1. Equipment used in applications with microcontrollers

1.1. Purpose of the work

This chapter aims to familiarize the reader on the one hand, with the instrumentation used during the works in the laboratory (the function generator, oscilloscope and logic analyzer), and on the other hand, with the ZK-12-B development board.

Skills learned by the end of this laboratory by the students should be:

- generating specific signals with the function generator;
- measurements using the oscilloscope;
- differentiate between the use of a logic analyzer and an oscilloscope;
- identify sections and learn the facilities offered by ZK-12-B development board.

1.2. Function generator

TG120 generator may supply a variety of signals with frequency from mHz up to MHz. TG120 generator facilities are detailed below by presenting the front panel in Figure 1:

1. Frequency: button that allows you to change the frequency of the generated signal;
2. Range Multiplier: frequency multiplier;
3. Function: button that allows you to change the type of signal supplied;
4. Symmetry: button with variable symmetry which involves generating variable pulse signals and the saw-tooth, thus adjusting the duty cycle;
5. Amplitude: adjust the amplitude of the generated signal;
6. DC Offset: translation of the signal relative to zero;
7. Sweep In: additional function for generating a signal whose frequency is constantly changing;
8. Aux Out: auxiliary output which provides a fixed level of voltage from 0 to 5V, able to work with TTL or CMOS loads;
9. Main Out: main output with a peak-to-peak voltage of 20V maximum;
10. Buttons 0dB, -20dB: are used in combination with Amplitude button to obtain amplitude peak-to-peak voltage of up to 10 mV;
11. Power: Power LED.

Figure 1 – TG120 function generator

1.3. Oscilloscope

The oscilloscope is a device that allows the display of the instantaneous value of the voltage *v(t)* versus time as well as quantitative measurement of voltage and time on this waveform. The paper describes Tektronix TDS1001 digital oscilloscope, currently present on the laboratory working tables.

1.3.1 Tektronix TDS1001 oscilloscope

Figure 2 shows the front panel image of the oscilloscope. The oscilloscope interface contains the following components (Tektronix, 2006):

1. **Oscilloscope display :** consists of image display area (screen graticule), control menus area (right graded area) and to display the parameters (above and below the grade area).

Figure 2 – The front panel of the oscilloscope

Figure 3 – Display of the oscilloscope

Graded area consists of N_x = 10 divisions on horizontal and Ny = 8 divisions on vertical, and is used to display the image. Besides this it displays various parameters of the oscilloscope or of the waveform depending on working mode selected. In Figure 3, the most relevant parameters are:

(1) the type of acquisition (normal, average, etc.);

(2) Trig'd = triggered = synchronized ;

(3) The timing of the trigger; can move using the HORIZONTAL POSITION control;

(5) Trigger level;

(6) Identification of paths 1 and 2;

(7) Cy values on the two channels;

(8) BW= Bandwidth Limit;

(9) Cx values for the main time base(Main);

(10) Cx values for the secondary time base (Window), only when it is used;

(11) Trigger source;

(12) Trigger front;

(12) The measured frequency of the signal.

2. Control buttons: allow changing the control fields displayed on the oscilloscope. These buttons are called *softkeys* because these fields change depending on the menu or mode selected.

3. The adjustments of channel 3 (vertical adjustments): shown in Figure 4 (a), with a set of separate adjustments for each of the two channels of the oscilloscope.

POSITION: allows the displacement vertically

VOLTS/DIV: button to change the coefficient of vertical deflection. Its value is shown in the bottom image (display the parameters area) as: CH1 2V, which is equivalent to CH1 = 2V / div.

CH1 MENU: pressing button results in the display in menu control area of the fields for verifying the vertical axis display for channel 1 (CH1). The following fields are displayed on the screen:

- **Coupling:** select the type of AC / DC / Ground coupling(alternating current / direct current / zero level)

Figure 4 – a) Adjustments channel Y b) Adjustments channel X

- **BW Limit:** limit the bandwidth to 20MHz instead of 40 (option ON / OFF)l
- **Volts/Div:** calibrated adjustment (Coarse) or not calibrated (Fine). For th calibrated adjustment the coefficient of the vertical deflection can only take discrete values of type Cy = {1,2,5 type} x10kV / div.
- **Probe:** type of probe used (x1 / x10 / x100 / x1000). The value must be the same as that used in the signal probe.
- **Invert:** reverses the image when it is ON.

