Resistor Colour Codes and Markings Page - 1

The first part of this document was taken from the web site sparkfun.com

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https://learn.sparkfun.com/tutorials/resistors/decoding-resistor-markings

Decoding Resistor Markings

Though they may not display their value outright, most resistors are marked to show what their resistance is. Through-hole resistors use a colour-coding system and SMD resistors have their own value-marking system. The same colour code system has also been used on some mica and ceramic capacitors in the past.

Decoding the colour bands

Through-hole, axial resistors usually use the colour-band system to display their value. Most older resistors will have four bands of colour circling the resistor, and the the newer resistors now made to a tolerance of 1 or two percent will usually have five colour bands.

The four colour bands, first two bands indicate the **two most-significant digits** of the resistor's value. The third band is a weight value, which **multiplies** the two significant digits by a power of ten. The final band indicates the **tolerance** of the resistor. The tolerance explains how much more or less the *actual* resistance of the resistor can be compared to what its nominal value is. No resistor is made to perfection, and different manufacturing processes will result in better or worse tolerances. For example, a 1kΩ resistor with 5% tolerance could actually be anywhere between 0.95kΩ and 1.05kΩ.

How do you tell which band is first and last? The last, tolerance band is often clearly separated from the value bands, and usually it'll either be silver or gold.

Here's an example of a 4.7kΩ resistor with four colour bands:

Resistor Colour Codes and Markings Page - 2

Here's a table of each of the colours and which value, multiplier or tolerance they represent:

Color	Digit value	Multiplier	Multiplied Out	Tolerance
Black	0	10^0	1	
Brown	1	10^1	10	
Red	2	10^2	100	
Orange	3	10^3	1,000	
Yellow	4	10^4	10000	
Green	5	10^5	100,000	
Blue	6	10^6	1,000,000	
Violet	7	10^7	10,000,000	
Gray	8	10^8	100,000,000	
White	9	10^9	1,000,000,000	
Gold				±5%
Silver				±10%

When decoding the resistor colour bands, consult a resistor colour code table like the one above. For the first two bands, find that colour's corresponding digit value. The 4.7kΩ resistor has colour bands of yellow and violet to begin - which have digit values of 4 and 7 (47). The third band of the 4.7kΩ is red, which indicates that the 47 should be multiplied by 10^2 (or 100). 47 times 100 is 4,700!

If you're trying to commit the colour band code to memory, a mnemonic device might help. There are a handful of (sometimes unsavory) mnemonics out there, to help remember the resistor colour code.

Some mnemonics that are easy to remember include:

- **B**ig **b**oys **r**ace **o**ur **y**oung **g**irls **b**ut **V**iolet **g**enerally **w**ins.
- **B**etter **b**e **r**ight **o**r **y**our **g**reat **b**ig **v**enture **g**oes **w**est.
- **B**eetle **B**ailey **r**uns **o**ver **y**our **g**eneral **b**efore **v**ery **g**ood **w**itnesses.
- **B**uster **B**rown **r**aces **o**ur **y**oung **g**irls **b**ut **V**iolet **g**enerally **w**ins.
- **B**etter **b**e **r**ight **o**r **y**our **g**reat **b**ig **p**lan **g**oes **w**rong. (p=purple for violet)
- **B**ack-**B**reaking **R**ascals **O**ften **Y**ield **G**rudgingly **B**ut **V**irtuous **G**entlemen **W**ill **G**ive **S**helter **N**obly (with tolerance bands Gold, Silver or None)

A mnemonic that has attained some traction in recent years which spells out the difference between black and *b*rown is:

- **B**ig **b**rown **r**abbits **o**ften **y**ield **g**reat **b**ig **v**ocal **g**roans **w**hen **g**ingerly **s**lapped.
- **B**ill **B**rown **R**ealized **O**nly **Y**esterday **G**ood **B**oys **V**alue **G**ood **W**ork

  Popular in the days of vacuum-tube radios:

Resistor Colour Codes and Markings Page - 3

- **B**etter **B**uy **R**esistors **O**r **Y**our **G**rid **B**ias **V**oltages **G**o **W**est (go west=die)

Offensive mnemonics include:

