Name: ……………………..…. Date: ………………..

1. Using of oscilloscope and function generator

Set the signals on the function generator given by the practical lecturer! Check the adjusted signal with oscilloscope. Perform the measurements in voltage/time and frequency mode too, and also with cursors. Indicate the SI units of the measured values. **Use the first measuring circuit!**

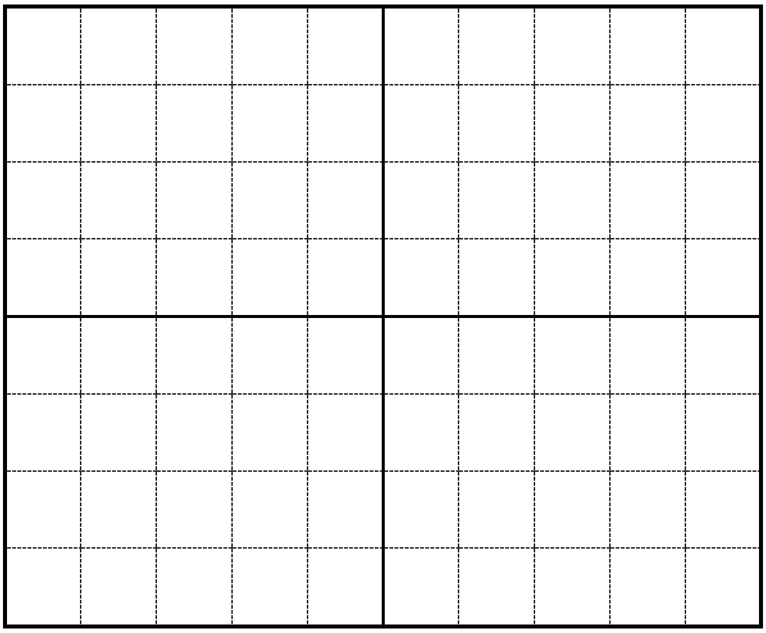
Signal	Signal*				
	f (frequency)*				
	U_p (amplitude)*				
	U_{off} (offset voltage)*				
	Measuring method*	voltage/ time	cursor	voltage/ time	cursor
Calculated	U_{min} (minimal voltage value of the signal)				
	U_{max} (maximum voltage value of the signal)				
Measured	f (frequency)				
	U_{min}				
	U_{max}				
	U_p (amplitude)				
	U_{off} (offset voltage)				

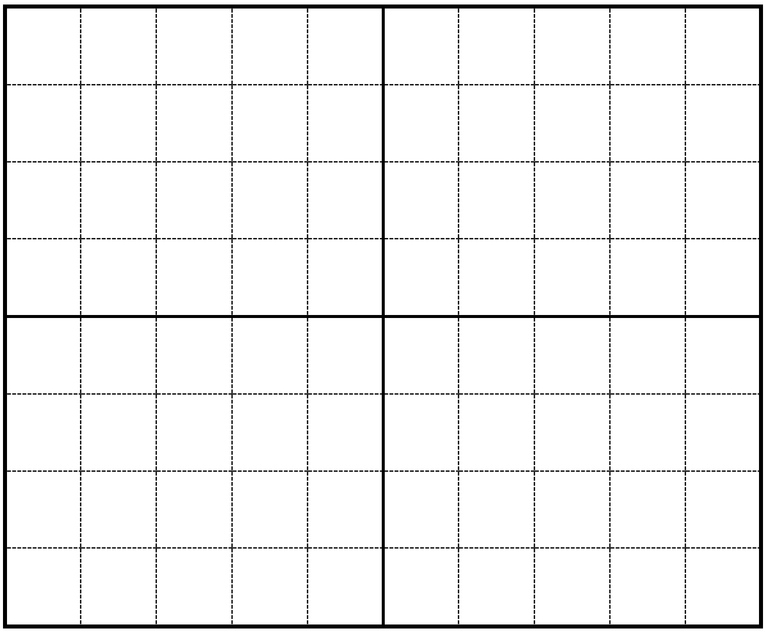
Set the signals on the function generator given by the practical lecturer! Check the adjusted signal with oscilloscope. Perform the measurements in voltage/time and frequency mode too, and also with cursors. Indicate the SI units of the measured values.

