Experiment 1
Signal Measurement

Objectives

1. To know how to use the Digital Oscilloscope.
2. To know how to generate signals using FUNCTION GENERATOR.

Equipment

Oscilloscope
Function Generator

Procedure

TIME DOMAIN SIGNAL MEASUREMENT USING DIGITAL OSCILLOSCOPE

The Oscilloscope can be set to display 1 signal or 2 signals (refer the front panel of TDS1012B Digital Oscilloscope in Figure E1.1):

- Press CH 1 to display signal at CH 1.
- Press CH 2 to display signal at CH 2.
- You can select both CH1 and CH2 to display 2 signals simultaneously.

Note: You can switch off CH 1/CH 2 display by press it again after it is on.

A. Display the test signal from PROBE COMP

Input the test signal from PROBE COMP to CH1 (or CH2) of the oscilloscope using a BNC-to-Crocodile Co-axial cable (see Figure E1.2).

1. Press **AUTOSET** button to obtain a stable waveform of the signal.

2. Set the **Attenuation** factor of CH 1/CH2:
   Press CH 1/CH2 MENU ➔ select Probe ➔ Voltage ➔ Attenuation ➔ 1X.

B. Measure the test signal using MEASURE method

You can access automatic measurements by pressing **MEASURE** button. Five types of automatic measurements can be observed simultaneously out of 11 types of automatic measurements given below:

Freq, **Period**, **Pk-Pk** (Peak-to-Peak), **Min**, **Max**, **Mean**,
Pos Width, **Neg Width, Rise Time**, **Fall Time**, and **None**.

