Resistors and simple network analysis

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Analog Electronics goals

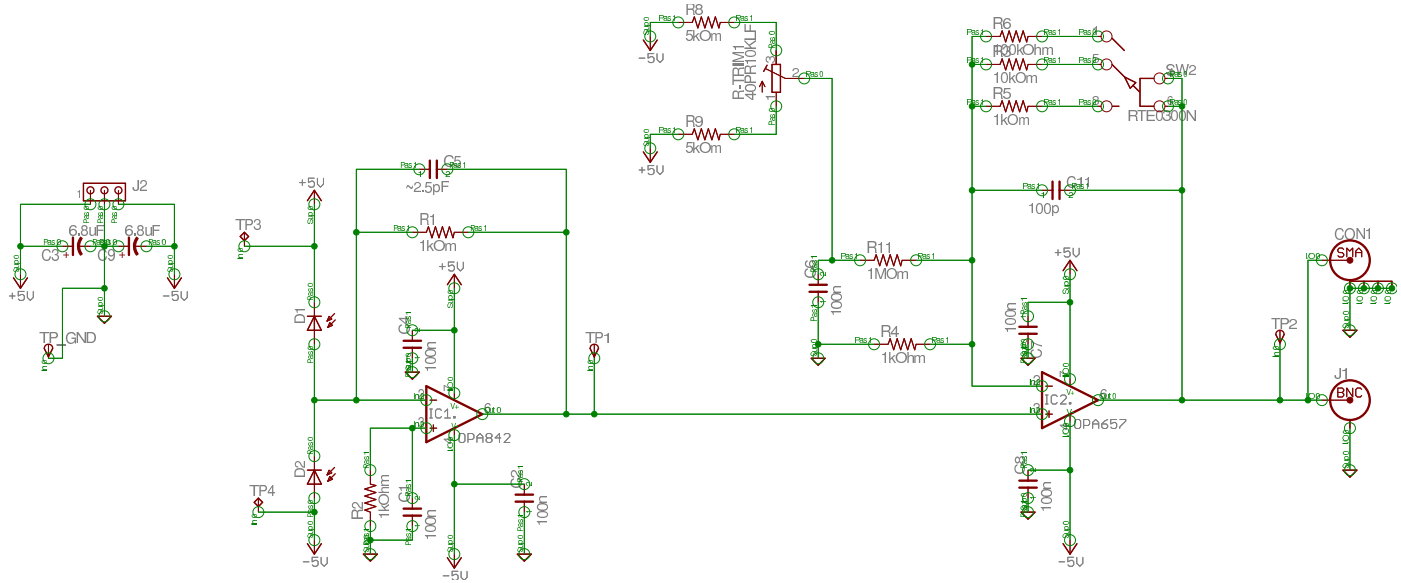
A major portion of the time spent preparing an experiment goes to design, construction, and interfacing different electronic components. Often, commercial circuitry is not available or it has to be matched with electronic front-ends (responsible for collecting usually weak signals) or back-ends (which do general purpose processing).
To perform above tasks we need:

- Lear basic discrete components
  - resistors, capacitors, inductors.
  - diodes, photo-diodes, transistors.
  - Op-amps, comparators.
- Multimeters, oscilloscopes, function generators.
- Breadboards and soldering irons.
- Modern circuit design and lay-out software.
- Master their usage

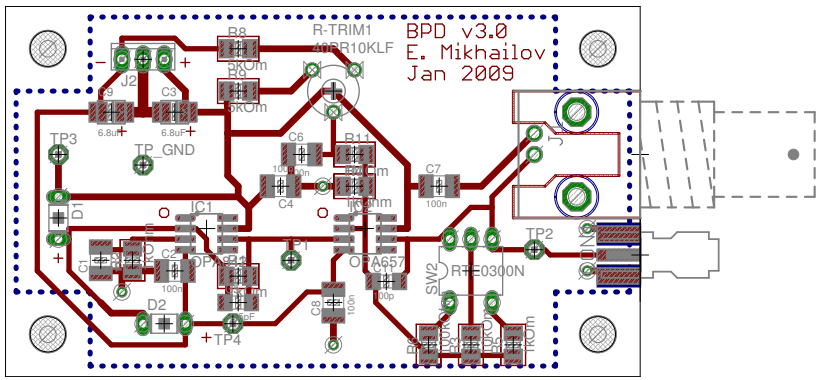
As result we will be capable to build simple yet capable electronics circuits

