Tabella Serie-Parallelo

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A handy double-sided printed table to put in the drawer perhaps laminated, to give any value with maximum error of 1% by combining in series or parallel two selected resistors in the E12 series, or to a better approximation by having elements of the later series.

Description

Print ***THIS PDF*** (from the site) double-sided in A4 and laminate it. For the less blind, even A5 (half A4) will do. Here is how to use the table: suppose we need a **3172 ohm** resistor **.**

1) We reduce the desired value to only three significant figures, rounding to **3170 ohms**

2) We divide by 10 until we are within the 100-999 range. **One time only** in this case. Let's remember. We get **317**

3) We look for the intersection of column **300** and row **+17** (300+17=317). The cell contains **330//8.2K**

4) This text should be interpreted as a parallel of two resistors of 330 ohms and 8200 ohms

5) We restore the original grain order by applying in reverse the operations done in step 2

6) In this case we multiply the values 330 and 8200 by 10 **once obtaining 3.3 Kohm** and **82 Kohm**

The result obtained with the parallel of **3.3 Kohm** and **82 Kohm** is 1/(1/3300 + 1/82000) = **3172.3 ohms**

Combinazioni Serie / Parallelo con serie commerciale E12 nell'intervallo 100-999 da rapportare all'ordine di grandezza (Err 1%)

R:	100	200	300	400	500	600	700	800	900
*+0	100	220//2.2K	330//3.3K	470//2.7K	560//4.7K	1K//1.5K	820//4.7K	820//33K	820+82
*+1	100	120+82	220+82	470//2.7K	560//4.7K	1K//1.5K	680+22	820//33K	820+82
*+2	120//680	270//820	270+33	470//2.7K	470+33	1K//1.5K	820//4.7K	820//39K	1K//10K
*+3	150//330	270//820	330//3.9K	680//1K	560//4.7K	1K//1.5K	680+27	820//39K	1K//10K
*+4	120//820	220//2.7K	330//3.9K	680//1K	560//4.7K	680//5.6K	680+27	820//39K	1K//10K
*+5	120//820	150+56	330//3.9K	680//1K	470+39	680//5.6K	680+27	820//47K	1K//10K
*+6	100+6.8	220//3.3K	560//680	680//1K	470+39	680//5.6K	680+27	820//47K	1K//10K
*+7	120//1K	330//560	560//680	560//1.5K	470+39	680//5.6K	560+150	820//47K	1K//10K
*+8	180//270	220//3.9K	330//4.7K	560//1.5K	470+39	680//5.6K	560+150	820//56K	1K//10K
*+9	120//1.2K	220//3.9K	390//1.5K	560//1.5K	560//5.6K	390+220	560+150	820//56K	1K//10K
*+10	120//1.2K	220//4.7K	390//1.5K	470//3.3K	560//5.6K	680//5.6K	680+33	820//68K	1K//10K
*+11	120//1.5K	220//5.6K	330//5.6K	470//3.3K	560//5.6K	680//5.6K	680+33	820//68K	1K//10K
*+12	120//1.8K	220//5.6K	330//5.6K	470//3.3K	560//5.6K	560+56	680+33	820	1K//10K
*+13	120//1.8K	220//6.8K	330//5.6K	470//3.3K	560//5.6K	560+56	820//5.6K	820	1K//10K
*+14	120//2.2K	220//8.2K	330//6.8K	470//3.3K	470+47	560+56	820//5.6K	820	1.2K//3.9K
*+15	120//2.7K	220//10K	330//6.8K	390+27	470+47	560+56	820//5.6K	820	1.2K//3.9K
*+16	120//3.3K	220//12K	270+47	390+27	470+47	680//6.8K	820//5.6K	820	1.2K//3.9K
*+17	120//4.7K	220//15K	330//8.2K	470//3.9K	560//6.8K	680//6.8K	820//5.6K	820	1.2K//3.9K
*+18	120//6.8K	220	330//8.2K	470//3.9K	560//6.8K	680//6.8K	680+39	820	1.2K//3.9K
*+19	120	220	330//10K	470//3.9K	680//2.2K	680//6.8K	390+330	820	820+100