Measure the properties of the given rectangular signal. Draw the results which can be seen on the oscilloscope and mark parameters in the time-diagram.

Signal	Measuring method*	voltage/ time	cursor
	f (frequency)*		
	U_{pp} (amplitude)*		
	U_{off} (offset voltage)*		
Calculated	U_{min}		

	U_{max}		
Measured values	t_r (rising time measured between 10% and 90 %)		
	t_f (falling time measured between 90% and 10 %)		
	Overshoot (in percent, measured at the rising edge)		
	Settling time (interval range: ±5%, measured at rising edge)		
	Settling time interval range: ±5%, measured at falling edge)		





2. Measuring circuits

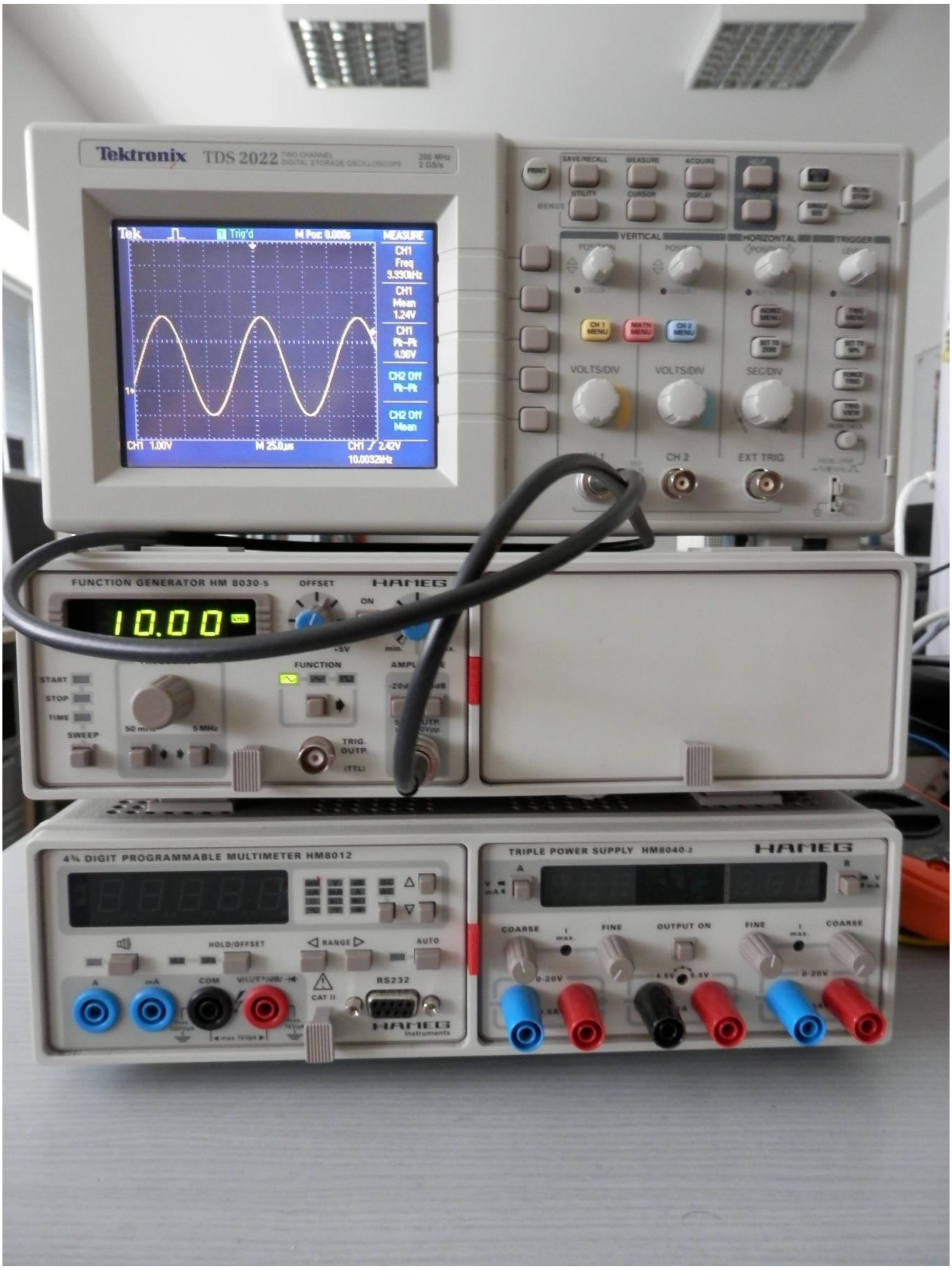


Fig. 1. First measuring circuit

Additional informations:

2.1. Basics

2.1.1. Electrical signals

The units which are forming in electrical circuits during operation are time functions and we called them signals.

The oscilloscope is capable to visualize the voltage, directly.

