RĪGAS TEHNISKĀ UNIVERSITĀTE
ELEKTRONIKAS UN TELEKOMUNIKĀCIJU FAKULTĀTE
ELEKTRONIKAS PAMATU KATEDRA

Signālu teorijas pamati

Laboratorijas darbs № 2
"Iepazīšanās ar periodisku signālu izvērsi trigonometrisku funkciju Furjē rindā"

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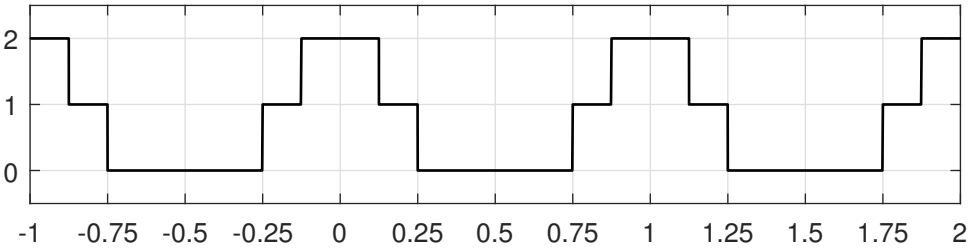
151REB096

Rīga, 2017

Mājas darbs

6. variants

s(t)



Trigonometrisku funkciju Furjē rinda

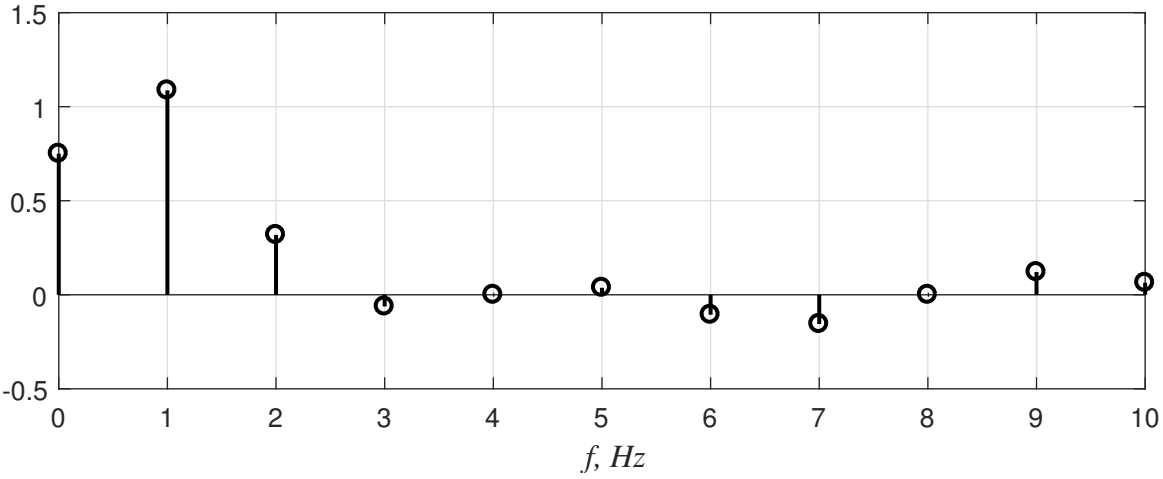
$$\frac{1}{2}a_0 = 2\int_0^{1/4} 1\,dt + 2\int_0^{1/8} 1\,dt = \frac{3}{4}$$

$$a_n = 4\int_0^{1/4} \cos(2\pi nt)\,dt + 4\int_0^{1/8} \cos(2\pi nt)\,dt = \frac{2}{\pi n}\left(\sin\left(\frac{\pi n}{2}\right) + \sin\left(\frac{\pi n}{4}\right)\right)$$

$$s(t) = \frac{3}{4} + \frac{2}{\pi}\sum_{n=1}^{\infty}\frac{1}{n}\left(\sin\left(\frac{\pi n}{2}\right) + \sin\left(\frac{\pi n}{4}\right)\right)\cos(2\pi nt)$$

