Electronics 1. Resistors and network analysis

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The College of William & Mary

Jan 25, 2010
Week 1

Analog Electronics goals

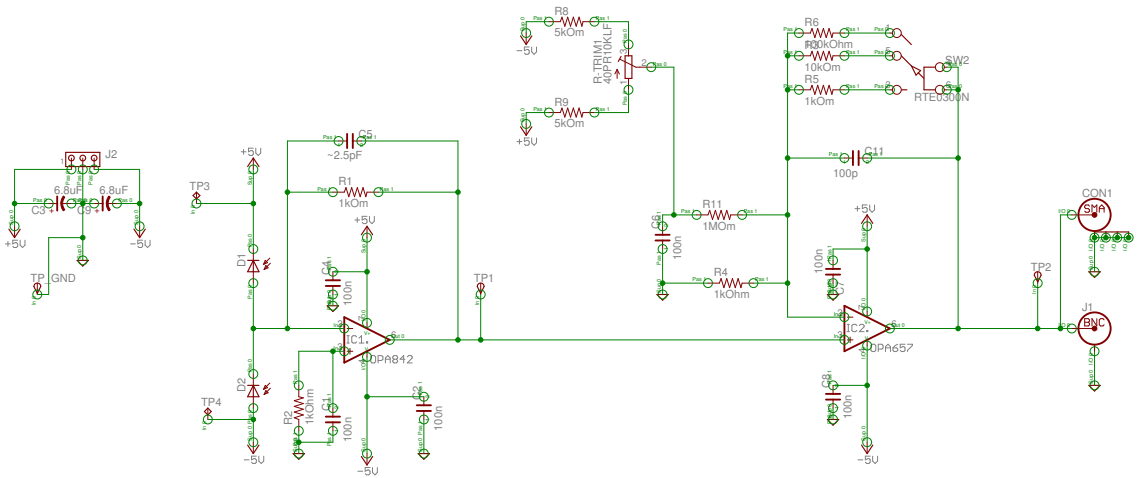
Major time spending for experiment preparation goes to design, construction and interfacing different electronics components.
Often a commercial circuitry is not available or it has to be matched with electronics front-ends (responsible for collecting usually weak signals) or back-ends (which do general purpose processing).
To perform above tasks we need:

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

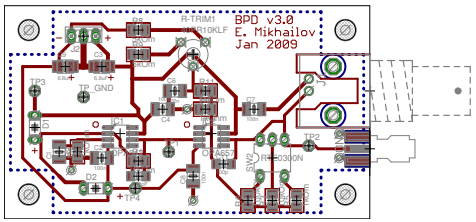
As result we will be capable to build simple yet capable electronics circuits

Resistors

Schematic



Board layout



Contact info

Instructor: Eugeniy E. Mikhailov

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- Email: eemikh@wm.edu
- Web: http://physics.wm.edu/~evmik/
- Office Hours:
  - M 14:05-15:00
  - T 11:00-12:00
  - W 11:00-12:00
  - and by appointment.

T.A. lab report grader: Austin Ziltz

T.A. lab book grader: Gleb Romanov

Evaluations

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

- Notebooks/Lab: 30% (design exercises 10%, lab 20%)
- Lab Reports: 20%
- Quizzes/Participation: 15% (being in class is not enough)
- Midterm: 15%
- Final: 20%

Most labs will include a design component. The designs must be prepared prior to attending lab so as to finish the lab measurements on time. 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-	90-93
B+	87-89	B	84-86	B-	80-83
C+	77-79	C	74-76	C-	70-73
D+	67-69	D	64-66	D-	60-63
F	<60				

Exams

Midterm test

There will a 1 hour midterm test in lab on February 24-25. There will be a lab session after the midterm.

Final exam

There will be a final exam on May 10 (2:00pm - 5:00pm) covering all course materials.

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 they were 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.

Lab reports

The lab report should present what you did in the lab, or some aspect of what you did as long as it encompasses the main theme of the lab. The reports should have the following characteristics and components:

- Typed or printed.
- Short report (14pts font, **max 3 pages** single space, but shorter is better).
- Structured with an introduction, a main body, and a conclusion.
- Measurement data should be included in tables and plots.
- All data should be analyzed and interpreted.
- Important measured numbers should include a justified error bar.
- All figures should be labeled, numbered, and referred to in the text.

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 by the next lab period. Reports are due in class the following week.
Late reports or logbooks 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.