During visualize the voltage, the horizontal axis (X) is the time, and the vertical axis (Y) is the value of the voltage. If the voltage is a vertical line then the signal is not changing in time (constant), this is the direct voltage (DC voltage). If the voltage is increasing or decreasing linearly, that means that the changing has constant velocity. As steeper is this linear changing, then the changing velocity becomes higher, namely the slope of the signal.

2.1.2. Signals

Periodical and non-periodical signals

We called the repeating signals as periodical signals. Those signals, which are always changing in time (without repeating) are non-periodical signals.

The periodical signal satisfies the following equations:

$f(t) = f(t+T_P)$

t = continuous time

T_P = period of time, namely the lowest signal which satisfies the equation

unit of the period of time is second [s]

Reciprocal value of the period of time is the frequency:

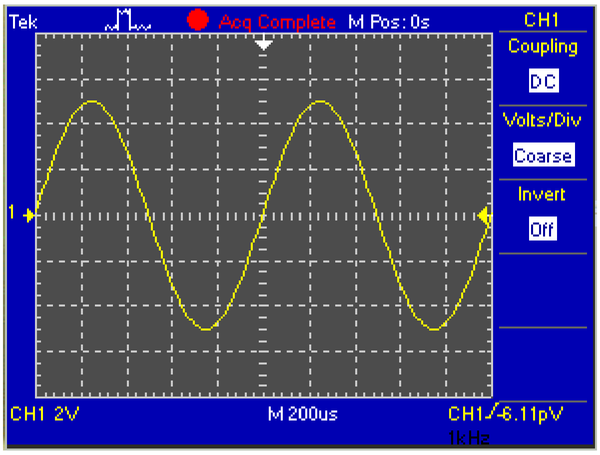
$\mathbf{f = 1/T_P}$,

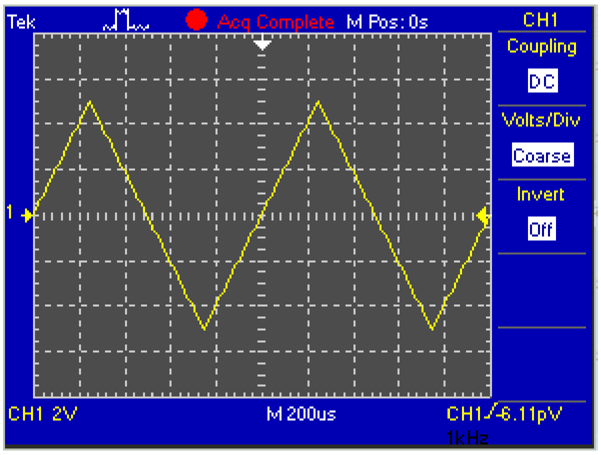
unit of frequency is Herz [Hz]