$\frac{1}{2}a_0$	a_1	a_2	a_3	a_4	a_5	a_6	a_7	a_8	a_9	a_{10}
$\frac{3}{4}$	$\frac{\sqrt{2}+2}{\pi}$	$\frac{1}{\pi}$	$\frac{\sqrt{2}-2}{3\pi}$	0	$\frac{2-\sqrt{2}}{5\pi}$	$-\frac{1}{3\pi}$	$\frac{-\sqrt{2}-2}{7\pi}$	0	$\frac{\sqrt{2}+2}{9\pi}$	$\frac{1}{5\pi}$
0.75	1.09	0.32	-0.06	0	0.04	-0.11	-0.16	0	0.12	0.06

Amplitūdu spektrs



Kompleksu eksponentfunkciju Furjē rinda

$$\frac{1}{2}C_0 = \frac{1}{2}a_0 = \frac{3}{4}$$

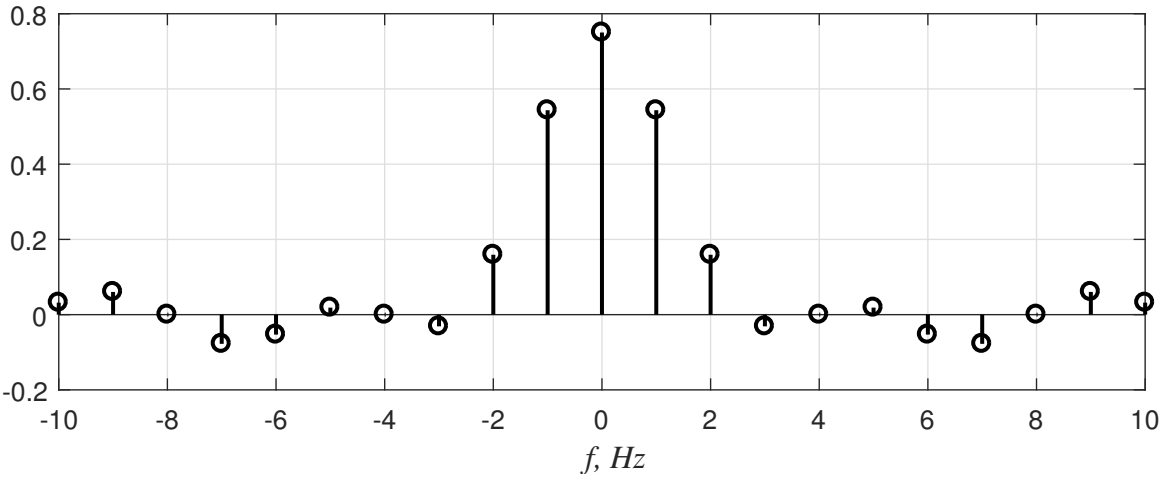
$$\frac{1}{2}C_n = \int_{-1/4}^{1/4} e^{-j2\pi nt}\,dt + \int_{-1/8}^{1/8} e^{-j2\pi nt} = \frac{1}{\pi n}\left(\frac{e^{\frac{j\pi n}{2}} - e^{\frac{-j\pi n}{2}}}{j2} + \frac{e^{\frac{j\pi n}{4}} - e^{\frac{-j\pi n}{4}}}{j2}\right) =$$

$$= \frac{1}{\pi n}\left(\sin\left(\frac{\pi n}{2}\right) + \sin\left(\frac{\pi n}{4}\right)\right)$$

$$s(t) = \frac{1}{\pi}\sum_{n=-\infty}^{\infty}\frac{1}{n}\left(\frac{e^{\frac{j\pi n}{2}} - e^{\frac{-j\pi n}{2}}}{j2} + \frac{e^{\frac{j\pi n}{4}} - e^{\frac{-j\pi n}{4}}}{j2}\right)e^{j2\pi nt}$$