Weekly topics

Week 0: 1/18	NO CLASS
Week 1: 1/25	DC Circuits Basics.
Week 2: 2/01	Kirchhoff's Law's and Thevenin's Theorem.
Week 3: 2/08	Capacitors, Inductors, and Complex Impedance.
Week 4: 2/15	Passive Filters and Transmission Lines
Week 5: 2/22	Diodes. **MIDTERM TEST** during labs time
Week 6: 3/01	Transistors 1: BJTs
Spring Break	
Week 7: 3/15	Transistors 2: More BJTs
Week 8: 3/22	Transistors 3: FETs
Week 9: 3/29	Op-Amps 1: Introduction to Op-Amps
Week 10: 4/5	Op-Amps 2: detectors, filters, power amplifiers
Week 11: 4/12	PID Control Theory
Week 12: 4/19	Electronic Circuit Design Tools
Week 13: 4/26	Comparators
Week 14: 5/13	**FINAL EXAM** Monday May 10, 14:00-17:00

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

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

Resistors

Standard leaded

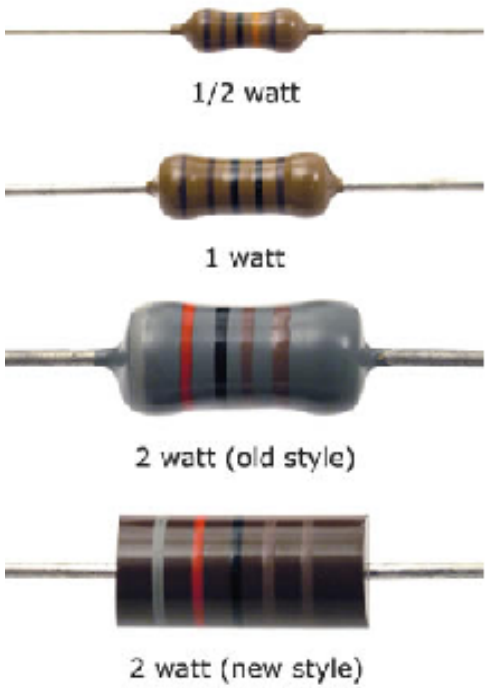


Image from
www.audionote.co.uk

Power

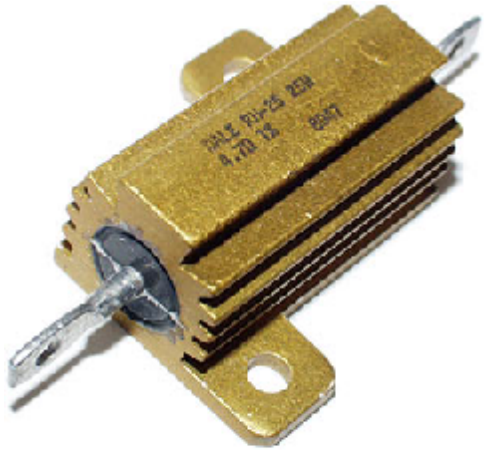
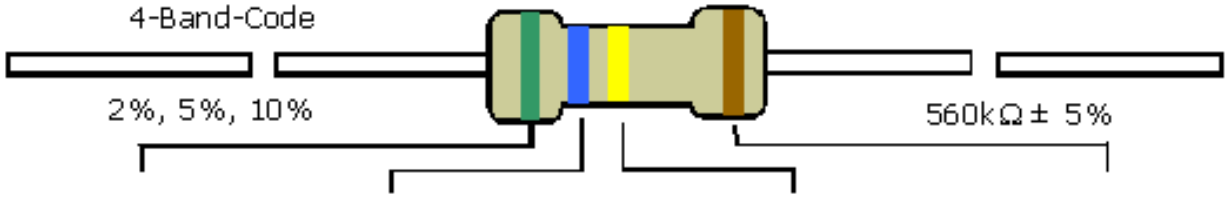


Image from
www.dansdata.com

Surface mounted

Image from
www.seed-solutions.com

Resistor color code

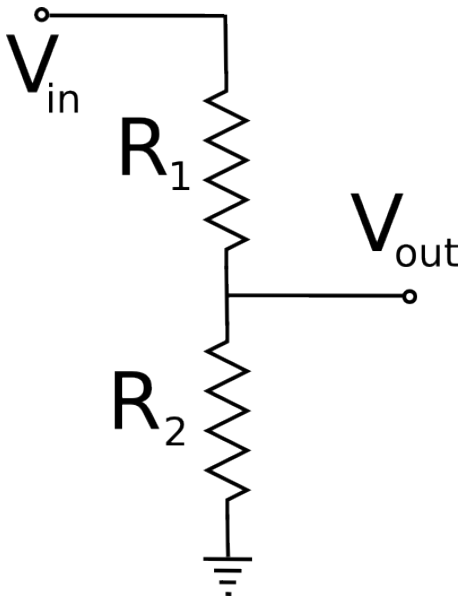


COLOR	1st BAND	2nd BAND	3rd BAND	MULTIPLIER	TOLERANCE	
Black	0	0	0	1Ω		
Brown	1	1	1	10Ω	± 1%	(F)
Red	2	2	2	100Ω	± 2%	(G)
Orange	3	3	3	1KΩ		
Yellow	4	4	4	10KΩ		
Green	5	5	5	100KΩ	±0.5%	(D)
Blue	6	6	6	1MΩ	±0.25%	(C)
Violet	7	7	7	10MΩ	±0.10%	(B)
Grey	8	8	8		±0.05%	
White	9	9	9			
Gold				0.1	± 5%	(J)
Silver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

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

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

Unloaded voltage divider



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