Periodical signal examples

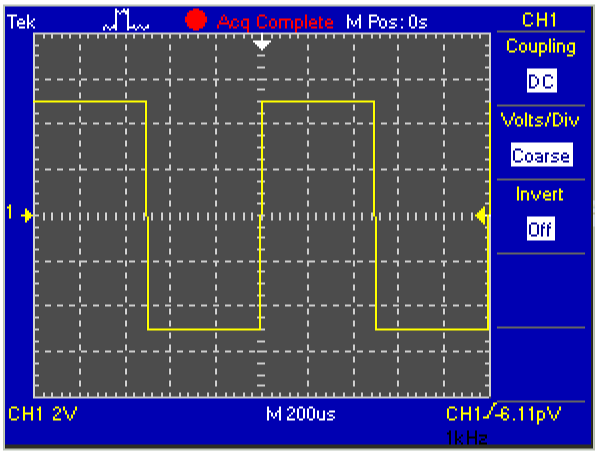
sinusoidal

triangle





rectangular



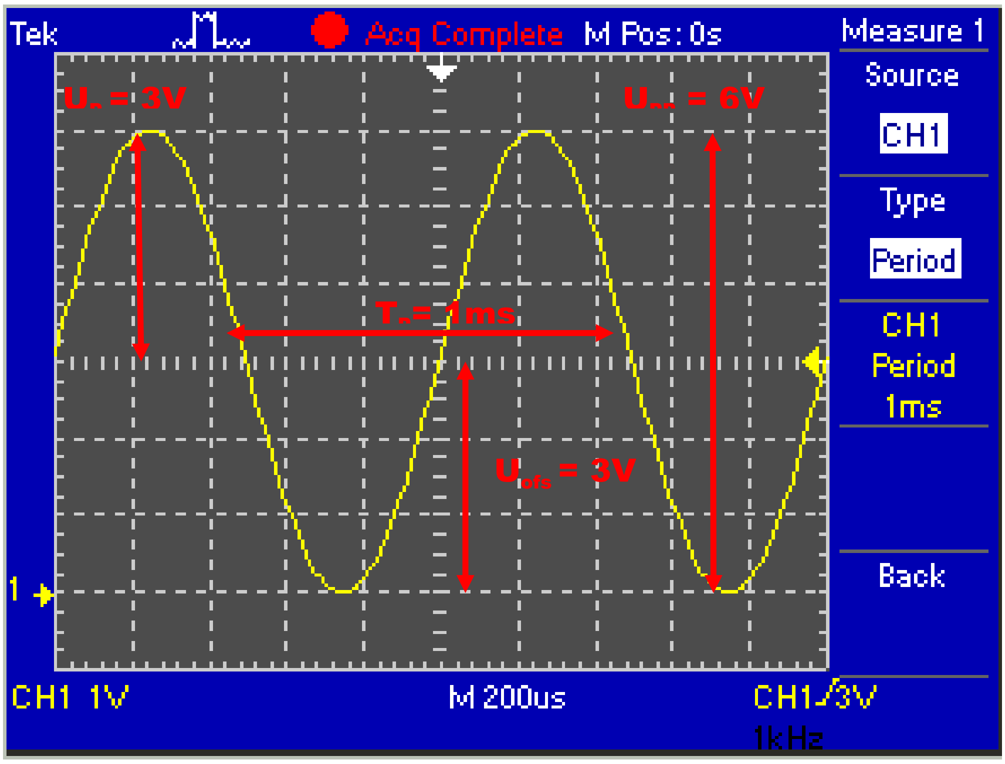
Mathematical form of sinusoidal signal's description:

$u(t) = U_P \sin(\omega t + \varphi) + U_{offset}$

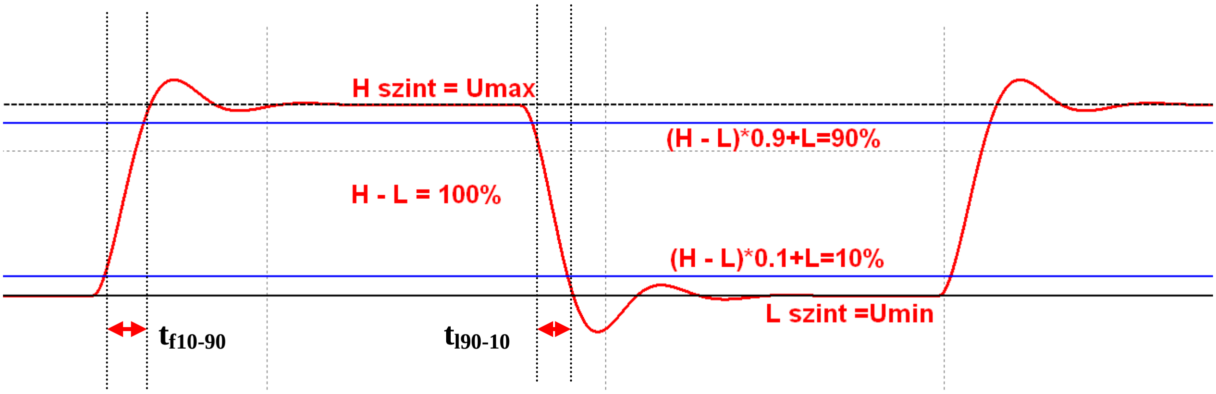
where:

u – **signal voltage**
t – **time**
U_P – **amplitude (maximum value)**
U_{PP} – **peak-to-peak amplitude = $2 \cdot U_P$**
ω – **angular frequency ($\omega = 2\pi f = 2\pi/T_P$)**
φ – **phase shift**
T_P – **periodic time of signal**
U_{ofs} – **offset of the signal (DC shift, ie. direct component)**

Example:


Tek
Acq Complete
M Pos: 0s
Measure 1
Source
CH1
Type
Period
CH1
Period
1ms
Back
U = 3V
U = 6V
T = 1ms
U_{ofs} = 3V
1
CH1 1V
M 200us
CH1 3V
1kHz

Properties of the periodic signal:



H szint (High level) = U_{max} : steady state voltage level after rising signal (bigger than L-level, but it can be a negative signal)

L szint (Low level)= U_{min} : steady state voltage level after falling signal (lower than H-level, but it can be a negative signal)

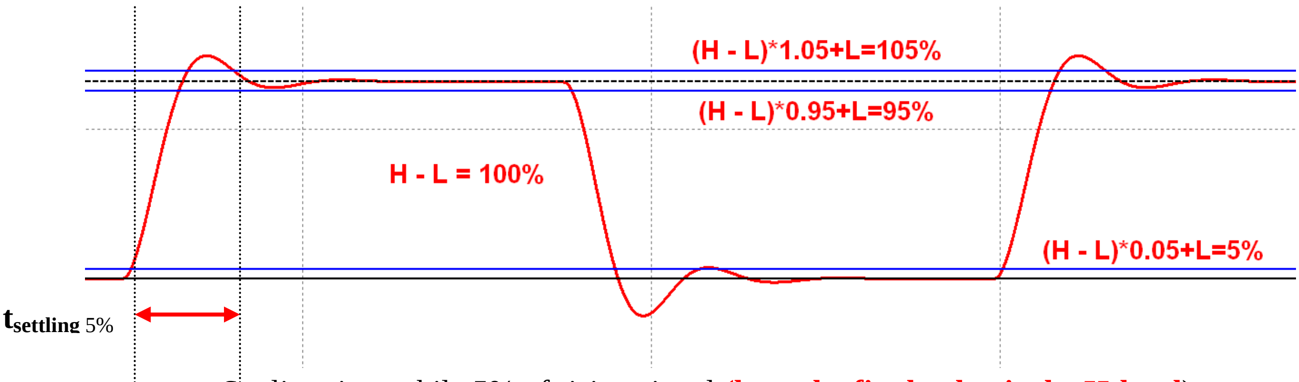
H – L = 100% : total changing range of the signal (obviously, this is always positive)