MATH MENU: allows the application of mathematical functions on signals (addition, subtraction, Fourier transform).

4. **Menus for digital functions:** pressing a button in this area, detailed in Figure 5, results in the display of a menu of specific functions of digital oscilloscopes (save, measurement, acquisition, cursors, utilities, display). Of these presents interest **DISPLAY** menu that contains the control field **Format** and buttons **RUN / STOP** and **SINGLE SEQ.**

Figure 5 – Digital function menu

DISPLAY

- **Format:** select the functioning in operation mode y(t) (**YT**) or x(y) (**XY**)

RUN/STOP: In **RUN** mode oscilloscope continuously acquires signal. In mode **STOP** acquisition is off , the image displayed is the last acquisition before pressing the STOP button.

SINGLE SEQ: The oscilloscope acquires a single image (corresponding to a single run on the screen) and then waits a new pressing on the button. Pressing button acts as **RESET**.

5. Adjustments for the X channel of the oscilloscope (horizontal adjustments): are shown in Figure 4 (b), are common to both channels of the oscilloscope.

- **SEC/DIV:** Adjusting horizontal deflection coefficient Cx. Value is displayed in the bottom of the screen in the form of M 10 ms, which is equivalent to Cx = 10 ms / div.
- **HORIZ MENU:** Displays the menu for controlling the display horizontally
    - **MAIN:** Select the display of the image for the main time base (the normal working mode).
    - **Window zone:** Selects the display of picture for a portion of the image that is displayed horizontally.
    - **Window:** Setting the time window for the second time base.
    - **Trigger Knob:** allows you to select the LEVEL button in the button TRIGGER area: default is adjust the trigger level; when selecting retention time adjustment (Holdoff), LED lights under the LEVEL button.
- **POSITION:** moves the image horizontally.
- **SET TO ZERO:** restore the image to its original position (eliminates horizontal displacement).

- **Adjustments for synchronization circuit (TRIGGER):** For TDS 1001 oscilloscope, the triggering corresponds to the middle of the screen.

    - **LEVEL:** allows you to adjust the trigger level and retention time (Holdoff)
    - **TRIG MENU:** menu activation for synchronization control (trigger).

    Contains the following control fields:

    - **Type**: select the type of synchronization, namely **Edge** (synchronization signal front), **Video** (synchronization after a video signal), **Pulse** (synchronization after pulses).
    - **Source:** synchronization signal source (**CH1, CH2, EXT, EXT/5, signal AC**)
    - **Slope:** front type, positive or negative (**Rising/Falling**)
    - **Mode:** synchronization mode (Auto/Normal):
        - **AUTO**: if the trigger conditions are met, the oscilloscope automatically generates, after a time expires, a trigger signal for the display. In this way, in the absence of the

input signal there is a horizontal line on the screen, which is the zero level. *This is the default mode in which it works unless otherwise specified!*

- **Normal:** in this case the display is triggered only if the trigger conditions are met. The oscilloscope does not display any image. Trigger level can be also adjusted outside the limits of the signal, there is the possibility that, although the oscilloscope input signal is applied, the signal is not displayed because the conditions for synchronization are not met.

- **Coupling**: The coupling mode of the synchronization signal: **AC** - removes the continuous component from the synchronization signal. **DC** – synchronization signal has DC component. **Noise Reject** - removed noise from synchronization signal. **HF REJ** (High Frequency Reject) - removes high frequencies from the synchronization signal. **LF REJ** - removes low frequencies from the synchronization signal.

1.3.2 Operating modes and adjustments

1. Mode y(t): in this case, at Y input a voltage is applied, the image represents the time course of voltage.

Horizontally, the block ensuring the performance of image is called the **time base**; length corresponding to the length of a division on the screen is adjustable from the outside with Cx button (horizontal deflection coefficient). It is graduated in units of time per division. It applies the following relationship between the number of divisions occupied by some event and time:

$$Tx = Nx * Cx$$

Example 1: A period of a sinusoidal occupies on the screen 4.2 divisions horizontally, and time base is in the position Cx = 5 ms / div. Sinusoidal signal period is

$$Tx = 4.2 \text{ div} * 5 \text{ ms/div} = 21 \text{ ms}.$$

Vertically Uy voltage is applied from the outer terminal Y. Similar to the reading on X, one can read the value of a voltage Uy occupying Ny vertical divisions on the screen with the relationship:

$$Uy = Ny*Cy$$

Cy is called the coefficient of vertical deflection. Values of Cx, Cy are called calibrated. When not desired voltage readings on the screen by counting divisions, but framing signal within certain limits in order to observe, shooting or screen printing, one can pass Cy at uncalibrated values (VOLTS / DIV on COARSE or FINE version). Some oscilloscopes can fine tune Cx, but usually in this case can not read its value.

