

University of Applied Sciences Hamburg	DEPARTMENT OF INFORMATION ENGINEERING	Laboratory for Instrumentation and Measurement
Group No :	<h1>Test No. 1</h1>	L1: in charge of the report
Date:		Assistant A2:
Professor:		Assistant A3:
Introduction to Scope Measurements		

Report History

Report 1		Date	Remarks
	received		
	checked		
	result	o.k.	
n.g.		→ 1. Correction → Term.....	
1. Correction		Date	Remarks
	received		Last chance!!
	checked		
	result	o.k.	
n.g.		→ 2. Correction → Term.....	
2. Correction		Date	Remarks
	received		
	checked		
	result	o.k.	
n.g.		→ not passed → back to L1.....	

Final decision:

o.k.

not passed

Prof.

Important

- no wiring before the presentation of a correct circuit diagram including all instruments
- maintain a log-book to document your experimental work

Objectives

- Basic knowledge of the principles and operating of an oscilloscope
- Correct measuring of periodic signals: period, frequency, amplitude
- Bode plots for RC filters
- Non-sinusoidal signals (triangle and square wave)

Preparation

Note:

This homework is to be prepared prior to the lab session and to be presented at the beginning of the lab session.

1. Determine the effective value, the mean value, and the rectified value of a sine wave, a square wave and a triangle wave with a peak-to-peak-value of $U_{PP} = 6.0 \text{ V}$ and no DC offset and put these values into a table .
2. Calculate the voltage ratio $F(f) = U_o/U_0$ of a low-pass filter with $R = 2.2 \text{ k}\Omega$ and a capacitance $C = 47 \text{ nF}$ in the frequency-range from 100 Hz to 10 kHz and plot a Bode-plot of $F(f)$. Determine the cutoff frequency f_c .
3. Read this information carefully:
Last EE1 lecture – Operating a Scope
Appendix 1: Digital Storage Oscilloscope
Appendix 2: Subsystems in a scope
Appendix 3: Time base and triggering

Remember:

Use grid paper in the lab to make plots, circuit diagrams and calculations. Use logarithmic paper for Bode plots.

Make a plot of the wiring diagram including all necessary instruments and a list of all important items in use.

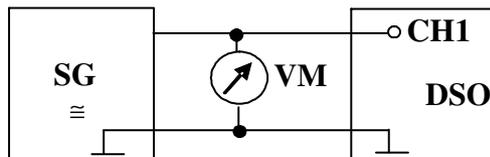
Experiment 1: Voltage Measurement

Measurement setup

SG : Signal generator
 VM: Digital voltmeter (18S)
 DSO: Digital storage oscilloscope

Signal generator setup: Frequency $f_0 = 800$ Hz, Voltage $u_{pp} = 6.0$ V (peak to peak)

DSO setup: Triggering on channel 1: DC , +0V ↑



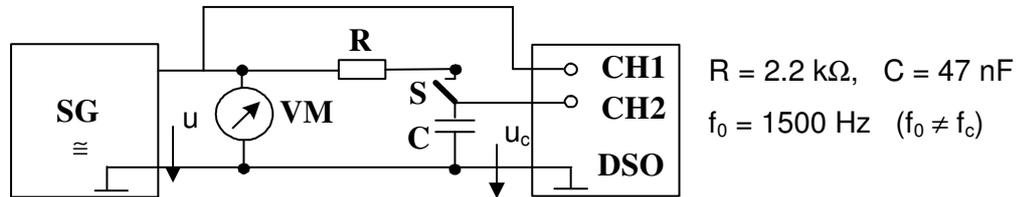
Experiment 1: Time measurement and adjustment of frequencies with a scope

- Generate a sinusoidal signal with a peak to peak voltage u_{pp} and the frequency f_0 given above and display this signal on the oscilloscope.
- Check the voltage with a digital voltmeter (VM type 18S) and adjust the settings of the signal generator so that the voltmeter displays the effective value $U_0 = 2.12$ V.

Experiment 2: Non-sinusoidal signals

- Generate a sine wave, triangle wave and square wave with a peak to peak voltage given above. Display these signals and take a screen shot.
- Measure the RMS and mean values of all signals with the digital voltmeter and the 'Measure' function of the scope and compare the results of the scope, the voltmeter and your pre-calculation.
- Set the function generator to square wave, 6 Vpp with a DC offset of 3V such that the signal changes between 0V and 6V. Measure the True RMS, RMS and mean value and compare them to the theoretical value.