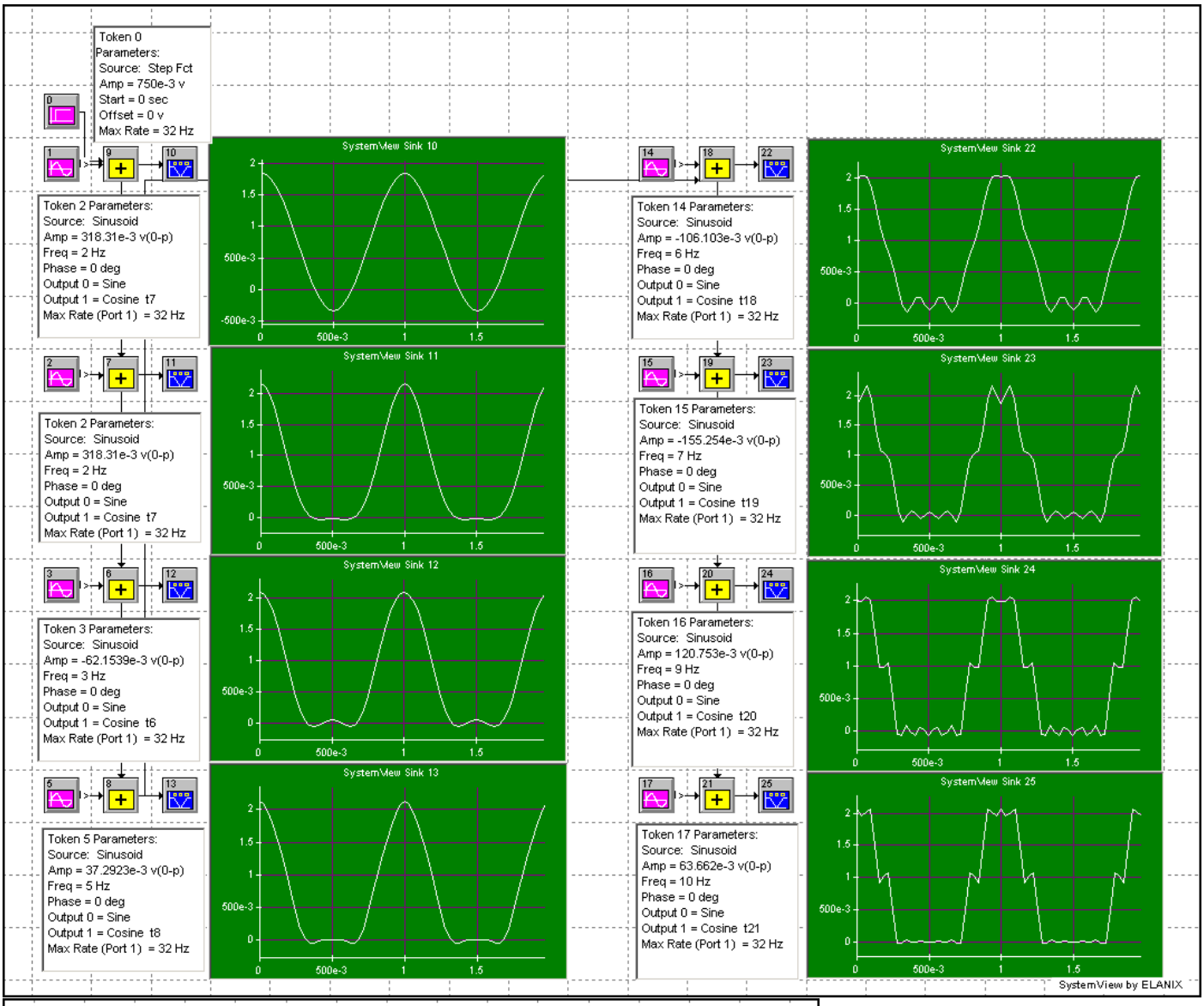
$\frac{1}{2}C_0$	$\frac{1}{2}C_1$	$\frac{1}{2}C_2$	$\frac{1}{2}C_3$	$\frac{1}{2}C_4$	$\frac{1}{2}C_5$	$\frac{1}{2}C_6$	$\frac{1}{2}C_7$	$\frac{1}{2}C_8$	$\frac{1}{2}C_9$	$\frac{1}{2}C_{10}$
$\frac{3}{4}$	$\frac{\sqrt{2}+2}{2\pi}$	$\frac{1}{2\pi}$	$\frac{\sqrt{2}-2}{6\pi}$	0	$\frac{2-\sqrt{2}}{10\pi}$	$-\frac{1}{6\pi}$	$\frac{-\sqrt{2}-2}{14\pi}$	0	$\frac{\sqrt{2}+2}{18\pi}$	$\frac{1}{10\pi}$
0.75	0.54	0.16	-0.03	0	0.02	-0.05	-0.08	0	0.06	0.03

