IN LAB

LAB STATION 2

SCOPE: AGILENT 54622D
Ser. no. MY40003103

FUNC. GEN: AGILENT 33120A
Ser. no. 40010800

ITEM 2 Sine wave: 200mVpp, 2.5kHz, 0VDC offset
(Front panel readings)

Scope measurements:
Using cursors: 406mVpp
period = 400μs ⇒ f = 2.5kHz

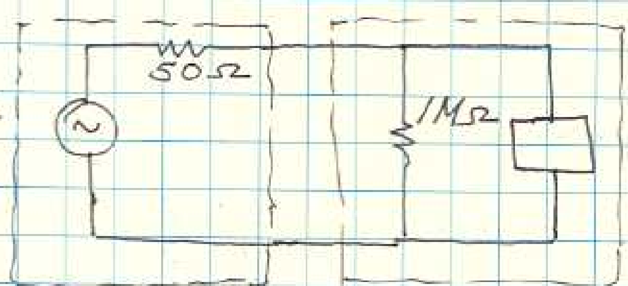
Auto. measurement: 405.9mVpp
f = 2.500kHz

Discrepancy in amplitudes on func. generator meter and measured by scope.

Input Z of scope: 1MΩ

Output Z of func. gen: 50Ω ALWAYS

Impedance mismatch causes the discrepancy in amplitudes.



The meter on the func. gen. reads correctly when it sees a 50Ω load. With a high Z load, set OUT TERM to HIGH Z to adjust meter reading.

With HIGH Z setting, func. gen. now reads
400 mVpp

ITEM 3 Func. gen: f_{max} = 15 MHz V_{max} = 10 Vpp } into 50 Ω
f_{min} = 100 μHz V_{min} = 50 mVpp

Current scope config:

Triggering: edge, ↑, source CH 1, DC coupled
auto level mode

Input: DC coupled, Probe 1:1

Acquisitions: avg., 8 avgs.

ITEM 4 (a) Saved to INTERN_0: current sine wave + setup.

NOTE: Can recall trace only, setup only, or both.

Recalled trace + setup from INTERN_0.

(b) NOTE: Can delete + load files from floppy —
UTILITY menu.

Saved sine wave + settings to QFILE_00 on
floppy.
→ Saved as QFILE_00.SCP setup
QFILE_00.TRC trace

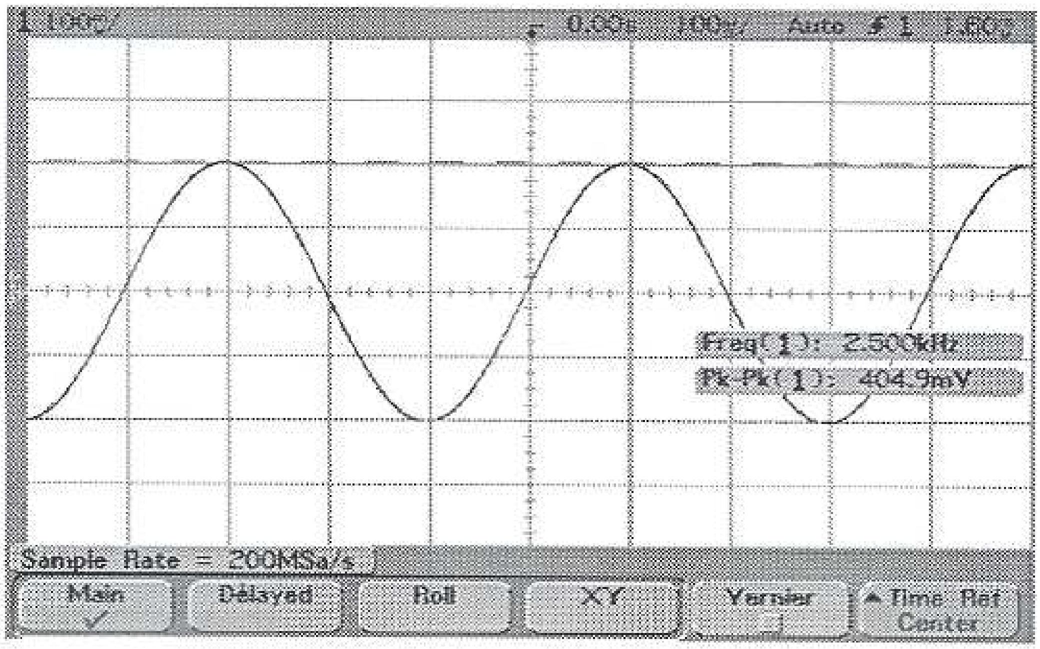
Recalled from QFILE_00.