Experiment 3: 2-channel-mode and RC low-pass filter



3.1 Filter response of sine wave

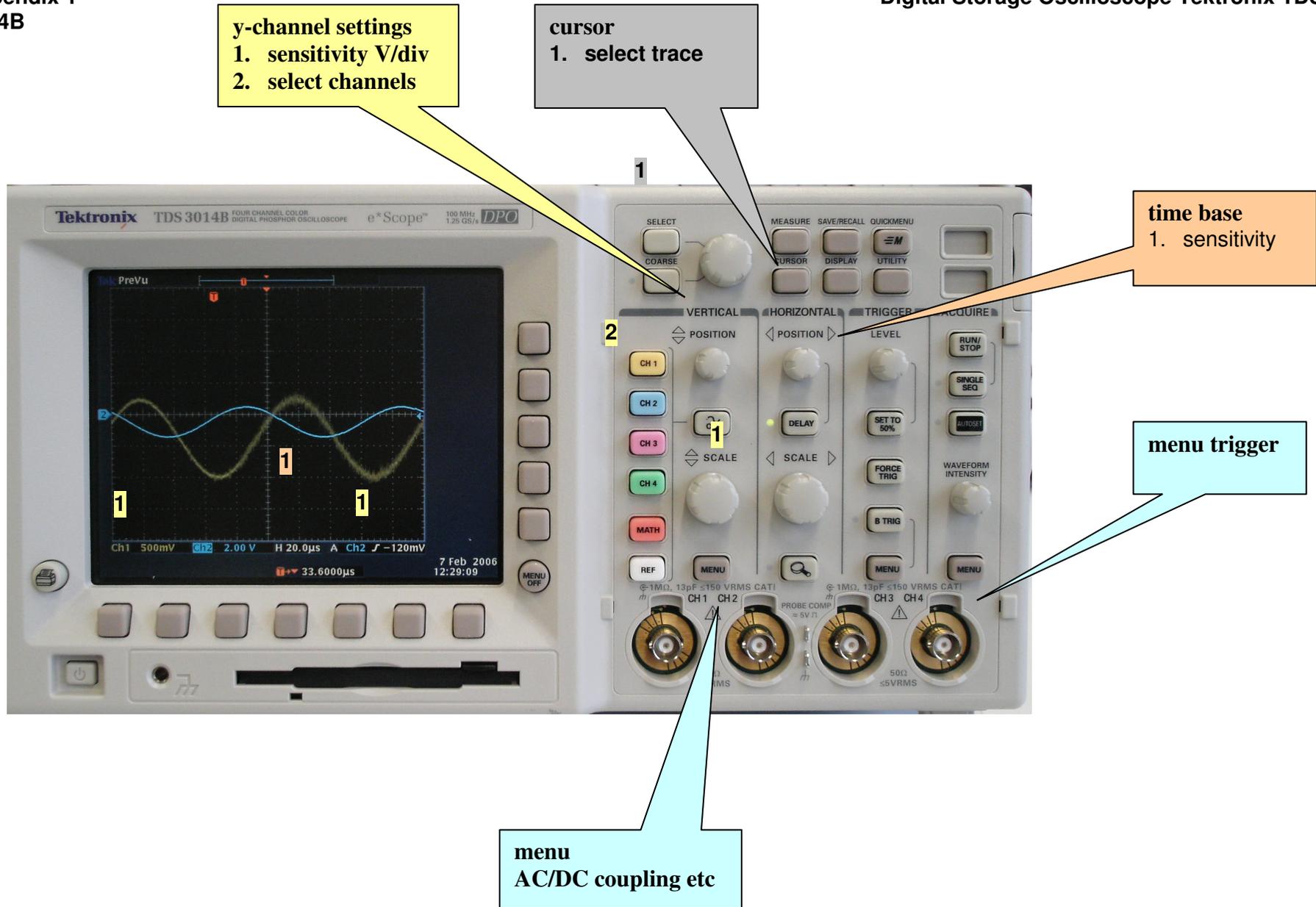
- Closing the switch S activates the low-pass filter. Display each channel separately first and then both simultaneously by the scope. (Attention: select DC-coupling in the channel menu.) Assure that the zero-line of both signals is in the centre of the screen.
- Set the frequency to f_0 and measure the time delay between both signals [CH1: $u(t) = 3.0 \text{ V} \sin(\omega t)$, CH2: $u_c(t)$] using the menus "Cursor" and the menu "Measure". Calculate the phase angle for the given frequency and compare the results with the theoretical value of the pre-calculated Bode plot.
- Determine the peak-to-peak voltage u_c and the phase angle between u and u_c for the following frequencies: $f = f_0/5, f_0/2, 2f_0, 5f_0$. Make a Bode plot of $u_c(f)$ in dB and $\varphi(f)$ on half-logarithmic paper. Determine the cutoff frequency graphically and compare it with the pre-calculated theoretical value f_c .