- **Mode y(x):** in this case apply external voltages Ux and Uy. Time base is no longer used, oscilloscope being passed in XY position.

Figure 6 – Lissajous figure

If the two signals are periodic with Ty = MT_0 and Tx = NT_0 (M, N integers) at intervals T=MNT_0, Ux (kT) and Uy (kT) have the same values (integer k), and hence Dy and Dx . Therefore, the spot describes a closed curve, called Lissajous figure (Figure 6).

3. Synchronize the oscilloscope

A stable picture on the oscilloscope screen is called synchronized (triggered). Physical meaning is the following: when two successive views of a periodic signal are made from the same point of time (relative to time), the two views will overlap perfectly, and as well the views from subsequent periods, the eye perceives one stable image (although, in fact, we have always a new image overlapping the previous one). An example where a rising edge is displayed is given in Figure 7 (b). But if the display picks up the signal from other point of time, images differ, and the eye will perceive many different and overlapping images - Figure 7 (a). In this case the image is called unsynchronized (untriggered)

Figure 7 – a) unsynchronized image b) synchronized image

To obtain a synchronized image select a *level* and a *slope* of where you want to start displaying the image. These are the *settings for synchronization*.

Example 2: We have the sinusoid of period T in Figure 8, of amplitude 3V, adjustment Cy = 1 V / div. Choose the 1.5 V trigger on rising edge. This trigger condition occurs once per period and corresponds to 1,2,3,4 moments on Figure 8. The first trigger (1) determines the beginning of the image display. How much of the image is displayed depends on the relationship between T and Cx but not essential to this discussion. Important to note is that, until it takes up all 10 divisions horizontally (time 10Cx), the trigger is inactive. Thus, the moment (2) does not start a new display, as is not over current display (note that we are only at 6.2 divisions 10). After it finished image display (thickened portion) next is a time t1 when the oscilloscope does not display anything and expects a new trigger. It comes at moment (3), and the process is repeated. It is noted that image 2 is identical to Figure 1, that is synchronized.

A situation in which the image should be unsynchronized is if it would be choosen level of 3.5V, higher than the amplitude. Oscilloscope doesn't detect any trigger. In this case there are two possibilities:

Figure 8 – Synchronization

Figure 9 – Signal with holdoff

1) in NORMAL mode (from trigger menu), without trigger nothing is displayed. The screen remains blank. 2) in AUTO mode (most preferred) oscilloscope waits a while and then automatically start to display the image. This image may start anywhere, not from (1). Afterwards waiting a while longer displays an image, but the start time will be different. Will see more overlapping images without temporal relationship between them, so unsynchronized.

Another concept associated to synchronization is HOLDOFF setting. It is time from end of the display to a new trigger (default is 0 or very small). During the holdoff (retention) oscilloscope ignores any valid trigger pulse. It can be used in more complex waveforms to "choose" a certain trigger point farthest.

Figure 10 – Signal without holdoff

Example 3: We have the train of impulses in Figure 9, synchronization on positive front, middle level. We want to view only the 3 pulses, not the 4th (of greater length). Holdoff time is chosen as shown (from end of the image at least over moment 4). In this case, moment 4 will be ignored and a new image will begin with trigger 5 identical to the first. But if not used holdoff, we get image in Figure 10, impulse 4 overlapping the 1 impulse.

1.4. Logic Analyzer

In a digital system is often desirable to monitor the logic states of several signals to determine if the system works as expected. A logic analyzer captures and displays the logic states of selected signals, over a period of time, allowing a designer to observe and study these signals. Logic analyzer probes are connected to points where signals are to be monitored, and the states of these signals are sampled and captured over a period of time. Sampling is performed at discrete intervals on transitions of a clock signal internally or externally. Signal status of each line is interpreted as 0 or 1, depending on the voltage level on the line, namely whether it was above or below a threshold value at the time of sampling. Captured states are then stored in memory, from which all or part of the data can be displayed as a chart (Janatek, 2009).