In general, the possible combinations that can be obtained are, in addition to two resistors in parallel, two resistors in series or a single resistor. The table gives the combination that best approximates the value sought. Let's take another example. Let us look for the combination that approximates a desired value of **90 ohms**. First we bring that value into the range 100-999, multiplying in this case by 10 once, yielding **900.** Then we look for the cell at the intersection of the **900** column and the **+0** row , obtaining the series **820+82 ...**Finally let us return to the initial order of magnitude, dividing by 10 once the two values: **82 ohms** and **8.2 ohms**

Such two resistors placed in series provide a total of 90.2 ohms. Again we are very close to the value sought. In every possible combination the deviation obtained never exceeds 1%. It is obvious that the selection of the two resistors to be combined should be done by checking their actual value with the tester so as not to add more inaccuracy. Slight differences may in fact be found between different samples.

Let us finish with another example. We want to obtain **211 Kohm.** To get within the range 100-999 we need to divide by 1000, that is, **three times** by 10. the cell at the intersection **200 and +11** gives the parallel combination 220//5.6K. We multiply **three times** by 10 and get the pair of resistors to be placed in parallel: **220 Kohm** and **5.6 Mohm.** Calculating the final value 1/(1/220000+1/5600000)=211684 ohms, with a deviation of about 0.3%.

Do we want a proof of the goodness of the combinations shown ? Let's look at a borderline case: let's look for the combination that best approximates **102 ohms.** Of course, it would come to mind the direct use of a 100 ohm resistor settling for the 2% error obtained ... but the table shows at the intersection **100** and **+2** the combination **120//680.** This parallel gives a better value: 1/(1/120+1/680)**=102** ...with zero error! While for the value **101** the use of a single 100 ohm resistor is suggested since we still do not exceed 1% inaccuracy.

The table is also applicable for combinations of standard ceramic, polyester or electrolytic **CONDENSERS**, interpreting Series and Parallels in reverse. To refer to the first example, **3172 pF** is obtained by putting two **3.3 nF** and **82 nF** capacitors in series.

We can also use the table for inductors, applying it as for resistors. So 3172 uH is obtained by putting 3.3 mH and 82 mH in parallel, but this practice leaves room for improvement because it is rare to find inductors that follow a standard. They are usually custom made by winding the turns perhaps following a calculator such as ***the one I created***, found on ***my personal site***.

Two other tables are available on my site, to get 0.5 percent accuracy if you have E24 resistors, or 0.1 percent by having E48.

What’s Precision

For those who would like to explore the topic of “*Accuracy of resistive series*” the web is full of resources. In summary, the values of a commercial series approximate the geometric progression of the Reynard series: Ri = (10^(**1/12**))^i (for the **E12** series with i=0..11):

```
echo 12 | awk '{for (i=0;i<$1;i++) printf("%.1f ',(10^(1/$1))^i)}' # bash/awk script
```

1.0 1.2 1.5 1.8 2.2 2.6* 3.2* 3.8 4.6* 5.6 6.8 8.3*

...for the asterisked items the commercial series deviates slightly from the theoretical value (2.7 3.3 4.7 8.2). Skipping the albeit interesting demonstration, this progression has the property of containing the relative difference between two consecutive values to a deviation having a fixed ratio with the first term of the pair, which will then be twice the “Accuracy” of the resistive series. In fact. one can easily verify that against any given value, the nearest sample of the E12 series is no more than 10% away from it! ...for example, if we want **3.172** ohms, the closest value **3.3** ohms offers a deviation equal to (3.3-3.172) * 100/3.3 = **3.9%.** The worst case happens at the exact center between two samples: for example, 1.1 ohm is **10%** away from 1.0 and 1.2... However, we will not exceed the 10% error by mail. Later series, having more terms, offer a lower error.

E6: 20%, E12: 10%, E24: 5%, E48: 2%, E96: 1%, E192: 0.5%.