3.2 Filter response of triangle and square wave

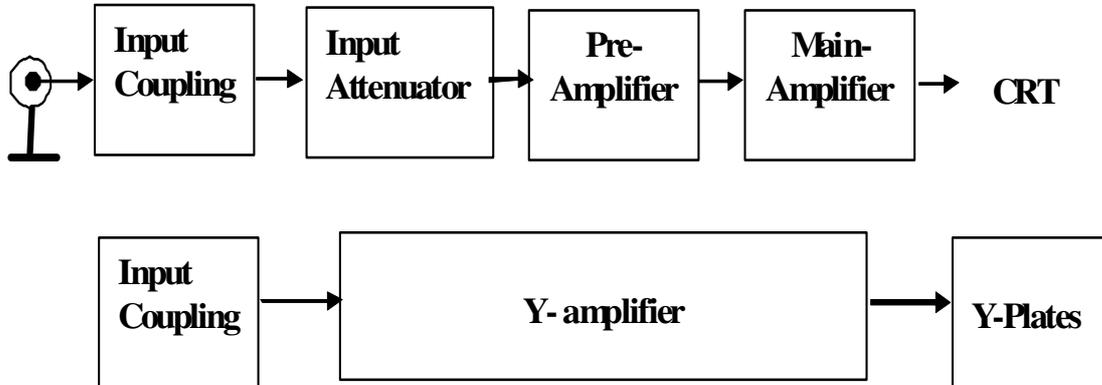
Generate a triangle wave and a square wave with $u_{pp} = 6.0 \text{ V}$ and $f = 1.0 \text{ kHz}$. Make a screen shot of both the original signal $u(t)$ and the filtered signal $u_c(t)$. Try to explain why the wave form of the signal output is different from the signal input.

Appendix 1
3014B

Digital Storage Oscilloscope Tektronix TDS



Appendix 2: Subsystems in a scope



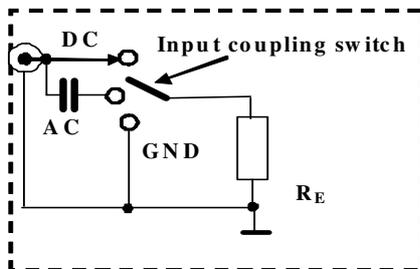
Vertical deflection system

Almost all amplifiers used in scopes are calibrated in terms of sensitivity rather than gain.

The actual attenuation or amplification is not important.

For special purposes and to give the scope more flexibility in the display of certain types of input signals an **input coupling selector** is provided for each channel:

Input coupling in a scope



In the **DC-position** (which is the most common one), the input signal goes straight to the vertical amplifier.

In the **AC-position**, a capacitor C blocks all dc and very-low-frequency signal components of the signal into the vertical amplifier. If for example an input signal consists of a DC component, U_{DC} , super-imposed onto an ac signal u_{ac} : $u(t) = U_{DC} + U_{AC}$ and only the AC component is of interest, then the AC-position is selected.

Warning! The blocked DC signals are not the only ones blocked. The input impedance [$R_E = 1\text{ M}\Omega$] forms a high pass filter with the capacitor C. The cut-off frequency is approx. 2-10 Hz depending on the value of C.

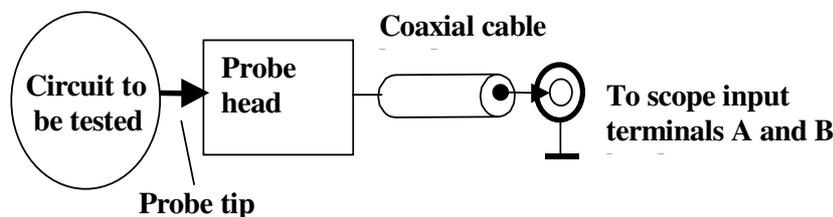
The **GND-position** of the input coupling switch grounds the internal circuitry of the amplifier. This is used to position the beam on the screen without having to remove the scope lead.