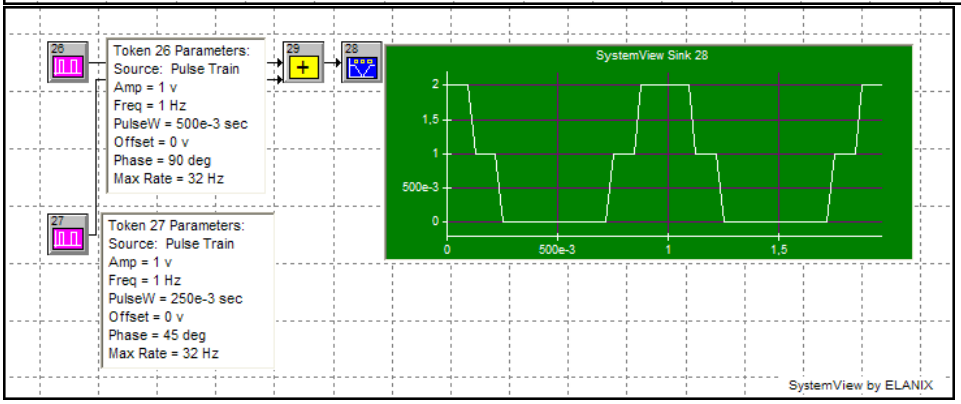
Divpusīgais amplitūdu spektrs



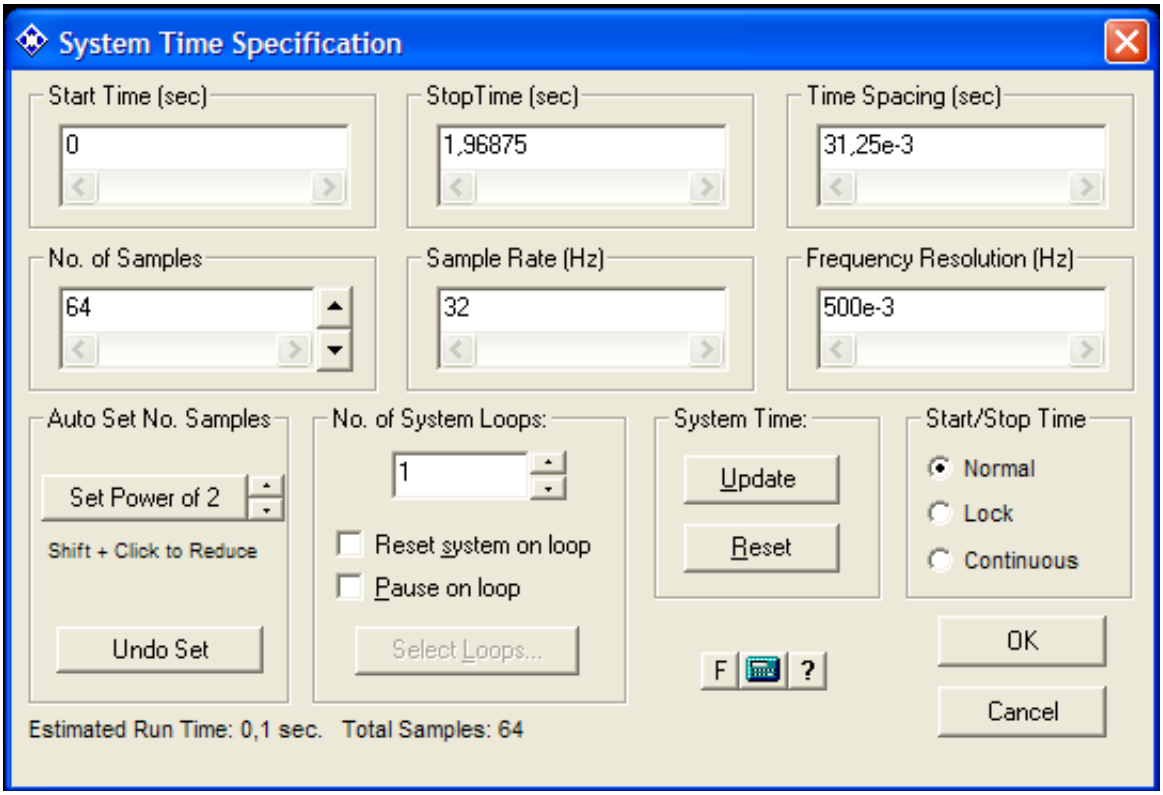