(c) Use QUICK PRINT to save screen as BITMAP
to floppy, file PRINT_00.

NOTE: under UTILITY, PRINT CONFG — setup
to Print to Disk, FORMAT — BMP.

NOTE: Have screen display whatever you want to see on the printout.

Opened up PRINT_00.bmp on lab station computer using Paint, printed output here.



ITEM 5 FFT display

Scale = 20 dB/div Window = Hanning Offset = -55.0 dBV
Span = 20 kHz Center = 10 kHz Sample rate = 200 k Sa/s

Peak line at: f = 2.50 kHz Ampl = -16.88 dBV

Very small peak at 5.0 kHz, -83.13 dBV

The func. gen. does not produce a pure sine wave — other freq. components are present. But, they are mostly in the noise floor — the line at 5 kHz is 66.25 dB below the fundamental.

Comparison with theory: (prelab).

Line at $f_0 = 2.5\,kHz$ should have amplitude

$A = \frac{400\,mV_{pp}}{2} = 200\,mV$. (The FFT display is one-sided: amplitude of fundamental is A, not A/2.)

~~$A_{dBV} = 20 \log (200\,mV$~~

Units of measurement on scope are dBV, which is:

$$dBV = 20 \log \left(\frac{A}{1\,V_{rms}} \right)$$

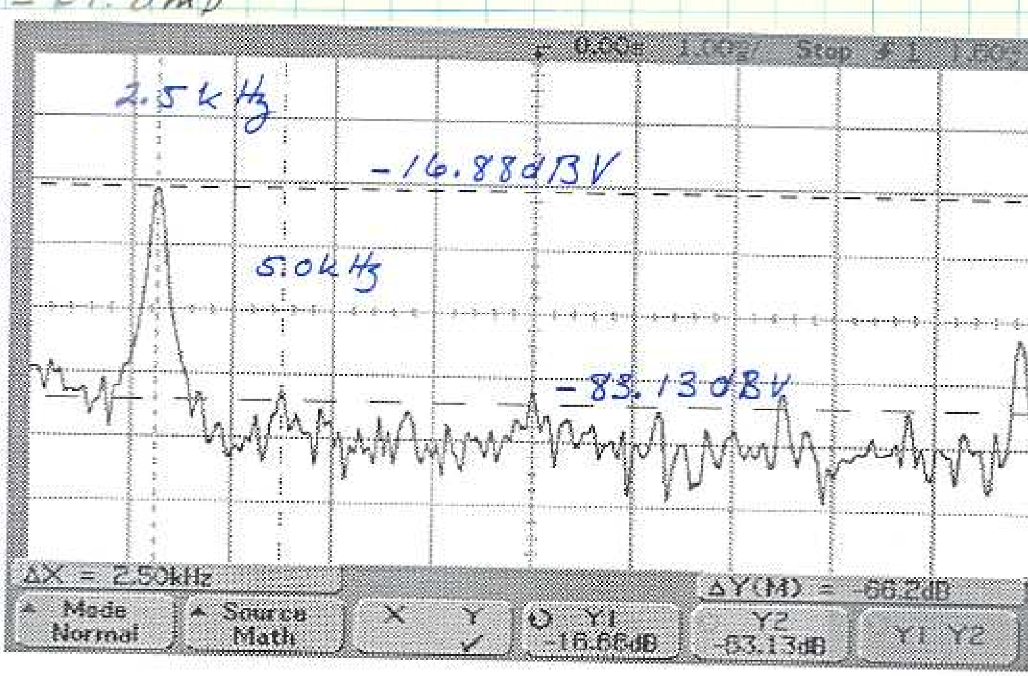
↑ NOTE: Ref. is 1 V rms

$A = 200\,mV \Rightarrow A = \frac{200\,mV}{\sqrt{2}} = 141.42\,mV_{rms}$.