When analyze or troubleshoot the circuit, elements of interest are related to the state of the system before, during and after specific events. Typical events of interest include writing data to an external input-output equipment, reading an instruction from a particular memory location, execution of instructions that appear to behave incorrectly, triggering an interrupt, etc. A logic analyzer assists the designer in this analysis by observing and storing the signal that results in such an event, but also during and after its occurrence. Interest event is called trigger condition ("trigger") and is defined by a set of values of signals. Logic analyzer monitors the status of these signals and detects when the selected signals satisfy the condition of trigger.

1.4.1 Main window

Janatek logic analyzer has a sampling rate of 200 MHz on 16 channels simultaneously. The main window is shown in Figure 11.

Figure 11 – The software interface on Janetek logic analyzer

1. **“Normalise channel order” button**: if the channel order was changed, this button can normalize the channel order to the original position 0-15. A channel is moved by moving the associated number to a new position.

2. **“Show channels” button:** activates dialogue window "Show channels", used to stop those channels which are not intended to be used in the main window.
3. **"Set-up" button:** activates dialog box "Set-up" used to set trigger options, sample rate, threshold voltage etc.
4. **"Capture" button:** is used for capturing data.
5. **"Jump to" buttons:** this buttons will cause the perspective of the screen to move to trigger (T), the cursor line (x), the cursor line Y (Y), the cursor line Z (Z).
6. "Stop" button: will cause shutdown of operation triggered by Capture button.
7. **"Trigger" button:** forces a trigger during Single or Continuous Conditional captures while the analyzer is waiting to see a trigger.

8. **The surface of drawing the stored data**. It can measure different time values for the obtained graphs by pressing left click in first measuring point (**cursor X**) and right click on the second point (**cursor Y**). Shift + left-click facilitate the emergence of a new measuring point (**cursor Z**). Differences between the various points are found in the **Set-up Statusbar** (see below this part of the screen).
9. **The "Data Scrollbar":** is used to move left and right through the captured data and the zoom in-zoom out of the data obtained.
10. **Catch Type:** indicates the type of catch on which the analyzer is set: Single, Unconditional Continuous , Conditional Continuous, Logger.
11. **The sampling rate**
12. **The threshold voltage**
13. **Post Trigger buffer**
14. **Capture extended time**
15. **The trigger condition.**

Example:

0u: (Channel 0, up) – a trigger will occur on the rising edge of channel 0.

5d: (Channel 5, down) – a trigger will occur on the falling edge of the channel 5.

14c: (Channel 14, change of state) – a trigger will occur on the rising or falling edge of channel 14, in other words, if this channel will change its state.

Pattern OR 0u – a trigger will occur if the pattern condition is met or on channel 0 will show a rising edge (whichever occurs first). Condition pattern appears in the pattern **(16)** part of the main window.

Pattern AND 0d – a trigger will appear when a falling edge occurs on channel 0 and the pattern condition is valid.

0c THEN pattern – the expectation that the first condition is true (channel 0 will change state) will be indicated by the fact that the LED **(17)** will be purple. When the first condition is fulfilled, the LED indicator will turn green indicating that they expect the fulfillment of the second condition.

Internal – will take place an Unconditional Continuous capture, indicating that trigger is internally forced.

18. **Status line:** used for general messages**.**

1.4.2. Dialog windows

1. Set-up

Set-up window contains two pages, trigger and general(Figure 12).

Figure 12 – Setup Window

- **Trigger page:** contains all the options needed to specify the conditions under which the analyzer will trigger.
    - *Trigger conditions* - conditions of front and model (pattern) can be connected with another front or pattern through variants None, Or, And, Then:
        - *None:* trigger operation is only allowed on the front or pattern.
        - *OR (Condition 1 OR Condition 2):* Trigger operation will appear either meeting the fulfill of Condition 1 or Condition 2, depending on which condition has the first occurrence.
        - *AND (Condition 1 AND Condition 2):* Trigger operation will occur when there is an front, while the pattern provided is valid. Pattern option for the channel for which front is set, must be set to "do not care".
    - *THEN (Condition 1 THEN Condition 2):* Logic analyzer will wait first to appear Condition 1. After condition 1 appeared, we expect Condition 2 to appear. After appearing Condition 2 capture will end and the data will be displayed.

