Exercise 2.

Basic measurements

Required knowledge

- Handling of basic instruments.
- Basic knowlege about rectifiers and voltage regulators.
- Ohm's law.

Aim of the measurement

The aim of this exercise is to get acquainted with the measurement instruments through simple measurement tasks. Electromechanical and digital measurement instruments will be used. DC and AC measurements, measurement accuracy will be covered.

Keywords

rectifier, voltage regulator, multimeter, measurement accuracy, measurement uncertainty, average, variance

Web links

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

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

Measurement instruments

Oscilloscope	AGILENT 54622A
Power supply	AGILENT E3630
Function generator	AGILENT 33220A
Digital multimeter (6½ digit)	AGILENT 33401A
Digital multimeter (3½ digit)	METEX ME-22T
Analog multimeter	Ganzuniv-3
Hall-effect current probe	HAMEG HZ-56
Micrometer	

Test boards

Test board (Fig. 2–1.)	VIK-01-01
Safety transformer (230 / 2x11.5 V)	VIK-01-02
Load resistance	VIK-01-03

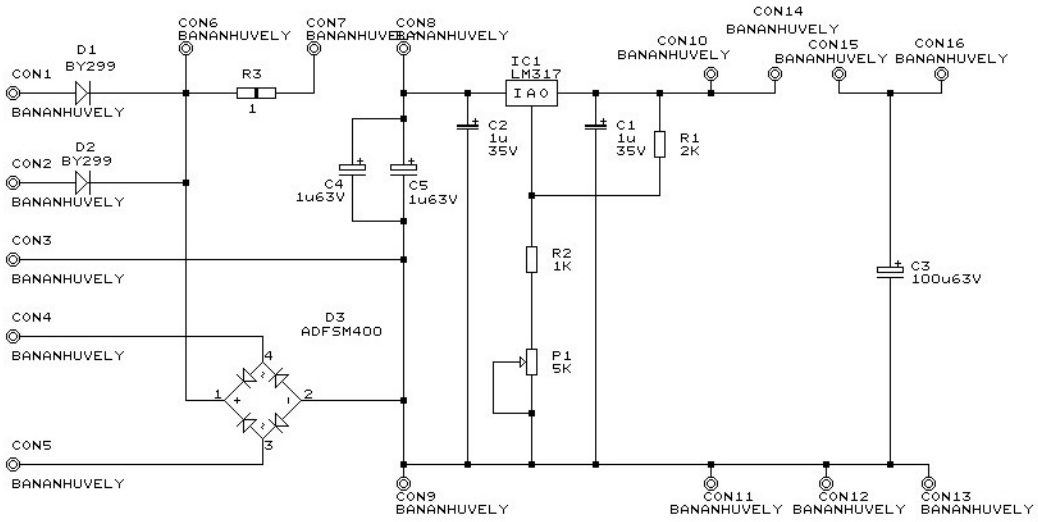

Fig. 2–1. Schematic diagram of the Test board (VIK-01-01)

Laboratory exercises

1. Practice of basic measurement instruments

The schematic diagram of the test board is shown in Fig. 2–1. By using an external transformer (230 V/2x11.5 V) half-wave or full-wave rectifier can be mounted. The rectified and by the capacitor filtered wavy DC voltage is lead to the linear voltage regulator IC, which assures a stable voltage on the load. We will use a potentiometer as a load resistance having the following parameters:47 Ω/25 W.

1.1. Connect the half-wave rectifier input to the transformer output. Connect the load resistance to the output, and measure the voltage across the load with and oscilloscope. Increase the load current (by reducing the load resistance), and find the critical value at which the output voltage does not remain constant, but it indents at every period for a certain amount.

1.2. Determine the minimal voltage drop between the input and output of the voltage regulator IC to get a stable output voltage!

1.3. By changing the load resistance determine

1.3.1. the relationship between the input and output voltages of voltage regulator IC,

1.3.2. ripple of the input and output voltages,

1.3.3. peak current of the diode and

1.3.4. conduction angle.

1.4. Repeat the previous measurement with the full-wave rectifier.

2. Thevenin equivalent circuit

2.1. Measure the parameters of the Thevenin equivalent circuit of a battery or power supply! Design your own measurement setup for that.

2.1.1. Select the appropriate measurement instruments for the purpose. Make an effort to have the largest measurement accuracy.

2.1.2. Determine the inner resistance, the open circuit voltage of the Thevenin equivalent, and the uncertainty of the voltage measurement.

3. Measuring distance with micrometer

3.1. Measure the diameter of a wire in 10-20 separate locations!

3.2. Determine the average, variance and A-type uncertainty of the measurement!

4. Calibration of digital multimeter

4.1. Calibrate a 3½ digit multimeter, on a given frequency, applying 10 V by a 6½ digit multimeter!

4.2. Determine the best measurement capability and the uncertainty of the calibration!

4.3. Provide the result of the calibration!

5. Frequency dependence of voltmeters

5.1. Apply a sine wave having 1 V effective value, 50 Hz frequency to a 6½ digit multimeter, to a 3½ digit portable multimeter and to an analog multimeter!

5.2. Increase the frequency starting from 20 Hz, and find the upper frequency at which the measured voltage is lower by 3 dB. The 6½ digit multimeter is assumed to provide the authentic measurement.

6. Effect of waveshape to the voltmeters

The simple AC voltmeters usually do not measure directly the effective value. The moving coil analog voltmeter having a permanent magnet provides an angle of rotation proportional to the simple mean of the voltage (DC mode). These voltmeters are usually equipped with a simple rectifier, and measure thus the absolute value of the voltage, however, they are scaled to show the effective voltage of a sine wave. Nowadays, modern AC voltmeters, the so called True RMS meters measure the effective value of the signal, independent on the wave shape. The 6 ½ digit voltmeter is such a true RMS instrument.

6.1. Set the waveform generator to provide a sine wave having an amplitude of 1 V, and a frequency of 50 Hz, and 1 kHz, respectively! Measure the voltages with all three voltmeters!

6.2. Switch the function generator to square- and triangle waveforms, and measure the voltages again with all three voltmeters.

6.3. Verify the wave shapes on the oscilloscope and measure the peak voltage on it!

6.4. Calculate the exact value of the measured quantity, knowing, that certain instruments measure either the mean absolute value or the peak value, but show the effective value assuming sine wave input.