Atskaite

Darbā izmantotā blokshēma

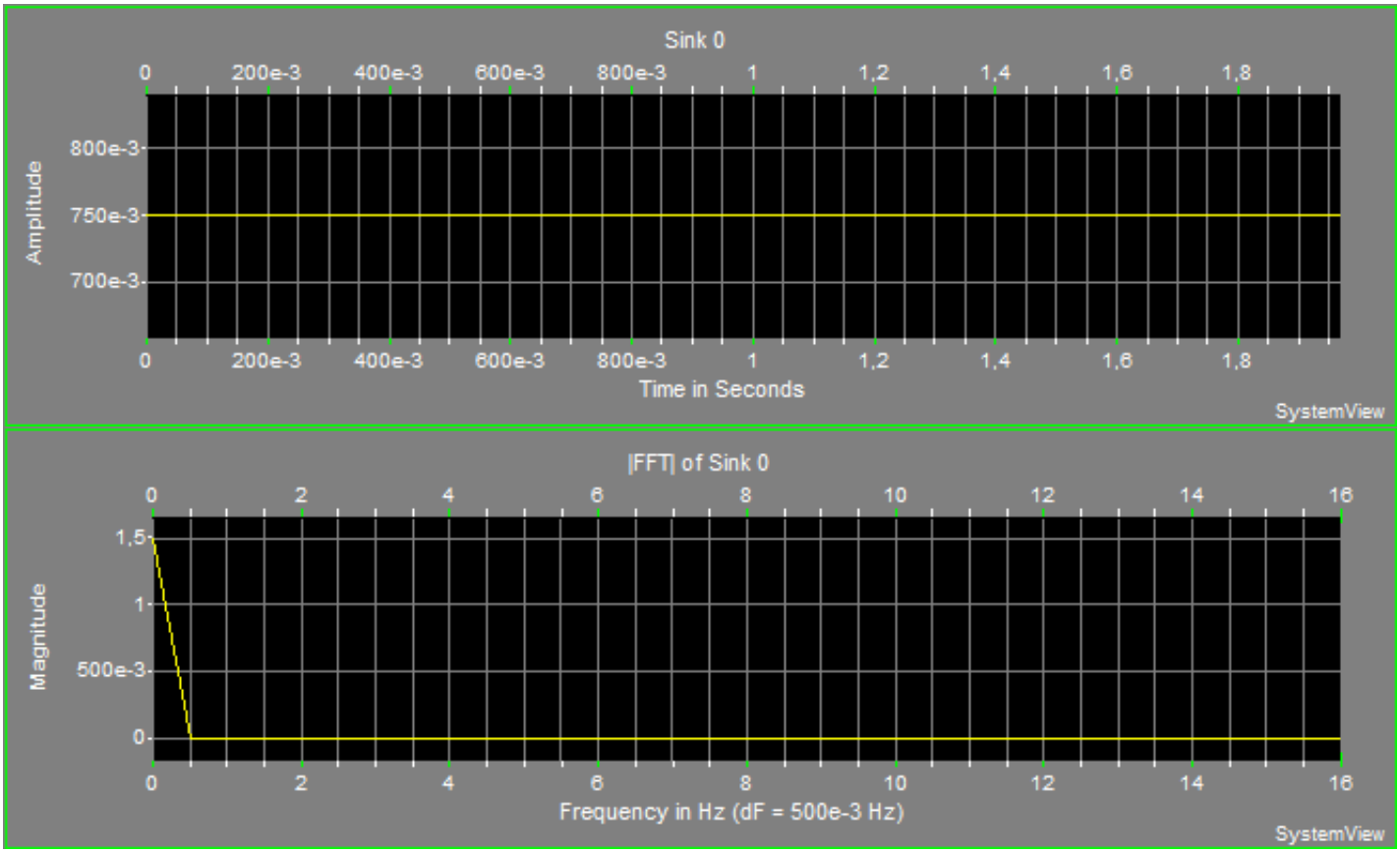


