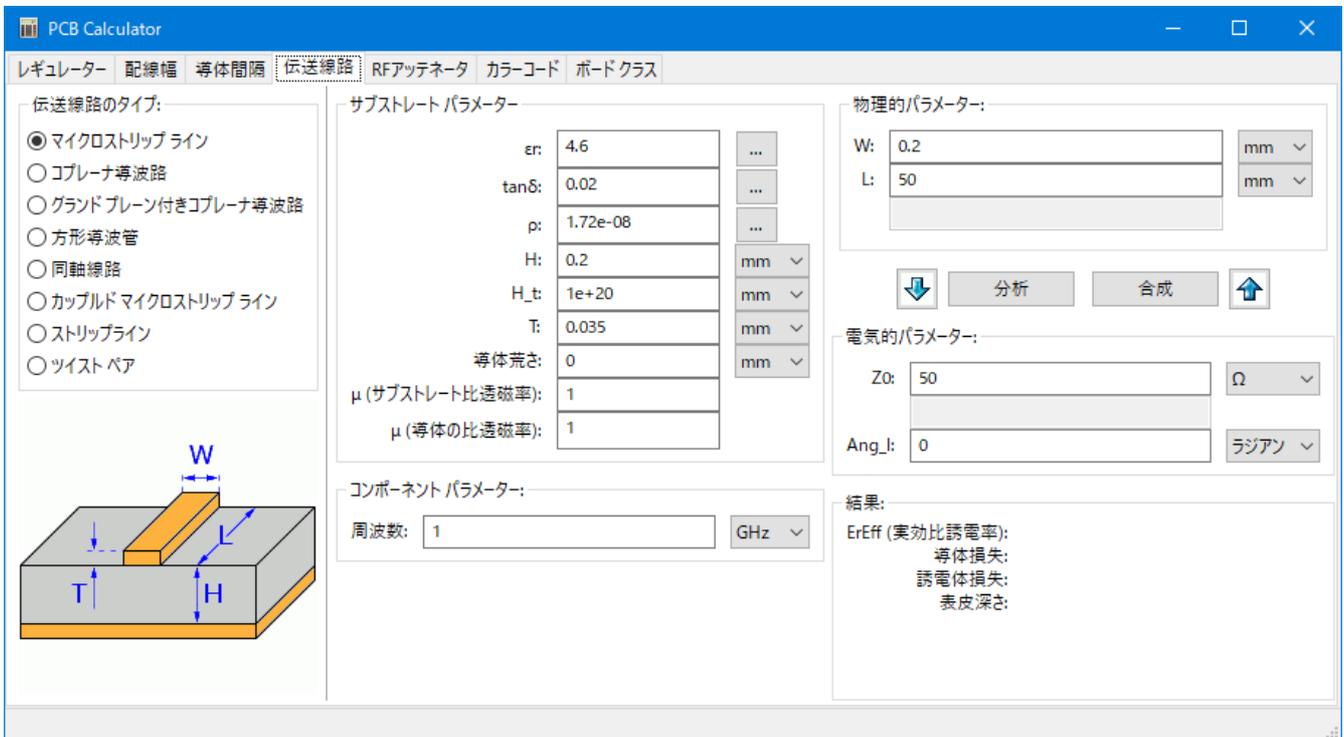
The transmission line types and the reference of their mathematical models are listed below:

- 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.