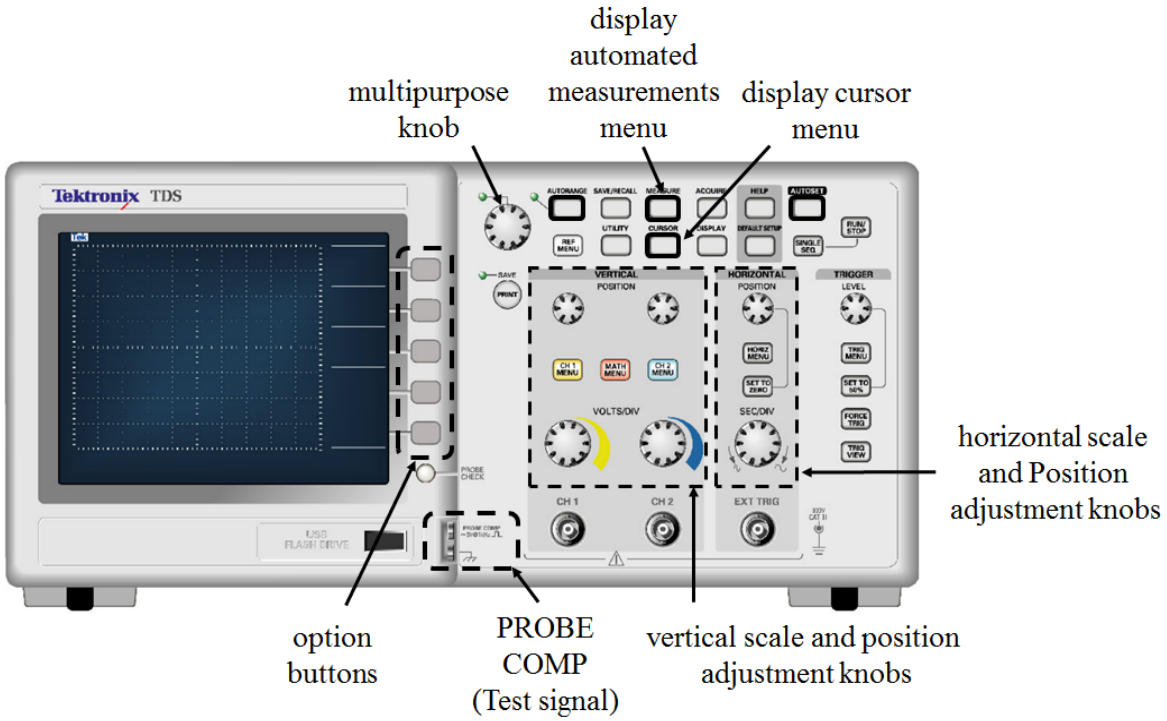

Figure E1.1 Front panel of the TDS1012B Digital Oscilloscope

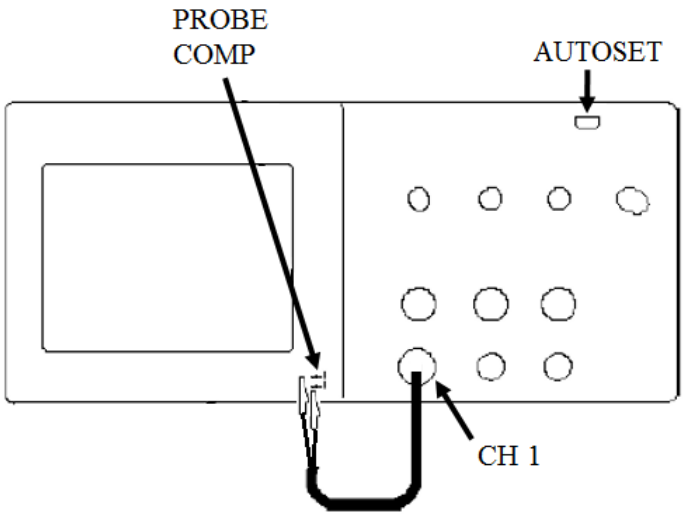

Figure E1.2 Display the signal from PROBE COMP

Set the oscilloscope to automatically measure the Frequency, Period, and Peak-to-Peak Amplitude, Rise Time, and Positive Width of the test signal as shown in Figure E1.3 following the steps below:

1. Press **Measure** button to access the Measure Menu if it is not yet done.

2. Press the first option button (refer to Figure E1.1) from the top to active Measure 1 menu. Select Type **Frequency**. Press the Back option button.

3. Press the second option button from the top to active Measure 2 menu. Select Type **Period** and Press the Back option button.

4. Press the remaining three option buttons one by one to set the measurements to **Pk-Pk**, **Rise Time** and **Pos Width** respectively**.**

   Note: Make sure **Source** is set to the same channel (CH1/CH2) that the input signal is connected to.

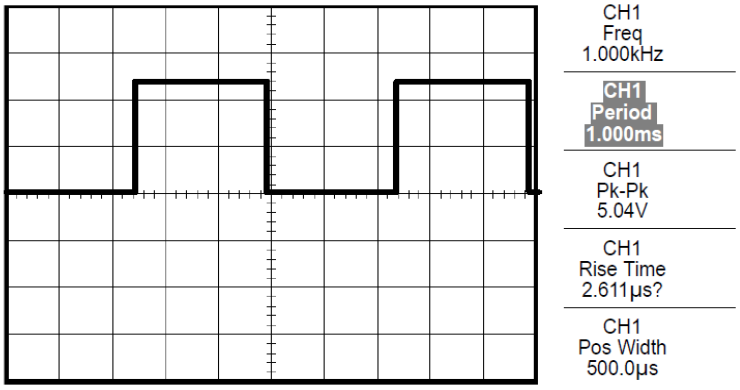

Figure E1.3 Automatic measurements

C. Measure the test signal using CURSOR method

Cursor method allows you to take measurements by moving the cursors, which always appear in pairs, and reading their numeric values from the display readouts. There are two types of cursors:

- **Amplitude Cursors** - appear as horizontal lines on the display.
- **Time Cursors** - appear as vertical lines on the display.

When you use cursors, be sure to set the **Source** to the waveform on the display that you want to measure. For instance, you need to press CH1 if the waveform to be measured is displayed at CH1.