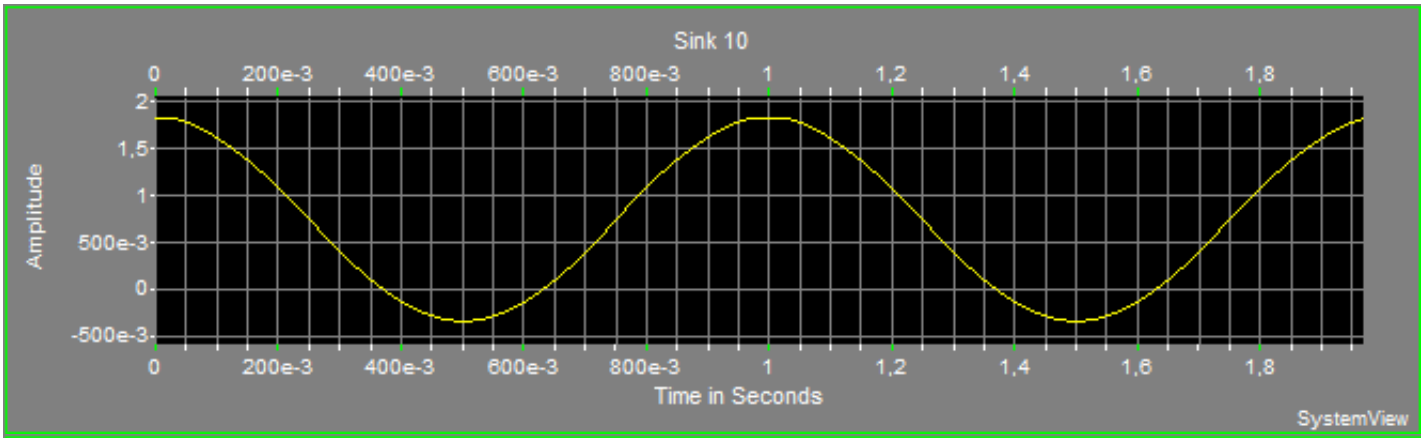


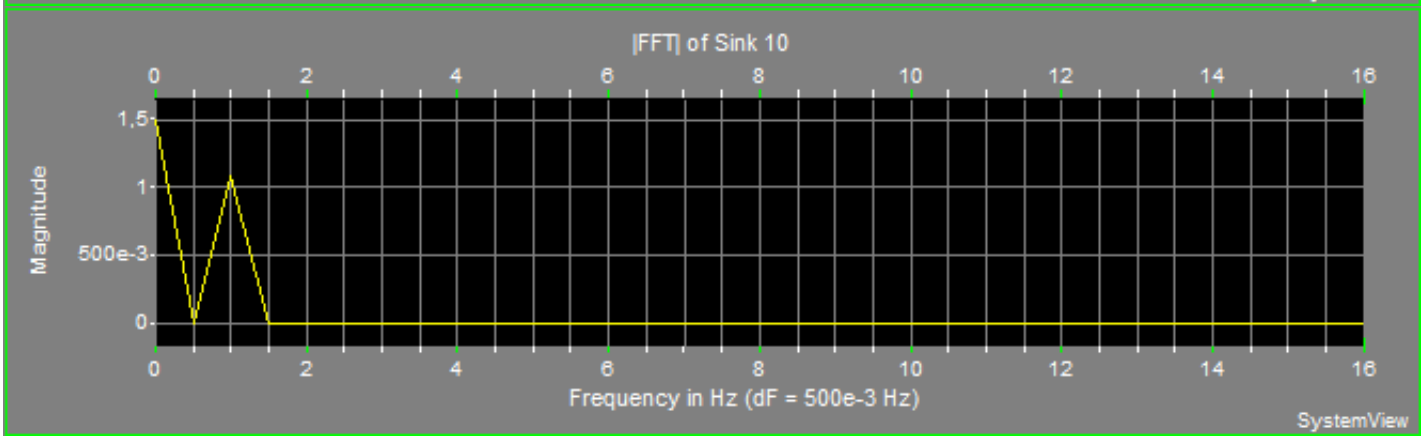
Simulēšanas laika parametri

