Electronic Measurements

Master degree in Electronics Engineering

WRITTEN TEST – 5 September 2024

Name _____ Student number _____

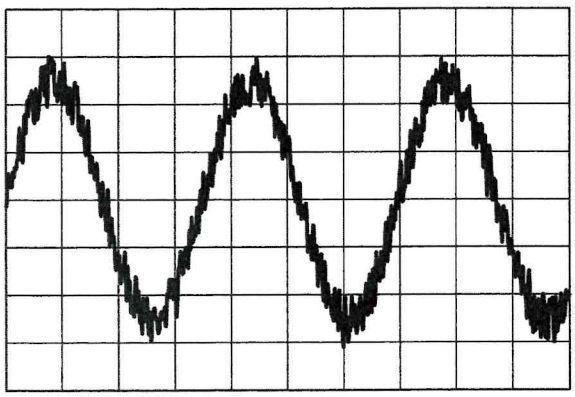
Question n. 1

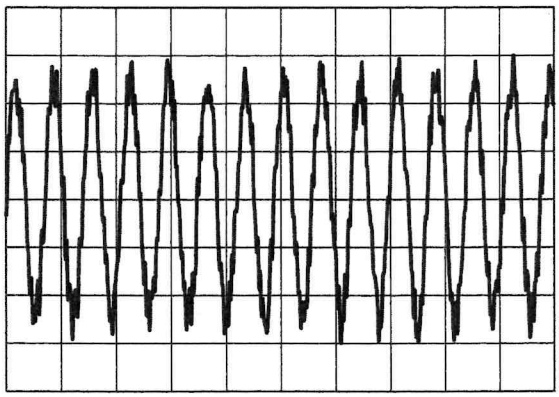
The two oscilloscope traces shown below refer to the **same** signal, a sinewave with additive noise, displayed with two different horizontal scale factors, respectively:

- 20 μs/div
- 100 μs/div

The vertical scale factor is the same in both cases: 0.5 V/div. The horizontal axis on the oscilloscope display is divided into N_V = 1000 intervals. Using information obtained from the time-domain traces, provide approximate estimates of:

- sinewave frequency
- sinewave amplitude (RMS)
- signal-to-noise ratio





A spectral analysis algorithm is employed to **measure the sinewave frequency and amplitude**. Assume that Fourier transform calculations are carried out on a sequence of $\mathbf{2}N_V$ **samples** (that is, **twice** the number displayed in the time domain). The sampling interval for Fourier calculations is equal to the time resolution of horizontal cursors, so that the observation interval for spectral analysis is also **twice** the time interval shown on the time domain display. The displayed frequency interval is $(0, f_{SPAN})$ and a **uniform window** is employed.

1. calculate the frequency axis **grid step** F for the spectral analysis observation intervals corresponding to each of the two timebase settings;
2. based on the approximate estimates obtained above, determine the values of
   a) amplitude (in dBV) and
   b) frequency (in Hz) – for both timebase settings

   that can be expected from the spectral analysis algorithm
3. for the sinewave shown above the normalized frequency, defined as $f \cdot T_W$, where T_W is the spectral analysis observation interval, can be determined as the (possibly non-integer) number of sinewave periods within T_W. Based on this:
   a) is it possible to determine whether spectral leakage will occur?
   b) is it possible to estimate the amount of scalloping loss?

