Electronics Lab Course Experiment #0: Introduction and Preparational Experiment

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Contents

1 Aims of the experiment

The aim of this experiment is to understand the tools used in the electronics lab course, which shall be archieved by determination of the ramp-up time of the oszilloscope.

2 Theoretical background

2.1 Amplitudes of AC voltage

To describe AC voltage amplitudes, the following voltages can be used:

$$\begin{aligned}
\text{peak-to-peak-voltage:} \quad U_{PP} &= max\{U(t)\} - min\{U(t)\} \\
\text{peak-voltage {\tiny (symmetric and most times also asymmetric voltage):}} \quad U_P &= max\{|U(t)|\} \\
\text{root-mean-square-amplitude-voltage:} \quad U_{RMS} &= \sqrt{\langle U^2(t) \rangle}
\end{aligned}$$

2.2 Measuring instruments

Every measuring instrument is made up of two parts:

- Measuring unit
- Displaying unit

2.2.1 Measuring unit

The measuring unit measures the measurand and controlls the displaying unit. It is made up itself of another 3 subunits:

- Measuring amplifier
- Area selection network
- Measuring converter

2.2.2 Displaying unit

The displaying unit allows us to read the value of the measurement. If the measuring instrument is an analogue one, it consists of a pointer a coil which steers the pointer and a scale. If it is a digital one, it consists of a counter which -most times- gets it's input from a so called dual-slope converter[1] and a LCD.

2.3 The oszilloscope

[1]it measures a measurand by the time it takes to decharge a build-in capacitor

3 Preperational exercises

3.1 0.2.1.A

$$\begin{aligned} U(t) &= U_0 \cdot \sin(\omega t) \\ U_{PP} &= 2 \cdot U_0 \\ U_P &= U_0 \\ U_{RMS} &= \tfrac{U_0}{\sqrt{2}} \end{aligned}$$

3.2 0.2.1.B

For a symmetrical rectangular voltage[2]

$$\begin{aligned} U_{RMS} &= \frac{U_0}{\sqrt{2}} \\ &= 7.07\,\mathrm{V} \end{aligned}$$

3.3 0.2.2.C

3.3.1 0.2.2.C.1

$$\begin{aligned} \text{To proof:}\quad R_i &= \frac{U_2 - U_1}{I_1 - I_2} \\ U_n &= U_0 \frac{R_n}{R_n + R_i} \\ I_n &= \frac{U_n}{R_n} \\ \Leftrightarrow I_n &= U_0 \frac{1}{R_n + R_i} \\ U_2 - U_1 &= U_0 \left(\frac{R_2}{R_2 + R_i} - \frac{R_1}{R_1 + R_i} \right) \\ I_1 - I_2 &= U_0 \left(\frac{1}{R_1 + R_i} - \frac{1}{R_2 - R_i} \right) \\ \Rightarrow \frac{U_2 - U_1}{I_1 - I_2} &= \frac{\left(\frac{R_2}{R_2+R_i} - \frac{R_1}{R_1+R_i} \right)}{\left(\frac{1}{R_1+R_i} - \frac{1}{R_2+R_i} \right)} \\ &= \frac{R_2 (R_1 + R_i) - R_1 (R_2 + R_i)}{R_2 + R_i - R_1 - R_i} \\ &= \frac{R_i (R_2 - R_1)}{R_2 - R_1} \\ &= R_i \end{aligned}$$

[2] In this case with $U_P = 10\,\mathrm{V}$

3.3.2 0.2.2.C.2

$$
\begin{aligned}
U_0 &= 10\,\mathrm{V} \\
U_n(50\,\Omega) &= 5\,\mathrm{V} \\
U_n &= U_0 \frac{R_n}{R_n + R_i} \\
\Rightarrow R_i &= 50\,\Omega
\end{aligned}
$$

3.4 0.3.3.E

$$
\begin{aligned}
\text{To proof:} \quad B\Delta t &= 0.35 \\
B &= \frac{1}{2\pi\tau} \\
\Delta t &= t(0.9U_0) - t(0.1U_0) \\
\text{Decharging-function of a capacitor:} \quad U(t) &= U_0 \exp\left(-\frac{t}{\tau}\right) \\
\frac{0.1}{0.9} &= \exp\left(-\frac{\Delta t}{\tau}\right) \\
\Leftrightarrow \Delta t &= -\ln\left(\frac{1}{9}\right)\tau \\
&= 2.197\tau \\
\Rightarrow B\Delta t &= \frac{2.197}{2\pi} \\
&\approx 0.35
\end{aligned}
$$

4 Experiment set-up

5 Procedure

6 Measurement

7 Evaluation

8 Conclusion