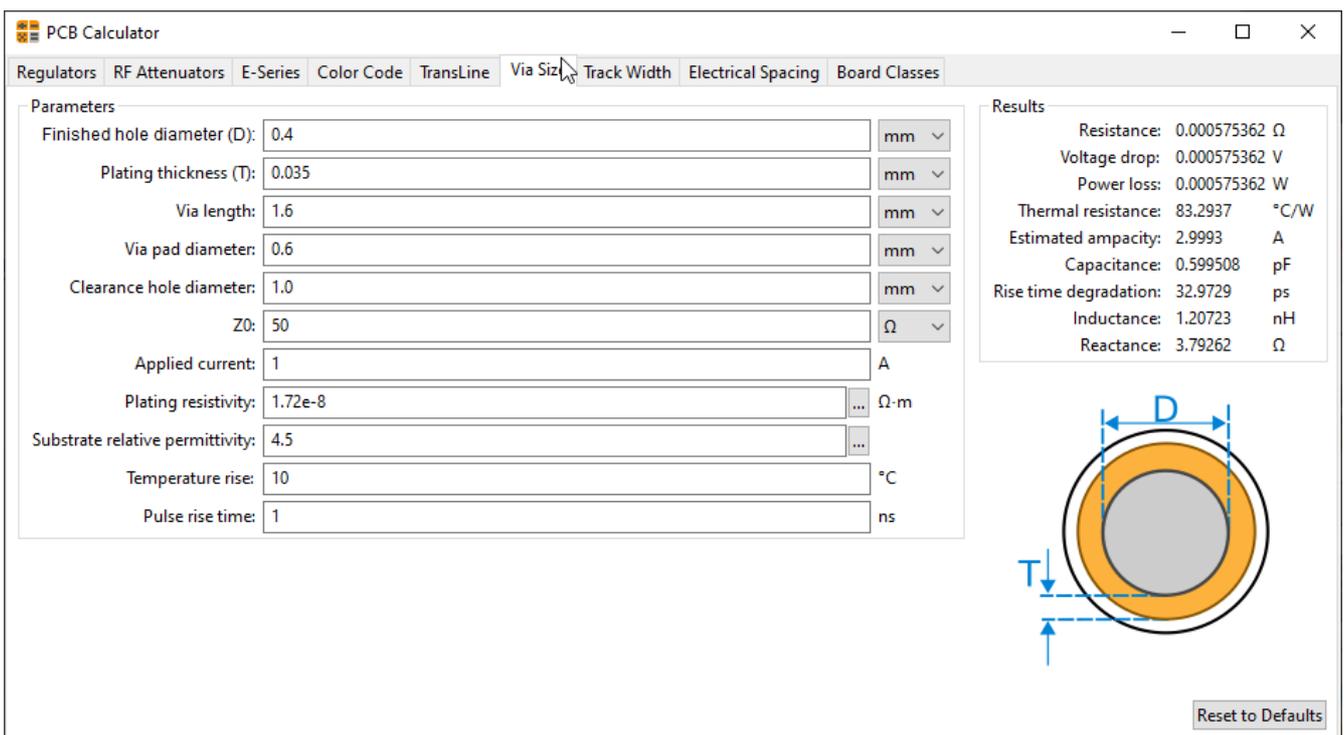
◦ S. March, "Microstrip Packaging: Watch the Last Step", Microwaves, vol. 20, no. 13, pp. 83.94, Dec. 1981.

- Stripline.
- Twisted pair.



## Via Size

The Via Size tool calculates the electrical and thermal properties of a given plated through-hole pad or via.



## 配線幅

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).

PCB Calculator

レギュレーター 配線幅 導体間隔 伝送線路 RFアッテネータ カラーコード ボードクラス

パラメーター:

電流: 1.0 A

温度上昇: 10.0 °C

導体長: 20 mm

抵抗率: 1.72e-8 電気抵抗計

最大電流を指定した場合、配線幅は適応するように計算されます。配線幅の一つを指定した場合、流せる最大電流が計算されます。また、この電流を流すことができるように他のコントロール値は、ボード体で表示されます。

計算は、電流に対しては 35A (外部) または 17.5A (内部) まで、温度上昇は 100°C まで、幅は 400mil (10mm) まで有効です。

計算式 (IPC 2221 より) は

$$I = K * dT^{0.44} * (W*H)^{0.725}$$

ここで:

I = アンペア表記による最大電流

dT = °C 表記による周囲に対する上昇温度

W,H = mil 表記による幅と厚さ

K = 内層配線 0.024 または 外層配線 0.048

外層配線:

配線幅: 0.300387 mm

配線の銅箔厚: 0.035 mm

断面積: 0.0105135 mm x mm

抵抗: 0.0327197 Ω

電圧降下: 0.0327197 Volt

電力損失: 0.0327197 W

内層配線:

配線幅: 0.781437 mm

配線の銅箔厚: 0.035 mm

断面積: 0.0273503 mm x mm

抵抗: 0.0125776 Ω

電圧降下: 0.0125776 Volt

電力損失: 0.0125776 W

## 導体間隔

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*.

PCB Calculator

レギュレーター 配線幅 導体間隔 伝送線路 RFアッテネータ カラーコード ボードクラス

mm

注: 値は最小値です (IPC 2221 より)

電圧 > 500V: 10000

値を更新

	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	24	50	250	29.775	29.775	30.475	29.775

\* B1 - 内層導体

\* B2 - 外層導体, コーティングなし, 海拔3050mまで

\* B3 - 外層導体, コーティングなし, 海拔3050m以上

\* B4 - 外層導体, 耐久ポリマーコーティング (海拔によらず)

\* A5 - 外層導体, Assy全体に絶縁保護コーティング (海拔によらず)

\* A6 - 外層 コンポーネントリード/終端, コーティングなし

\* A7 - 外層 コンポーネントリード/終端, 絶縁保護コーティング (海拔によらず)

# ボードクラス

## 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 such as 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.

## 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 or buried vias
  - 6 Multilayer metal core board with blind and/or buried vias

mm ▾

注: 値は最小値です

	クラス1	クラス2	クラス3	クラス4	クラス5	クラス6
配線幅	0.8	0.5	0.31	0.21	0.15	0.12
最小クリアランス	0.68	0.5	0.31	0.21	0.15	0.12
ビア: (直径 - ドリル)	--	--	0.45	0.34	0.24	0.2
メッキありパッド: (直径 - ドリル)	1.19	0.78	0.6	0.49	0.39	0.35
メッキなしパッド: (直径 - ドリル)	1.57	1.13	0.9	--	--	--