$\therefore A_{dBV} = 20 \log (141.42 \times 10^{-3}) = -16.99\,dBV$

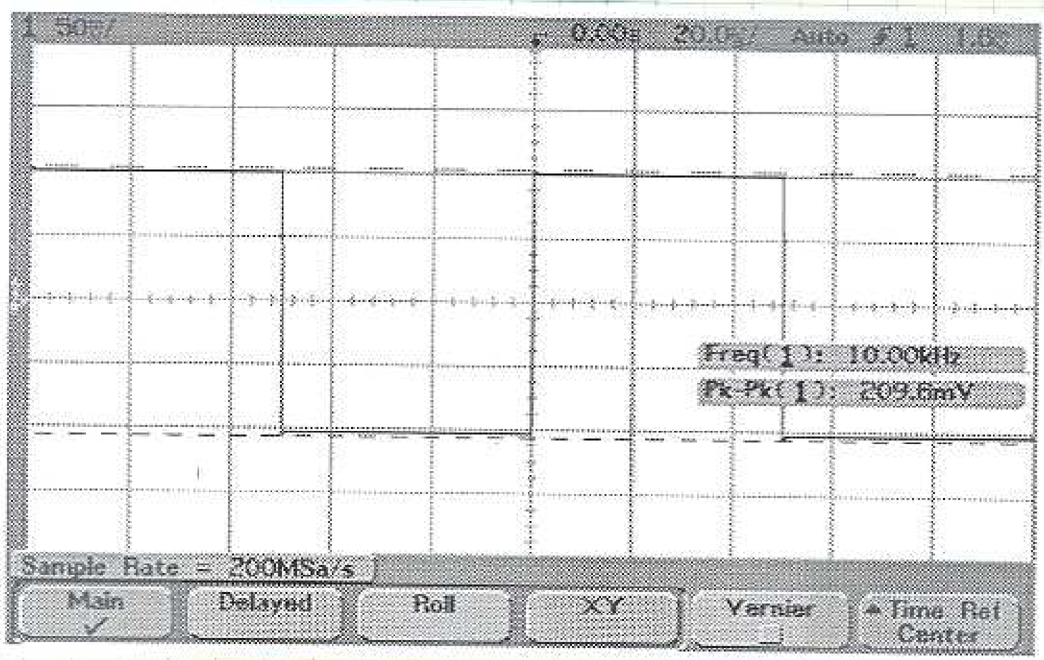
Measured value: $-16.88\,dBV$

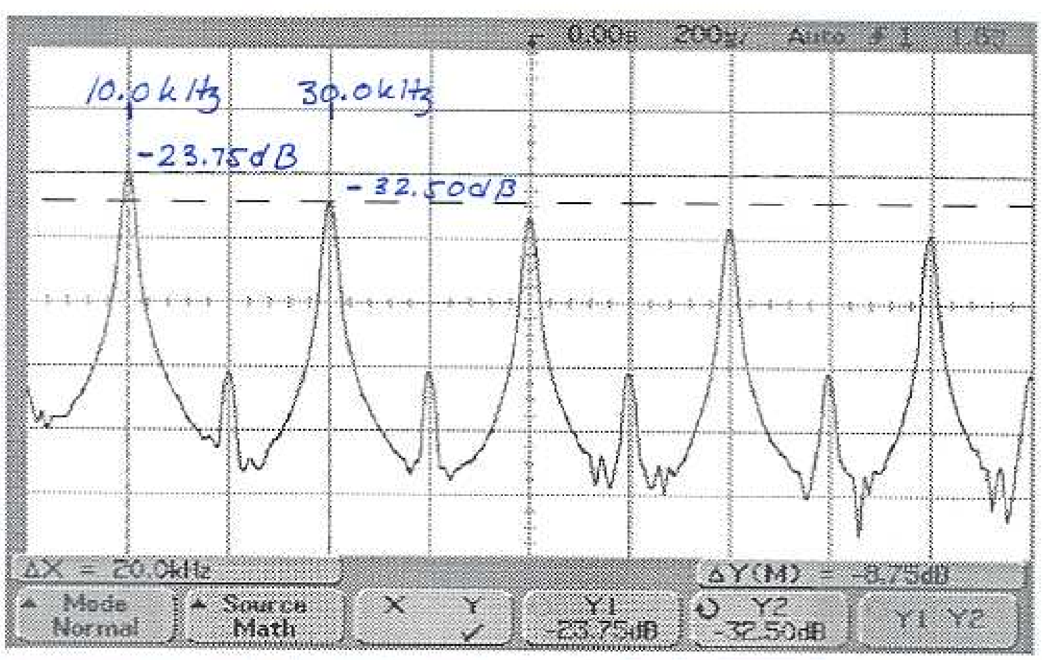
ITEM 6 PRINT_01.bmp



The lines have non-zero width because of the window — we are taking the spectrum of $(\cos 2\pi f_0 t)(u(t)-u(t-T))$, T = window width. $\left| \mathcal{F}[u(t)-u(t-T)] \right| = T \operatorname{sinc}(Tf)$.

ITEM 7 Square wave : PRINT_02 FFT: PRINT_03





FFT settings for square wave:

Scale = 20 dB/div   Offset = −63.4 dB   Window = Hanning
Span = 100 kHz   Center = 50 kHz   Rate = 1.00 MSa/s

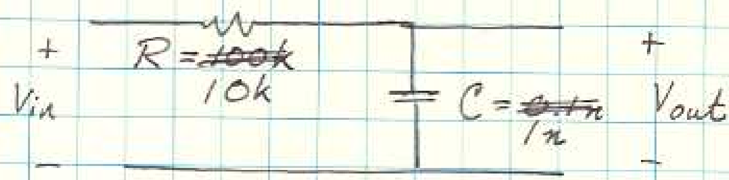
Note that the spectrum should have lines only at odd harmonics (10 kHz, 30 kHz, etc.). There are small lines at even harmonics because it is not a perfect square wave.

	Line freq. (kHz)	Meas. Ampl. (dBV)	Meas Ampl. (V_{op})	Theor. Ampl. (V_{op})	($2 \cdot \frac{2A}{\pi n}$
n=1	10	−23.75	91.84 mV	127.32 mV	($\frac{400m}{\pi}$
	20	−86.25	68.87 μV	0	
n=3	30	−32.50	33.53 mV	42.44 mV	($\frac{400m}{3\pi}$
	40	−86.25	68.87 μV	0	
n=5	50 (49.9)	−37.50	18.85 mV	25.46 mV	($\frac{400m}{5\pi}$
	60	−86.25	68.87 μV	0	
n=7	70 (69.9)	−40.00	14.14 mV	18.19 mV	($\frac{400m}{7\pi}$
	80	−86.25	68.87 μV	0	
n=9	90	−42.50	10.61 mV	14.15 mV	($\frac{400m}{9\pi}$

Conversion: $dBV = 20 \log\left(\frac{A_{rms}}{1 V_{rms}}\right) \Rightarrow A_{rms} = 10^{\frac{dBV}{20}}$