Edge up
Edge down
Change of state*
Pattern (Any duration)
Pattern < Duration (glitch capture)
Pattern > Duration
Pattern OR Edge up
Pattern OR Edge down
Pattern OR Change of state
Pattern AND Edge up
Pattern AND Edge down
Pattern AND Change of state
Pattern THEN Edge up
Pattern THEN Edge down
Pattern THEN Change of state
Edge up THEN Pattern
Edge down THEN Pattern
Change of state THEN Pattern

Figure 13 – Trigger conditions

When set to Unconditional Continuous option, trigger operation will be disabled automatically, the data being captured and displayed at regular time periods.

If Conditionally Continuous option is selected, the trigger condition will remain active, so the screen will display the information only after a trigger condition will occur. If trigger does not appear, you will see a message "waiting for trigger". This feature is extremely useful for inspecting data transmitted continuously (eg serial data lines). An overview of the trigger conditions is given in Figure 13. Any of these conditions can be combined with the capture option Conditionally Continuous.

- *Edge/Pattern* settings - Option for each channel is changed by left-click in the rectangle associated to channel. Edge Trigger can take values: deactivated, rising edge, falling edge and state change. Changing status will be achieved when the trigger is set to low-to-high transition (rising edge) or high-to-low (falling edge). The pattern of bits that can create a trigger, can be made of X-type states "do not care", 0 "low" and 1 "high." In this case a trigger will occur when all channels marked with 0 are "low" and all marked with one are "high". Channels marked with X are not considered.

- *Pattern duration* - A condition of pattern can be set to appear only if a pattern is valid for a certain period of time.

- **General settings page**

- *Clock signal source*

  1. *Internal* – is the sampling frequency of the 16-channel analyzer.

  2. *External* – clock signal must be applied by the user on channel 15.

- *Threshold level* – the signals are compared to a fixed voltage. If the signal voltage is less than the threshold voltage, the sample will be considered as 0 if it is greater than the threshold voltage, it will be

considered as one.

2. Show Channels window

It is useful to change, activate and deactivate various channels. Renaming a channel is done by left-click on a channel name.

3. Signal Info window

It is useful for storing information relating to the data captured.

1.4.3. Example of use of logic analyzer

Connect braided wires(GND) of logic analyzer to GND of test circuit. Connect the probes to the test points. Set the desired parameters in Set-up window (which appears when operating the Set-up button). Operate the Capture button. Measurements can be made using cursors.

1.5 ZK-S12-B board

ZK-S12-B Starter Kit is designed for developing applications based on microcontroller family with 80-pin Freescale HCS12 (X) . ZK-S12-B board contains the following sections (see Figure 14):

Figure 14 - ZK-S12-B board sections

1. Section **MCU**, which in turn is composed of::
    a. The MC9S12DJ256 microcontroller (80-pin);
    b. ZIF Socket for microcontroller;
    c. A portion of connectors to access the input / output pins of the microcontroller;
    d. Three clock signal sources: an area for a module clock signal, a 16MHz crystal in configuration

Pierce and a 16 MHz crystal in Colpitts configuration, selectable via jumpers **"OSC SEL"** and **"XCLK = 0"**;

e. The connector (jumper) "**XFC SEL**" to select the type of RC filter;

f. Two connectors ("**VRH SEL**" **and** "**VRL SEL**") which set the voltage reference High or Low for Analog / Digital converter of the microcontroller;

g. Connector "**VREGEN**" that enables / disables the voltage regulator;

h. Two connectors ("**MODA = 1**" **and** "**MODB = 1**") that define the operation of the microcontroller.

2. Section **"Power Supply"** that supports 12V input. Connector **"VDD SEL"** allows to the microcontroller two supply voltages VDD: 3.3V or 5V. *Always connect the board to the computer's USB port only after the board was fed and control LED lights!*

3. Section "**USB TO BDM INTERFACE"** which allows the PC to communicate with the microcontroller through a USB interface. When using an external debugger circuit, this section should be disconnected by removing connectors **"RESET ENA"** and **"BKGD ENA**".