From schematic to the board layout

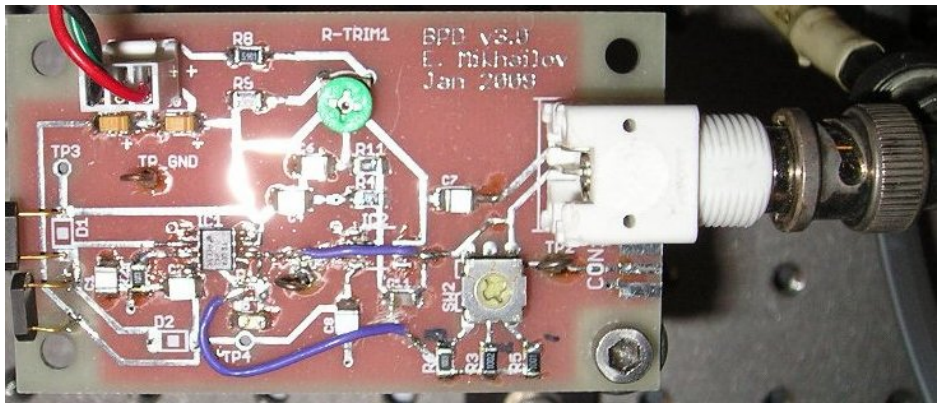
Schematic



Board layout



Hardware



Evaluations

Your final grade for the course will be determined from the following grading weight distribution:

- Notebooks/Lab: 40% (design exercises 15%, lab 25%)
- Quizzes: 10%
- Participation: 5% (being in class is not enough)
- Midterm: 20%
- Final: 25%

Most labs will include a design component. The designs must be prepared prior to attending a lab. I will check preparation of the design exercise at the beginning of each lab. An unprepared/incomplete design exercise will have up to 50% penalty.

Grades table

Grade	Score	Grade	Score	Grade	Score
		A	94-100	A-	90-94
B+	87-90	B	84-87	B-	80-84
C+	77-80	C	74-77	C-	70-74
D+	67-70	D	64-67	D-	60-64
F	<60				

Lab books

Your lab book is the primary record of your work and data.

- What you did.
- How you did it (e.g. circuit diagrams).
- How you made measurements (which test equipment and how it was connected).
- Your data and enough information to tell us what that data is.
- What you observed.
- Your calculations and analysis (including scratch work).
- Plots.
- Answers to questions and justifications for your answers.

Diagrams, data, graphs, and other notes on separate pieces of paper should be glued, taped, or stapled into the lab book.
If something falls out of the lab book during reading, shaking, transporting, it is not the part of the log book and will be discarded.
The lab book will be graded primarily on completeness and to a lesser extent on neatness.

Due days

Lab books are due by 5pm on next day after lab (i.e. Thursdays for the Wednesday section and Fridays for the Thursday section) and will be returned on Monday during the lecture time.
Late lab book submission will have points deducted. If you know you will have a problem getting the report on time please send me an email as soon as you can to let me know about your situation.

Illness

Please notify the instructor if you are ill, so that arrangements can be made to make up missed labs.

Basic blocks

Voltage (V)

Short for electrical potential difference
Potential energy divided by charge ($V = E/Q$)
Derived Unit: J/C
SI unit: V (Volt)

Current (I)

Rate of flow of electric charge (dQ/dt)
SI unit: A (Ampere)

Power (P)

Energy per time (dE/dt)
In electronics: $P = VI$
SI unit: W (Watt)

Electrical resistance

Resistance (R)

Different objects have different current passing through when the same voltage difference is applied.
Which indicates: they have different electrical resistance.
SI unit: Ω (Ohm)