$$\Rightarrow A = \sqrt{2} \cdot 10^{\frac{dBV}{20}}$$

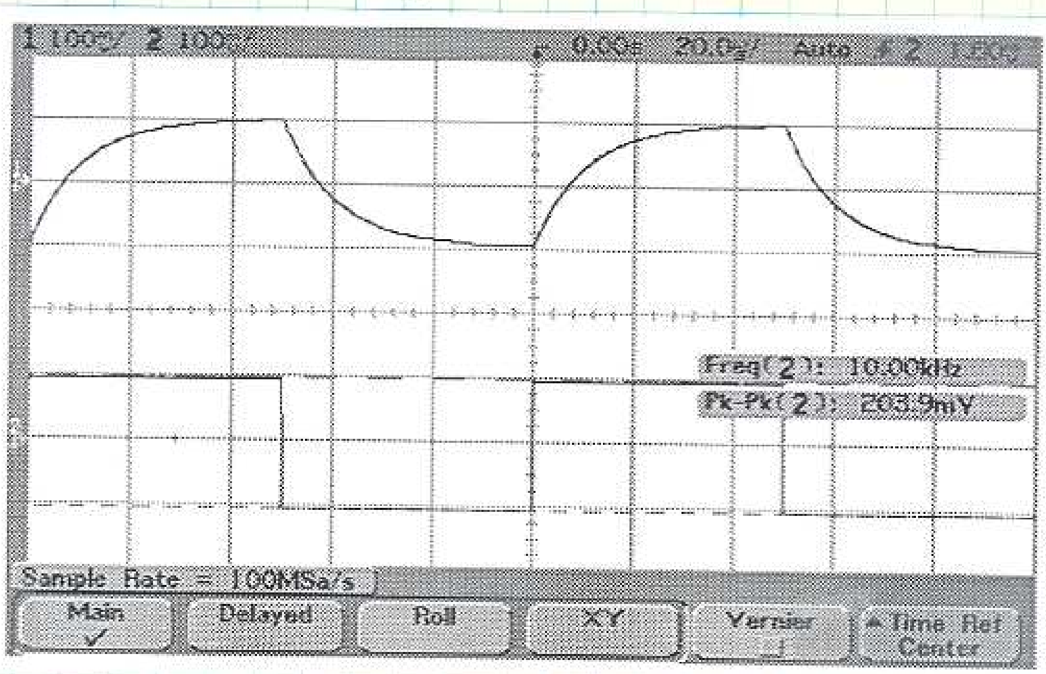
ITEM 8 RC filter

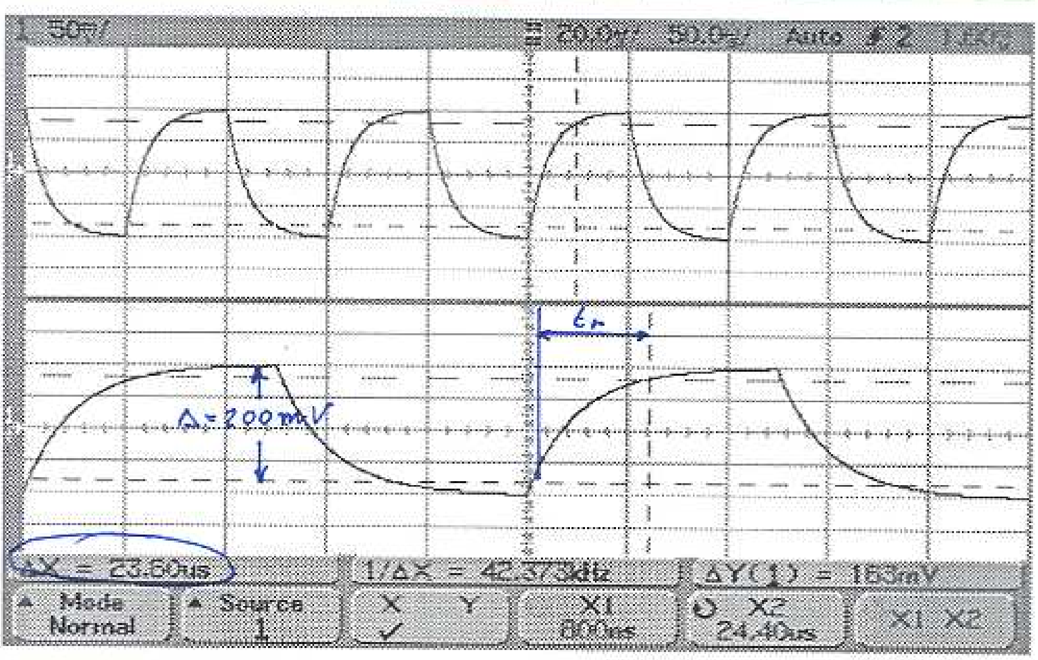


$RC = 10\mu s$

V_{in} : square, f = ~~25~~ 10 kHz, A = 200 mVpp, 0 V offset

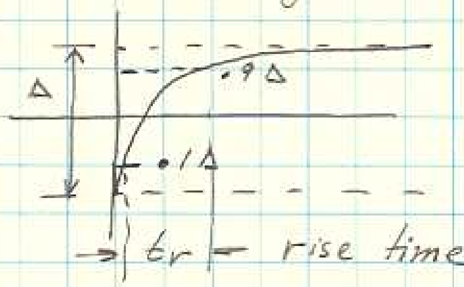
1st plot: sq. wave out of filter
2nd plot: measurement of time const.