Other subsystems in a scope:

1) Dual trace features

It is often advantageous to be able to display two or more signals simultaneously on the screen. This can be accomplished by electronic switching of the input signals to produce separate traces. There are two possible modes:

the **ALTERNATE** mode, and the **CHOPPED** mode.



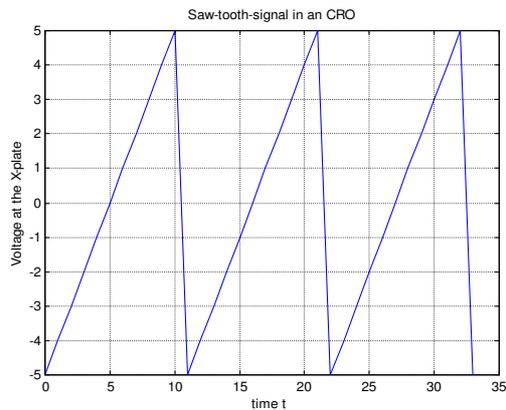
2) Oscilloscope probes

Oscilloscope probes should perform the simple task of sensing signals at their source and transferring them to the input of a scope without loading or disturbing the circuit under test. The simplest types of probes could be simply lengths of wire.

However, this type of probe is usually unsuitable because they pick up unwanted noise which is transferred to the scope input. A common probe is a passive voltage probe with no attenuation which consists of a co-axial cable. This type is capable of transmitting high frequency signals without distortion and external interference.

Basically oscilloscope measure voltages between the scopes input and ground and thus they can load the circuits to which they are connected. The typical input impedance of a scope is $R_E = 1.0 \text{ M}\Omega$.

Appendix 3: Time-base and Triggering system



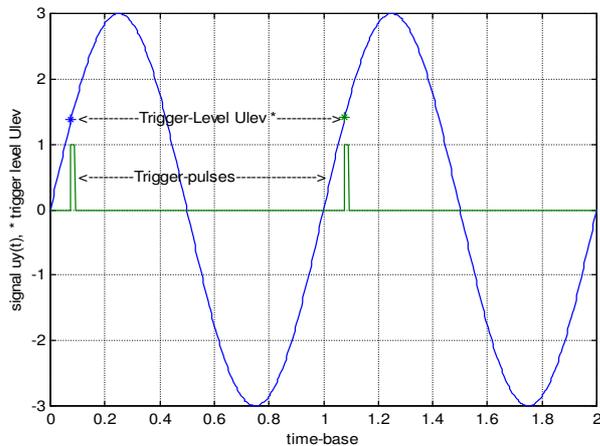
The most common use of the scope is to display a signal against time (**Y-t mode**).

To generate this type of display, a ramp voltage that causes a linear deflection of the beam must be applied to the X-plates. Additionally this voltage has to be repetitively applied to the horizontal plates and it must be synchronised with the periodic signal being displayed, such that a steady image appears on the screen.

This is the function of the **time-base circuit** which produces a sweep waveform (saw-tooth)

starting at t_0 . In practice, the left edge of the screen corresponds to a negative voltage U_{min} and the right edge of the screen corresponds to a maximum saw-tooth of U_{max} , so that the middle line of the display corresponds to a sweep level of zero Volts.

Triggering level U_{LEV} and –slope in a DSO



The **TIME/DIV** control on the front panel of the scope determines how much time it takes for the sweep waveform to move the spot one division. During the short time required for the spot to be returned from the right edge of the screen to the starting position, the beam has to be shut off (retrace blanking). This is achieved by additional circuitry manipulating the beam intensity.

To achieve a stable display for the swept waveform it is necessary to start at the same point of the signal waveform.

This is achieved by the triggering signal.

Each time a triggering signal meets a pre-selected **SLOPE** or a voltage **LEVEL** (U_{LEV}) condition, the pulse generator emits a pulse to start the sweep generator.

The point on the triggering signal at which the pulse generator emits a pulse is controlled by the **Trigger Slope** and **Trigger Level** switches on the scope.

The trigger slope switch allows to choose whether the slope of the triggering signal should be **positive** or **negative** when the pulse generator emits a pulse.

Similarly the trigger level switch determines the value (sign and magnitude) of the triggering voltage at which a pulse is generated.

When a sweep is triggered an LED is lit on the front panel. For different applications different trigger couplings are requested.