Ohm's law illustrated

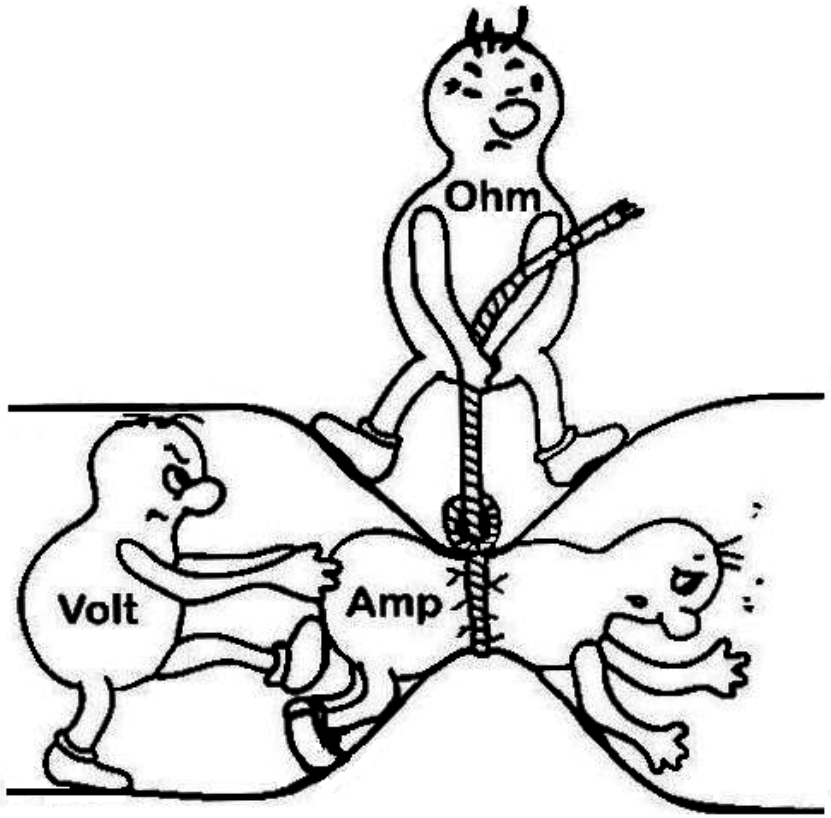
Ohm's law

$$I = \frac{V}{R}$$

Ohm's law illustrated

Ohm's law

$$I = \frac{V}{R}$$



picture taken from www.sengpielaudio.com

Resistors

Standard leaded

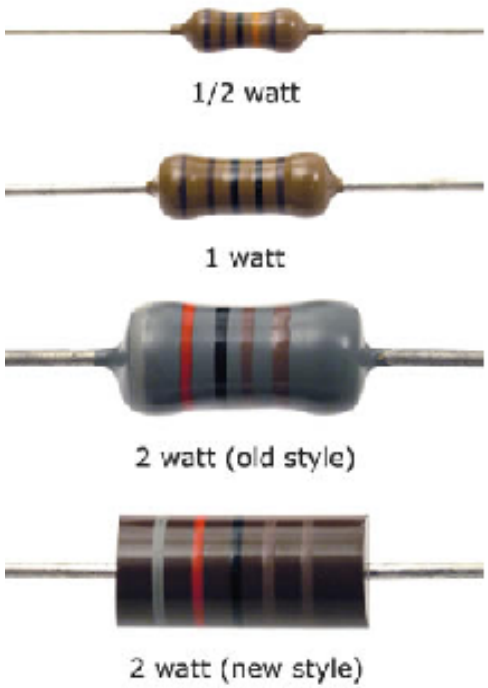


Image from
www.audionote.co.uk

Power

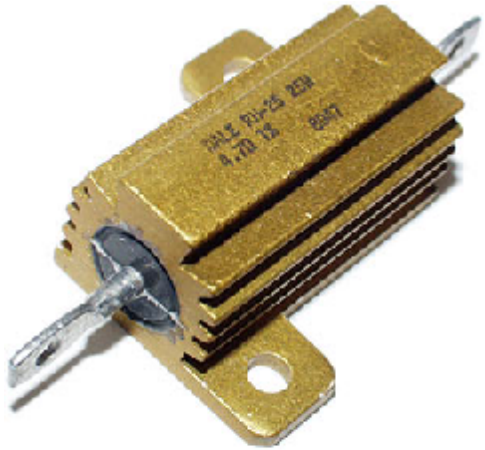
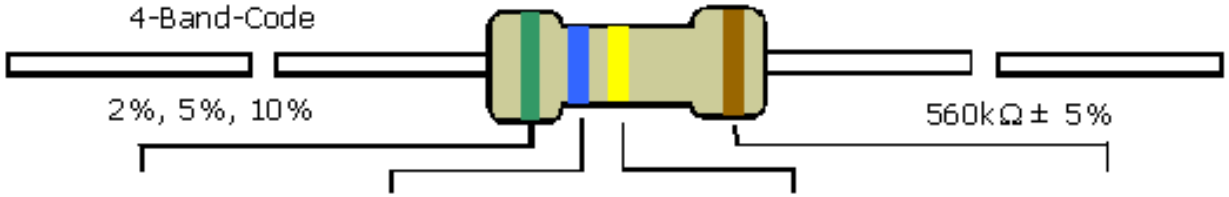


Image from
www.dansdata.com

Surface mounted

Image from
www.seed-solutions.com

Resistor color code



COLOR	1st BAND	2nd BAND	3rd BAND	MULTIPLIER	TOLERANCE	
Black	0	0	0	1Ω		
Brown	1	1	1	10Ω	± 1%	(F)
Red	2	2	2	100Ω	± 2%	(G)
Orange	3	3	3	1KΩ		
Yellow	4	4	4	10KΩ		
Green	5	5	5	100KΩ	±0.5%	(D)
Blue	6	6	6	1MΩ	±0.25%	(C)
Violet	7	7	7	10MΩ	±0.10%	(B)
Grey	8	8	8		±0.05%	
White	9	9	9			
Gold				0.1	± 5%	(J)
Silver				0.01	± 10%	(K)