ITEM 9 Time constant measurement — use delayed sweep.

Total swing: $\Delta = 200\text{ mV}$



Use Y cursors to find 10% and 90% levels, then X cursors to measure rise time:

$$t_r = 23.6\,\mu s$$

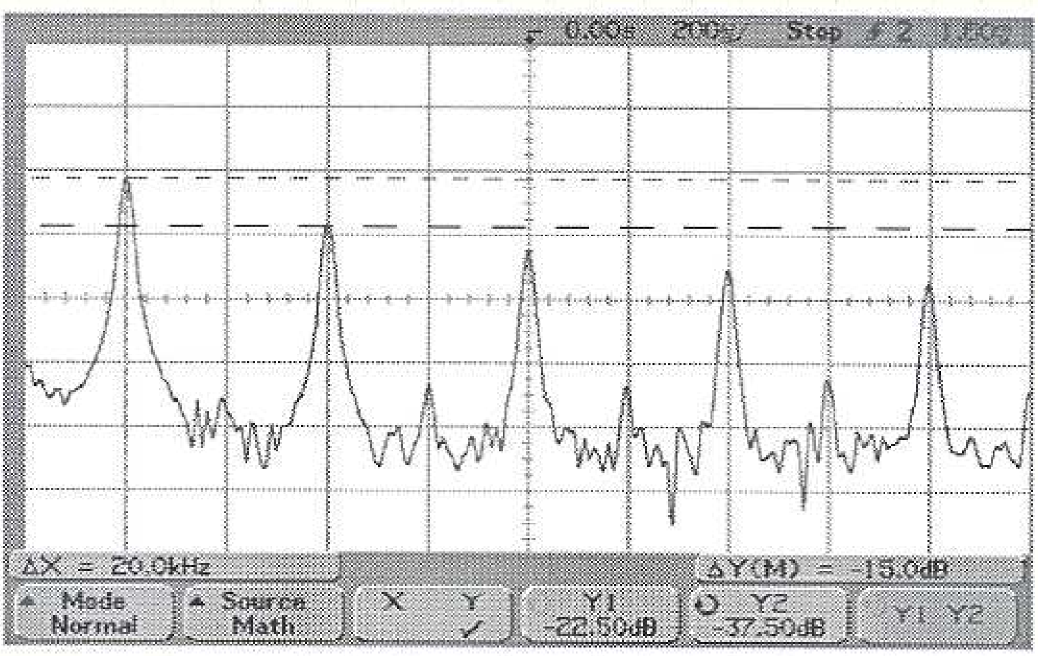
$$\left.\begin{aligned} .1\Delta &= \Delta(1-e^{-t_1/\tau}) \\ .9\Delta &= \Delta(1-e^{-t_2/\tau}) \end{aligned}\right\} \quad t_2 - t_1 = \tau \ln(9)$$

$$\Rightarrow t_r = \tau \ln(9)$$

~~$\tau = \frac{t_r}{\ln 9} = \frac{22.4\,\mu s}{\ln 9} = 10.2\,\mu s$~~

$$\tau = \frac{t_r}{\ln(9)} = \frac{23.6\,\mu s}{\ln 9} = \boxed{10.74\,\mu s}$$ Expected τ.

FFT of output: Scale: 20 dB/div Offset: −60 dB Window: Hanni[ng]
Span: 100 kHz Center: 50 kHz Rate: 1 MSa/s



	Line freq (kHz)	Meas Ampl (dBV)	Meas. Ampl (V_{o-p})	Theoretical Ampl (V_{o-p})
n=1	10	−22.50	106.05 mV	107.81 mV
2	20	−91.25	39 μV	0
3	30	−37.50	18.86 mV	19.89 mV
4	40	−87.50	60 μV	0
5	50	−45.62	7.41 mV	7.72 mV
6	60	−87.50	60 μV	0
7	70	−50.62	4.16 mV	4.03 mV
8	80	−85.63	74 μV	0
9	90	−55.00	2.52 mV	2.46 mV

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$$A = \sqrt{2}\,10^{dBV/20}$$