Electronic Measurements

Master degree in Electronics Engineering

WRITTEN TEST – 21 February 2022

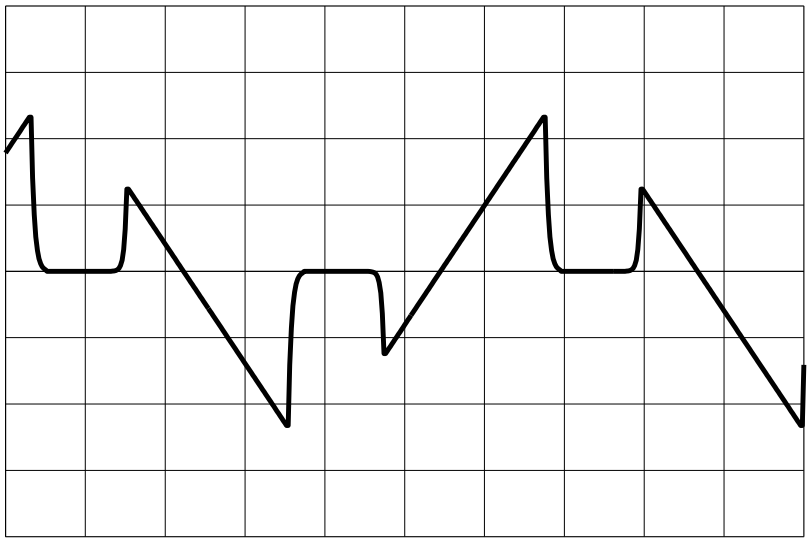
Name _____ Student number _____

TIME TO COMPLETE: 90 minutes

Exercise n. 1

The periodic voltage waveform shown below is measured by an oscilloscope at the voltage-controlled oscillator (VCO) input of a phase-locked loop (PLL) circuit. Instrument bandwidth is 200 MHz, the horizontal scale factor is 20 ms/div and the vertical scale factor is 1 V/div. Vertical offset is 4 V, so that the displayed voltage range is from 0 V to 8 V. The measurement allows to determine the PLL capture range and lock-in range.

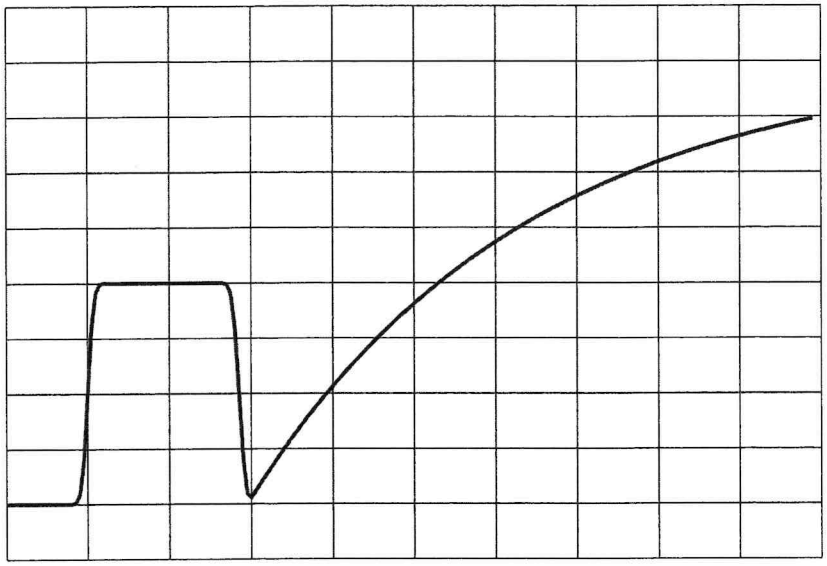
It is known that, within the range from 0.5 V to 8.5 V, the relationship between VCO input voltage and VCO output frequency is linear and the proportionality factor is: K_v = 80 kHz/V.



- explain the measurement scheme, indicating what kind of input is sent to the PLL for this measurement and how a signal generator must be set-up for the purpose;
- provide the **frequency** values of the PLL capture range and lock-in range;
- determine the waveform period;
- discuss any aspect that could limit the choice of the waveform period for this kind of test.

Domanda n. 3

The figure below shows the display of a digital oscilloscope employed for time-domain reflectometry. The measured trace refers to a coaxial cable with a characteristic impedance of 50 Ω (insulation: polyethilene – $\varepsilon_r \cong 2.3$).
Instrument bandwidth is 200 MHz, the horizontal scale factor is 20 ns/div and the observation interval is divided into $N_V = 1000$ steps. The cable is terminated into a purely capacitive load.



- indicate what are the assumed values of the signal generator output impedance and of the oscilloscope input impedance;
- determine cable length l and evaluate the associated uncertainty, assuming it depends only on the resolution of time cursor positioning;
- estimate the value of the load capacitance;
- (*optional*) using information provided above, indicate the minimum distance Δ_l at which two disctinct cable discontinuities can be detected.

TIME TO COMPLETE: 90 minutes