Measure the Peak-to-Peak amplitude of the test signal using Amplitude Cursors following the steps below (see Figure E1.4):

1. Press the CURSOR button to access the Cursor Menu.

2. Select Type **Amplitude** and Source **CH1/CH2**.

3. Select the **Cursor 1** option button. Turn the multipurpose knob to place cursor 1 on the peak of the signal.

4. Select the **Cursor 2** option button. Turn the multipurpose knob to place Cursor 2 on the lowest part of the signal.

5. You can obtain the measured peak-to-peak amplitude, **ΔV**, of the signal in the Cursor Menu (refer to Figure E1.4). Record your measured Peak-to-Peak amplitude below:

   peak-to-peak amplitude $V_{P\text{-}P}$ = _____.

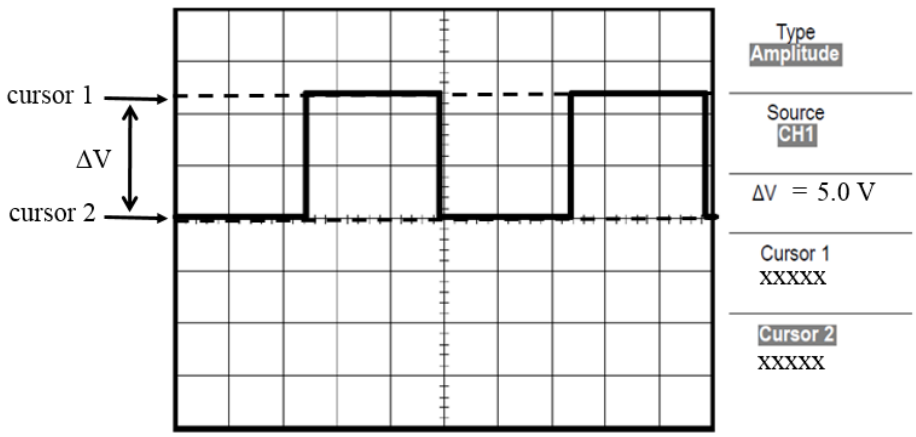

Figure E1.4 Measuring Amplitude

Measure the Frequency and Period of the test signal using Time Cursor following the steps below (see Figure E1.5):

1. Press the **CURSOR** button.

2. Select Type **Time** and Source **CH1/CH1**.

3. Select the **Cursor 1** option button. Turn the multipurpose knob to place a cursor on the start of a cycle of the signal.

4. Select the **Cursor 2** option button. Turn the multipurpose knob to place a cursor on the end of a cycle of the signal.

5. You can obtain the measured period, Δt and frequency, 1/Δt in the Cursor Menu (refer to Figure E1.5). Record your measured frequency and period below:

   Period = _____.

   Frequency = _____.

6. Measure the **Pos Width** (Pulse Width) of the signal based on the steps described above and record your measured **Pos Width** below:

   Pos Width = _____.

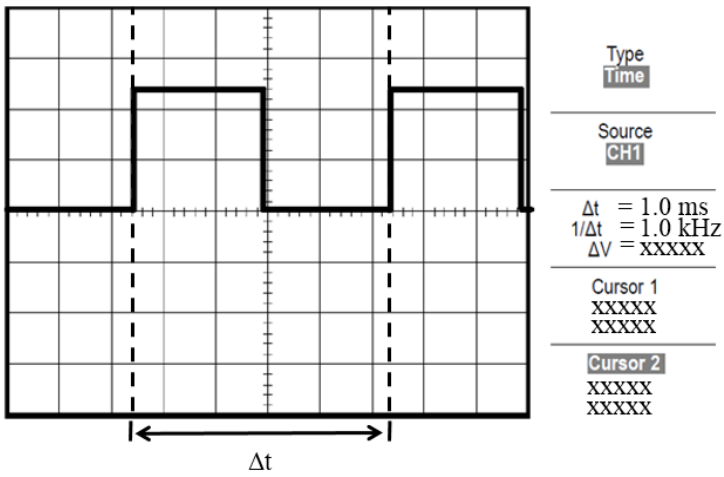

Figure E1.5 Measuring Period and Frequency

D. Adjust the vertical and horizontal scale of the test signal.

The vertical scale and position of the waveform can be adjusted by turning the **Volts/Div** and **POSITION** knobs. The vertical scale can be adjusted using **Coarse** or **Fine** adjustment. The coarse adjustment changes the Volts/Div in steps of 1-2-5 volts (or mVolts). The fine adjustment changes the Volts/Div by either 10 or 40 mVolts.

