Objective:

An introduction to basic electrical & electronic components.

General Information:

An electronic component is a basic electronic element usually packaged in a discrete form with two or more connecting leads or metallic pads. Components are intended to be connected together, usually by soldering to a printed circuit board, to create an electronic circuit with a particular function (for example an amplifier, radio receiver, or oscillator). Components may be packaged singly (resistor, capacitor, transistor, diode etc) or in more or less complex groups as integrated circuits (operational amplifier, resistor array, logic gate etc).

Resistors

A resistor is a two-terminal electrical or electronic component that resists an electric current by producing a voltage drop between its terminals in accordance with Ohm’s law:

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

The electrical resistance is equal to the voltage drop across the resistor divided by the current through the resistor. The resistance value can be presented by color code. The first two numbers are the first two significant digits of the resistance value, the third is a multiplier, and the fourth is the tolerance of the value. Each color corresponds to a certain number, shown in the example below.

Example: 4.7K or 4700 ohms (Carbon)
Capacitance

The capacitor’s capacitance ($C$) is a measure of the amount of charge ($Q$) stored on each plate for a given potential difference or voltage ($V$) which appears between the plates:

$$C = \frac{Q}{V}$$

In SI units, a capacitor has a capacitance of one farad when one coulomb of charge is stored due to one volt applied potential difference across the plates. Since the farad is a very large unit, values of capacitors are usually expressed in microfarads ($\mu F$), nanofarads (nF), or picofarads (pF).

Capacitors are often used in electrical circuits as energy-storage devices. They can also be used to differentiate between high-frequency and low-frequency signals; this makes them useful in electronic filters.

Diodes

Diode is a component that restricts the directional flow of charge carriers. Essentially, a diode allows an electric current to flow in one direction, but blocks it in the opposite direction.

Leds

A light-emitting diode (LED) is a semiconductor diode that emits incoherent narrow-spectrum light when electrically biased in the forward direction of the p-n junction.

The color of the emitted light depends on the composition and condition of the semiconducting material used, and can be infrared, visible, or near-ultraviolet.

Transistors

A transistor is a semiconductor device, commonly used as an amplifier or an electrically controlled switch. The transistor is the fundamental building block of the circuitry that governs the operation of computers, cellular phones, and all other modern electronics.
Integrated Circuits (IC)

Integrated Circuits are usually called ICs or chips. They are complex circuits which have been etched onto tiny chips of semiconductor (silicon). The chip is packaged in a plastic holder with pins spaced on a 0.1" (2.54mm) grid which will fit the holes on stripboard and breadboards. Very fine wires inside the package link the chip to the pins.

![Integrated circuitry of IC die bonded by electrical wire to metal leg pins, encapsulated in DIP chip design. Illustration by electronetwork.org 2004, ©-free.](image)

The pins are numbered anti-clockwise around the IC (chip) starting near the notch or dot. The diagram shows the numbering for 8-pin and 14-pin ICs, but the principle is the same for all sizes.

*DIL socket*  
*8-pin and 14-pin ICs*

Integrated circuits are classified by the number of transistors and other electronic components they contain:

- SSI (small-scale integration): Up to 100 electronic components per chip
- MSI (medium-scale integration): From 100 to 3,000 comp. per chip
- LSI (large-scale integration): From 3,000 to 100,000 comp. per chip
- VLSI (very large-scale integration): From 100,000 to 1,000,000 comp. per chip
- ULSI (ultra large-scale integration): More than 1 million comp. per chip

Chip holders (DIL sockets)
ICs (chips) are easily damaged by heat when soldering and their short pins cannot be protected with a heat sink. Instead we use a chip holder, strictly called a DIL socket (DIL = Dual In-Line), which can be safely soldered onto the circuit board. The chip is pushed into the holder when all soldering is complete.

Chip holders are only needed when soldering so they are not used on breadboards.

FPGAs:
- Digilent Basys2 Board
- Xilinx Spartan3E FPGA
- Digilent Adept

Design & Verification Tools
- Xilinx ISE Web Pack
- Mentor Graphics ModelSim

Lab Equipment:
- Oscilloscope, signal generator, DC power supply, breadboards, resistors, capacitors, ICs, FPGA boards, software (Xilinx ISE WebPack, ModelSim).

Procedure:
1. Take some resistors and find out their resistance values from color codings and verify your findings with multimeter. Show these values on a table with errors.
2. Try to light a led considering its current limits. Calculate which value of resistors must be used with 1,8V red light led. (power supply 3V)
3. Be familiar with ICs and learn how to use datasheets.
4. Familiarize with Digilent Basys2 board.
5. Make sure Xilinx WebPack, Mentor Graphics ModelSim installations are up and running.

Useful Links

http://www.doctronics.co.uk/design.htm
about resistors and color codes
http://www.doctronics.co.uk/resistor.htm
how to use multimeter
http://www.doctronics.co.uk/meter.htm
datasheets
http://www.datasheet4u.com/
http://www.datasheetcatalog.com/
http://www.standardics.nxp.com/logic/
http://www.alldatasheet.com/
http://model.com/content/modelsim-pe-student-edition-hdl-simulation
http://www.digilentinc.com/