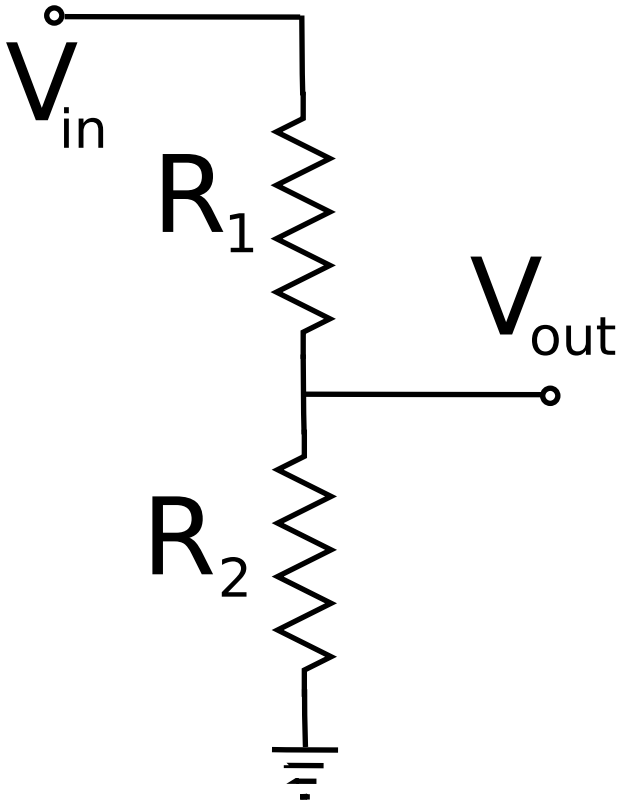
Electronix Express / RSR
http://www.elexp.com

1-800-972-2225
In NJ 732-381-8020

Resistors usage

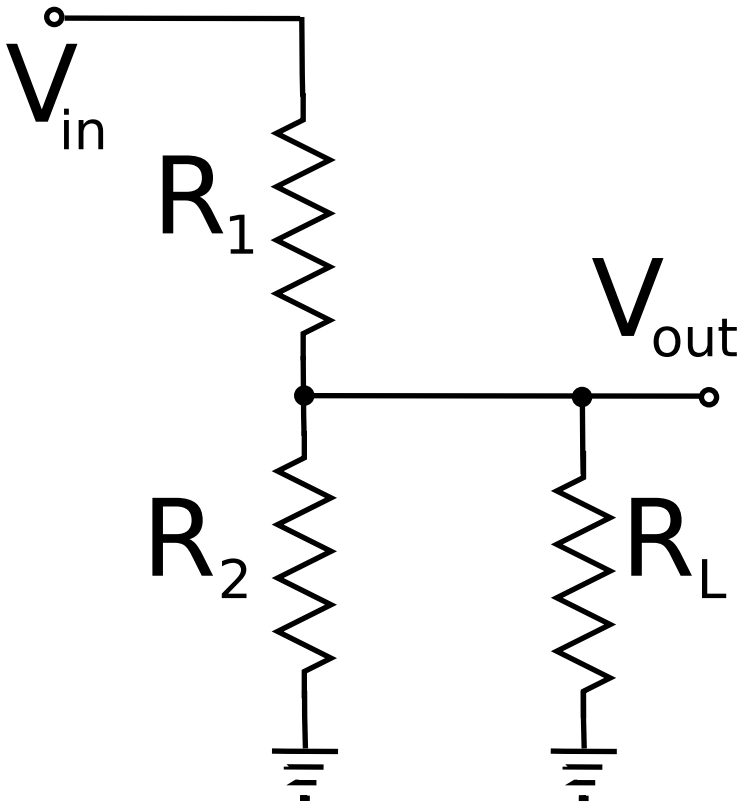
- current limiters
- fix voltage from a current source (exotic use)
- generate heat
- fuse (non standard use)
- lowering the voltage of the source (i.e. voltage dividers)

Unloaded voltage divider



$$V_{out} = V_{in} \frac{R_2}{R_1 + R_2}$$

Loaded voltage divider



$$V_{out} = V_{in} \frac{R_2}{R_1 + R_2} \frac{R_L}{R_L + R_{1||2}}$$

$$V_{out} = V_{out_{unloaded}} \frac{R_L}{R_L + R_{1||2}}$$