1. Set the vertical adjustment to coarse (or fine) by pressing CH 1 MENU ➔ select Vots/Div ➔ select Coarse (or fine).

2. Adjust the **vertical** scale and position to allow the waveform to occupy 6 divisions vertically (see Figure E1.6) and record the VOLT/DIV setting:

   VOLTS/DIV =_____.

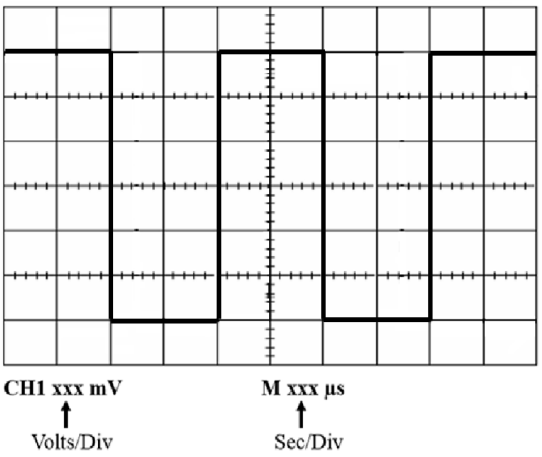

Figure E1.6 Vertical and horizontal scale

3. Adjust the **horizonta**l scale of the waveform by turning the **SEC/DIV** and **POSITION** knob to display 2.5 cycles of the waveform (see Figure E1.6). Record the SEC/DIV setting:

   SEC/DIV =_____

SIGNAL GENERATION OF FUNCTION GENERATOR

The function generator,TG1010 FUNCTION GENERATOR, can produce different types of waveforms up to a maximum frequency of 10 MHz. Figure E1.7 shows the front panel of the function generator.

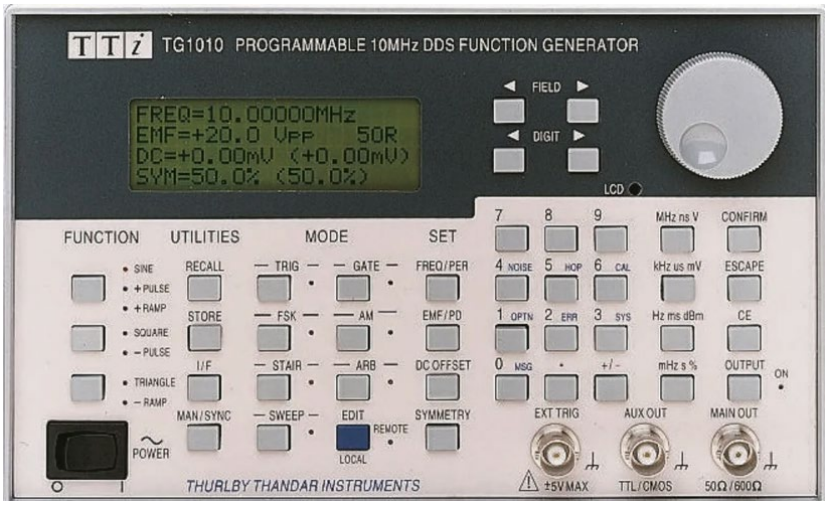

Figure E1.7 Front panel of TG1010

A. Generate and display a sine wave with frequency of 50 kHz and amplitude of $4V_{pp}$

1. Under the "FUNCTION" choose "SINE".

2. Under the "FIELD" use the right arrow button move the cursor to the 1st line of the display panel "FREQ=xxxx kHz" of the numerical part xxxx, key in 50 then press "kHz μs mV". (50 kHz).

3. Under the "FIELD" use the right arrow button move the cursor to the 2nd line of the display panel "EMF = +20.0 V" of the +20.0 part, key in 4 then press "MHz ns V". (4 volts peak-to-peak).

4. Make sure the 3rd line of the display panel is "DC = +0.00mV" and the last line of the display panel is "SYM = 50.0%".

5. Press "CONFIRM" then "OUTPUT", the "ON" will light.

   Note "CE" is back space, can be used to correct error key.