- **B**ad **b**eer **r**ots **o**ut **y**our **g**uts **b**ut **v**eggies **g**o **w**ell.
- **B**ad **b**oys **r**un **o**ur **y**oung **g**irls **b**ehind **v**ictory **g**arden **w**alls.
- **B**ad **b**oys **r**ape **o**ur **y**oung **g**irls **b**ut **V**iolet **g**ives **w**illingly, **G**et **S**ome **N**ow (the last three refers to the tolerance bands Gold, Silver or None)

Since *B* can stand for both "black" and "brown", variations were formed such as "*Black* boys rape our young girls. At the risk of adding a racism to the mnemonic, "black" has the advantage that it stands for the colour of the same name and helps to differentiate it from the other 2 colours that start with 'b'. Though most forms of those mnemonics include bad, boy and but in that order:

- b**a**d → bl**a**ck
- b**o**ys → br**o**wn
- b**u**t → bl**u**e

Color Code Calculator

If you'd rather skip the math, and just use a handy calculator, give this a try from this web site:-

https://learn.sparkfun.com/tutorials/resistors/decoding-resistor-markingsDecoding surface-mount markings

Decoding surface-mount markings

SMD resistors, like those in 0603 or 0805 packages, have their own way of displaying their value. There are a few common marking methods you'll see on these resistors. They'll usually have three to four characters – numbers or letters – printed on top of the case.

If the three characters you're seeing are *all numbers*, you're probably looking at an **E24** marked resistor. These markings actually share some similarity with the colour-band system used on the PTH resistors. The first two numbers represent the first two most-significant digits of the value, the last number represents a magnitude.

In the above example picture, resistors are marked *104*, *105*, *205*, *751*, and *754*. The resistor marked with *104* should be 100kΩ ($10x10^4$), *105* would be 1MΩ ($10x10^5$), and *205* is 20MΩ ($20x10^5$). *751* is 750Ω ($75x10^1$), and *754* is 750kΩ ($75x10^4$).

Another common coding system is **E96**, and it's the most cryptic of the bunch. E96 resistors will be marked with three characters – two numbers at the beginning and a letter at the end. The two numbers tell you the first *three* digits of the value, by corresponding to one of the not-so-obvious values on this lookup table.

Code	Value	Code	Value	Code	Value	Code	Value	Code	Value	Code	Value
01	100	17	147	33	215	49	316	65	464	81	681
02	102	18	150	34	221	50	324	66	475	82	698

Resistor Colour Codes and Markings Page - 4

03	105	19	154	35	226	51	332	67	487	83	715
04	107	20	158	36	232	52	340	68	499	84	732
05	110	21	162	37	237	53	348	69	511	85	750
06	113	22	165	38	243	54	357	70	523	86	768
07	115	23	169	39	249	55	365	71	536	87	787
08	118	24	174	40	255	56	374	72	549	88	806
09	121	25	178	41	261	57	383	73	562	89	825
10	124	26	182	42	267	58	392	74	576	90	845
11	127	27	187	43	274	59	402	75	590	91	866
12	130	28	191	44	280	60	412	76	604	92	887
13	133	29	196	45	287	61	422	77	619	93	909
14	137	30	200	46	294	62	432	78	634	94	931
15	140	31	205	47	301	63	442	79	649	95	953
16	143	32	210	48	309	64	453	80	665	96	976

The letter at the end represents a multiplier, matching up to something on this table:

Letter	Multiplier	Letter	Multiplier	Letter	Multiplier
Z	0.001	A	1	D	1000
Y or R	0.01	B or H	10	E	10000
X or S	0.1	C	100	F	100000

So a *01C* resistor is our good friend, 10kΩ (100x100), *01B* is 1kΩ (100x10), and *01D* is 100kΩ. Those are easy, other codes may not be. *85A* from the picture above is 750Ω (750x1) and *30C* is actually 20kΩ.

Web sites where some of this material can be found:

http://www.wikihow.com/Remember-Electrical-Resistor-Color-Codes

http://www.wisc-online.com/Objects/ViewObject.aspx?ID=DCE1002

http://www.learnabout-electronics.org/resistors_06.php

http://en.wikipedia.org/wiki/Electronic_color_code

http://en.wikipedia.org/wiki/List_of_electronic_color_code_mnemonics