The typical voltage levels of impulse signal (5%, 10%, 50%, 90%, 95%, 105%) are interpreted to the total changing range of the signal

$t_{f10\text{-}90}$: rising time, the time while the signal runs up from 10% to 90% of the total changing range

$t_{l90\text{-}10}$: falling time, the time while the signal runs down from 90% to 10% of the total changing range

Settling time **at rising edge**



$t_{settling}$ $_{5\%}$: Settling time while 5% of rising signal **(here the final value is the H-level)**

necessary time if we use an ideal leap signal as the input of the circuit and the answer signal stays between a symmetric error range. Now, the error range means the **5%** changing of t **H - L = 100%** answer signal's changing (**±5% tolerance band of the H-level final value**). Other error band can be given.

Without input signal, we can start the measuring of the settling time when the rising input signal reaches the 5% value.

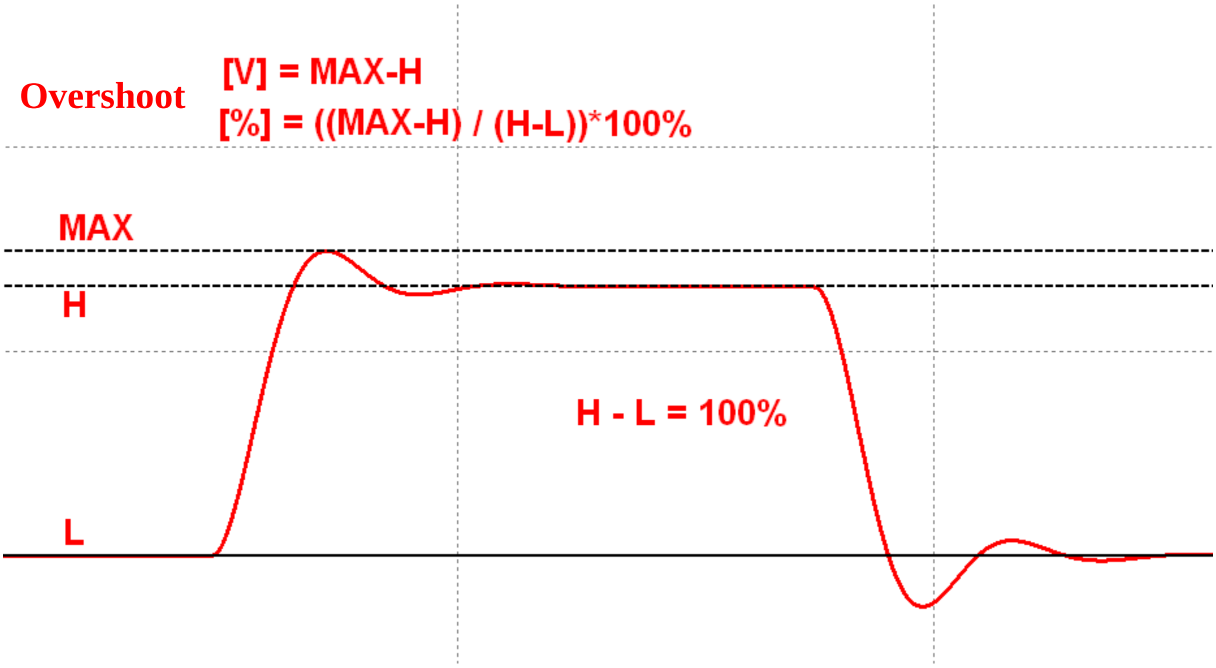
Measuring of settling time is over, when the first time the signal enters to the tolerance level of the final value after rising and then not exits from it.

"Fisk rule": usually the signal enters to the **±5%** tolerance level at the second track

$t_{settling\ 5\%}$: 5% settling time at **falling signal** (here **the final value is the L-level**)

Almost the same as the rising settling time, the difference here is that the final value is the L-level and the time measuring starts at the 95% of the

Overshoot at rising signal:



Impulse width and period of time