FREQ = 50 . 0 0 0 0 0 KHZ
EMF = + 2 . 0 Vpp 50Ω
DC = + 0 . 0 0 mV (+0.00mV)
SYM = 5 0 . 0 % (5 0 . 0 %)

6. Display the sine waveform on the oscilloscope.

B. Generate and display a rectangular wave shown in Figure E1.8.

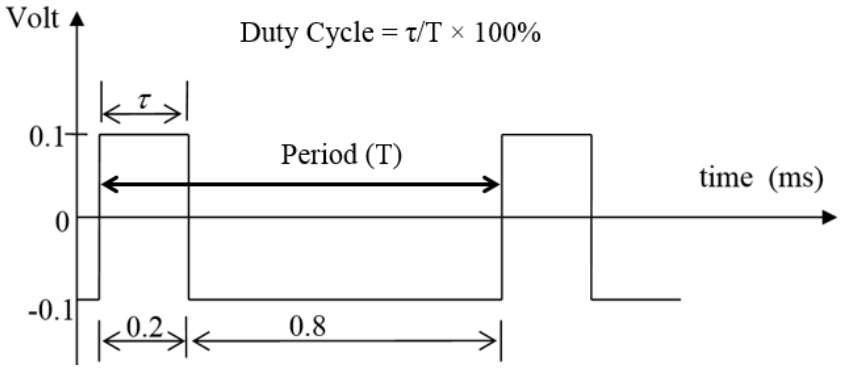

Figure E1.8 Rrectangular waveform

Determine the following **before** you start generating and displaying the waveform:

Frequency : _____

Amplitude : _____

SYMMETRY (duty cycle) :_____

Set the function generator to generate the waveform and display about 4 cycles of the waveform on the oscilloscope. **Show your result to your Lecturer.**

C. Generate and display a sawtooth wave shown in Figure E1.9.

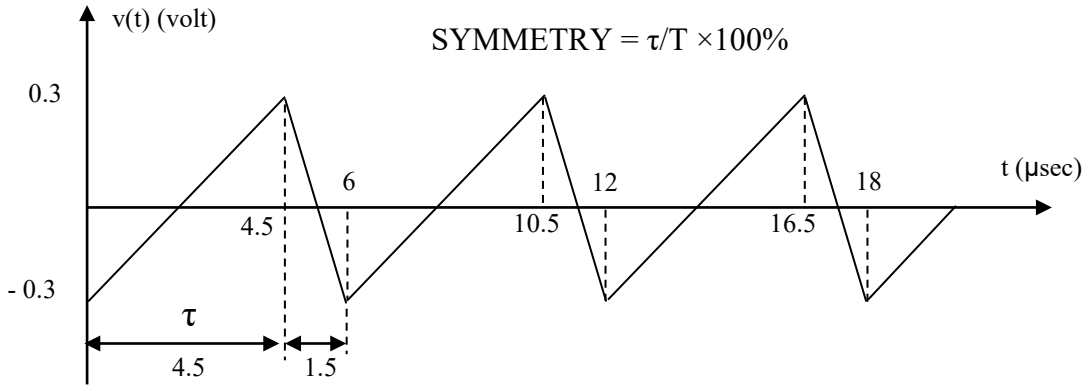

Figure E1.9 Sawtooth waveform

Determine the following **before** you start generating and displaying the waveform:

Frequency :_____

Amplitude :_____

SYMMETRY :_____

Set the function generator to generate the waveform and display about 4 cycles of the waveform on the oscilloscope. **Show your result to your Lecturer.**

D. Generate a 1.5 V DC voltage

Generate a DC voltages from the function generator.

1. Enter the 1.5 V DC value on the third line in the display (leave the other lines as they are).

2. Press the "**GATE**" button.

Note: Remember to deactivate the "gate" button when other waveforms e.g. sine waves are required.

FREQ =xx. xxxx KHZ
EMF = + 1 . 0 Vpp 50Ω
DC = **+ 1 . 5 0 V** (+0.00mV)
SYM = 5 0 . 0 % (5 0 . 0 %)