4. A **BDM connector** for debug operations

5. Section **"Reset"** contains Reset button corresponding to the terminal connected to the microcontroller.

6. Section "**Inputs**" which contains:

   a. 4 buttons connected to PP0, PP1, PP2, PP3 of microcontroller;

   b. 8 **DIP** switches (Dual-In-Line Package) connected to the T port of the microcontroller;

   c. A potentiometer which is associated with a connector to connect / disconnect from PAD00.

7. Section **"Outputs"** contains 8 LEDs with 8 connectors for connecting / disconnecting the LEDs on port B of the microcontroller.

8. Section **"RS-232"** provides two RS-232 channels connected to the microcontroller serial communication interfaces, SCI1 and SCI0. Each RS-232 channel may be configured as a DTE (Data Transmission Equipment) or DCE (Data Communication Equipment) through connector "**RS-232 x DTE/DCE SEL**". RX and TX lines of the microcontroller used by the RS-232 lines are shared with RX and TX of module LIN (Local Interconnect Network). You can use connectors "**RXDx SEL**" **and** "**TXDx SEL**" in "SERIAL SETTINGS" to determine whether or not RX and TX lines are used related to RS-232, LIN or microcontroller.

9. Section **"LIN"** comprises two LIN modules, each being capable of speeds up to 100 Kbps. Each node can be configured as master via connector "**MASTER NODEx ENA".** Sharing RX and TX lines is done as in Section 8.

10. Section **"SERIAL SETTINGS"** contains four connectors which allow SCI1 and SCI0 interfaces.

11. **"CAN"** section contains two fault tolerant CAN modules. TX and RX signals related to CAN0 and CAN4 can be disconnected from the microcontroller pins by removing connectors "**CANx TX ENA**" and "**CANx RX ENA**".

12. Development Area, provided with some SMD.

1.6 Development of the work

1.6.1 Automatic settings of the oscilloscope

It is generated using the sine wave function generator (**Function** button) of maximum amplitude (**Amplitude** control), frequency of 1 kHz (**Frequency 1.0, Range Multiplier 1 kHz** control). Connect OUTPUT 50Ω output of the generator to channel 1 of the oscilloscope using a cable.

Press oscilloscope **AUTOSET** button. Press **CH1 MENU** to display channel 1 settings (from repeated pressings, channel 1 is successively turned off and on).

What Cx value the oscilloscope automatically set (M indication at the bottom)? Measure the period counting Nx number of divisions of a period and applying the formula T = Cx * Nx. Calculate the frequency and verify it is equal to generator. Worksheet be completed.

Repeat for vertical adjustment. What is the vertical deflection coefficient Cy? (**CH1** indication in the lower left). Counting Ny divisions vertically and applying the formula U = Ny * Cy, measure amplitude. Measure the peak value and the peak-to-peak. Worksheet be completed.

1.6.2 Automatic measurements using oscilloscope

Check measurements using **MEASURE** button on the oscilloscope. You can program up to five measurements on the 5 softkeys. Press a softkey, select **SOURCE=CH1** and from **TYPE** are pursued: **Freq** (frequency), **Period, Mean** (average), **Pk-Pk** (peak-to-peak value), **Cyc RMS** (Cycle RMS = effective value), **Min, Max** (positive and negative peak value). Compare the values with the ones determined in section 1. Note in the Worksheet.

1.6.3 Study and adjustment of synchronization

For sinusoidal signal generated at 1.6.1, adjust the synchronization voltage (threshold) from the **TRIGGER LEVEL** button symbolized on the screen by arrow 5 in Figure 3. Note that moving the arrow below / above the signal image is not synchronized. Default sync level corresponding on horizontal to the middle of the screen (arrow 3 in Figure 3). To facilitate observation of the trigger, move the arrow 3 of rotating **HORIZONTAL POSITION** control until it reaches just to the left of the screen to 0 division. Fine tune button until the precise moment the arrow 3 reaches the edge and becomes from vertical, horizontal.

Now notice that the sinusoid starts (left) at the height that where is tge arrow 5 in right, ie the trigger level marks the beginning of the display image. To easily observe this, press and hold the button **TRIG VIEW** while turning the **TRIGGER LEVEL** so arrow 5 turns into a horizontal line. Check that this line intersects the left point where the image begins.

From **TRIG MENU-> Slope** change the value of front from Rising (front +) to Falling (front -). Notice

that now the image starts on the decreasing slope of the sinusiod. Draw the image obtained on the worksheet.

1.6.4 Study of a rectangular signal. Measurements using cursors

Generate a symmetrical rectangular signal (**Symmetry** button in middle position, 50%), with peak-to-peak amplitude Ai = 16V, 1kHz frequency.

Modify the signal from generator to make unsymmetrical, with 25% duty cycle. Seek obtain the correct changed signal using the two cursors by following the indication "delta", ie the time difference between the two cursors.

In this sense press **CURSOR-> Type Time**. It is noted that the two LED under the vertically position buttons light, signaling their new function, ie moving the cursor. Move cursors to the extremes of ranges that need measured (indication "delta" that is the time difference between the two cursors): for the first signal with factor 50% and, after modification of Symmetry for the second signal. Seek the correct value at the indication "delta". Note the value of "delta" and draw the signal obtained in Worksheet.

Amplitude is measured by checking the value **CURSOR-> Type Amplitude**.

Turn off the cursors using **CURSOR-> Type Off.**

1.6.5 Study of logic analyzer

Write in Worksheet the differences between logic analyzer and oscilloscope.

1.6.6 Study of ZK-S12-B development board

Write in Worksheet the periphery related to INPUTS and OUTPUTS section.

1.6.7 Questions

1. The control named Volts/div is used to:

    a.Scale a waveform vertically

    b.Position a waveform vertically

    c.Attenuation or amplification of an input signal

    d.Set the number of volts represented by each division

2. The trigger performs operations::

    a. Stabilize the waveforms that are repeating on the screen.

    b. Captures waveforms.

    c. Marks a point of acquisition

    d. All previous versions.

3. Measurements on which the oscilloscope is used most often are:

a. Measurements of time and frequency.

b. Measurements of time and voltage.

c. Measurements of voltage and phase shift.

4. After attaching an oscilloscope probe to a test circuit the oscilloscope screen is blank. In this case you should:

a. Check that the intensity of the display button is on.

b. Verify that the oscilloscope is set to display the channel to which the probe is connected.

c. Set the trigger mode to auto.

d. Check the probe: GND connection and the possibility to have a malfunction.

e. Check the setting of the oscilloscope to trigger on the input channel used.

f. All previous answers.

5. The logic analyzer is used to:

a. Monitoring logic states of several signals.

b. Making measurements using cursors.

c. Measurement of impedance.

1.7 Abstract of the work

- The function generator may provide a variety of signals with frequency of mHz up to MHz.
- The oscilloscope is a device that allows the display of the instantaneous value of voltage *v(t)* versus time and quantitative measurements of voltage and time on the waveform.
- A logic analyzer captures and displays the logic states of selected signals, over a period of time, allowing a designer to observe and study these signals.
- ZK-S12-B Starter Kit is designed for developing applications based on microcontroller family 80-pin Freescale HCS12 (X).

1.8 Commented references

1. Deepening the operation and use of oscilloscope can be achieved by consulting reference (Tektronix, 2006), available at the root of the working directory under the name TDS1000B.pdf.

2. Different information on logic analyzer can be found in reference (Janatek, 2009), available at the root of the working directory named Lula-Usb-Manual-Release3.pdf.

3. Oscilloscope and virtual function generator can be installed from the archive sim_mee.zip in the working directory.

1.4. Worksheet

Write your name:……

Semigroup:……..

Section 1.6.1. Automatic settings of the oscilloscope

Value *Cx* =

T = *Cx* * *Nx* =

Frequency =

Value *Cy* =

U = *Cy* * *Ny* =

Value peak-to-peak =

Section 1.6.2. Automatic measurements using the oscilloscope

Freq	**Period**	**Mean**	**Pk-Pk**	**Cyc RMS**	**Min**	**Max**

Section 1.6.3. Study and adjustment of synchronization

Obtained image:

Section 1.6.4. Study of a rectangular signal. Measurements using cursors

The delta value for the signal with the duty cycle 50% =

The delta value for the signal with the duty cycle 25% =

Obtained image:

Section 1.6.5. Study of logic analyzer

_____
_____
_____

Section 1.6.7. Study of ZK-S12-B development board

_____
_____
_____

Section 1.6.8. Questions

1	2	3	4	5

Other observations

_____
_____