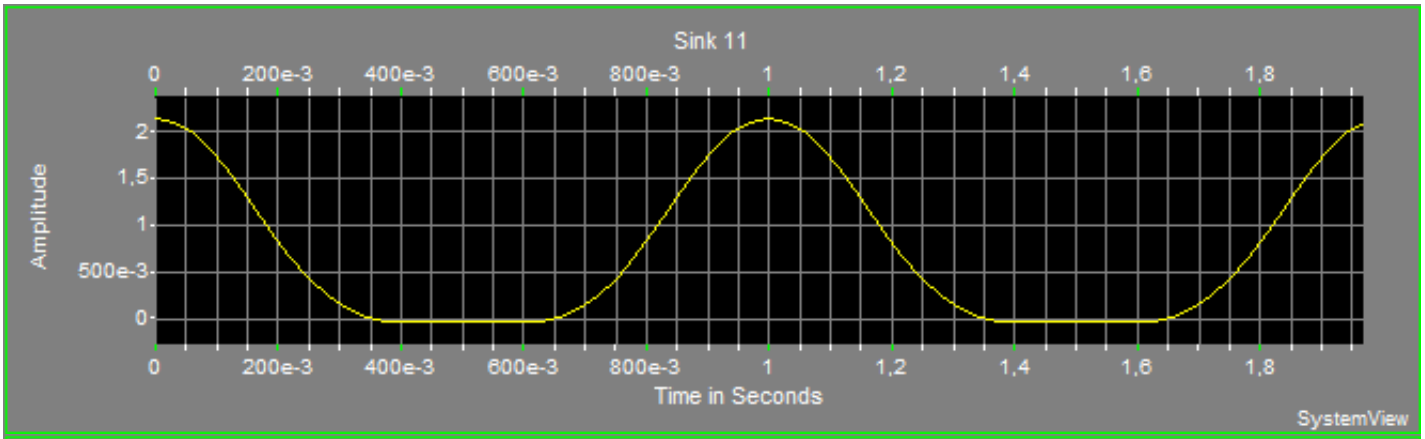


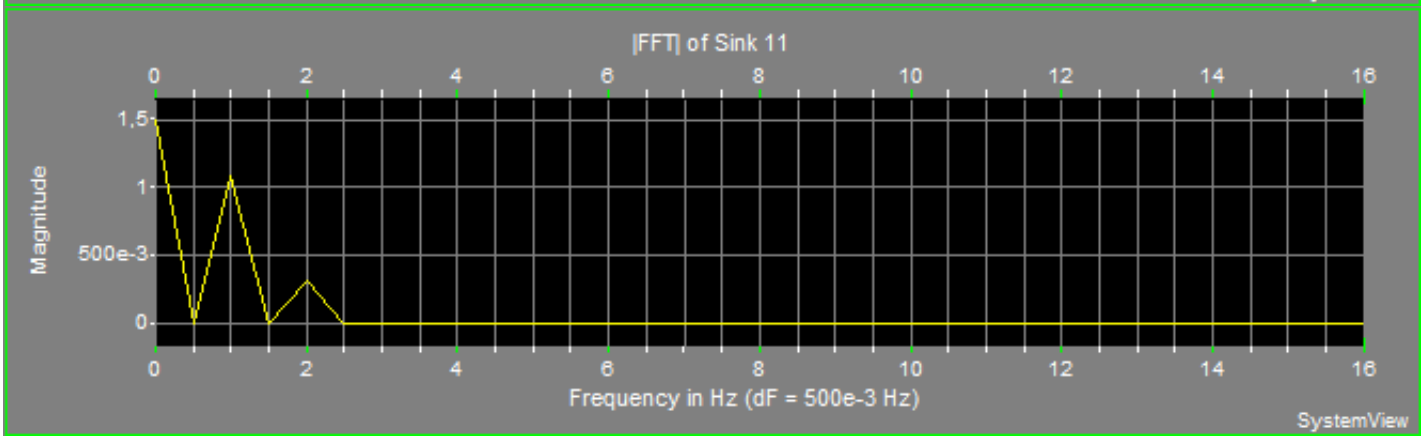
Iegūtās oscilogrammas

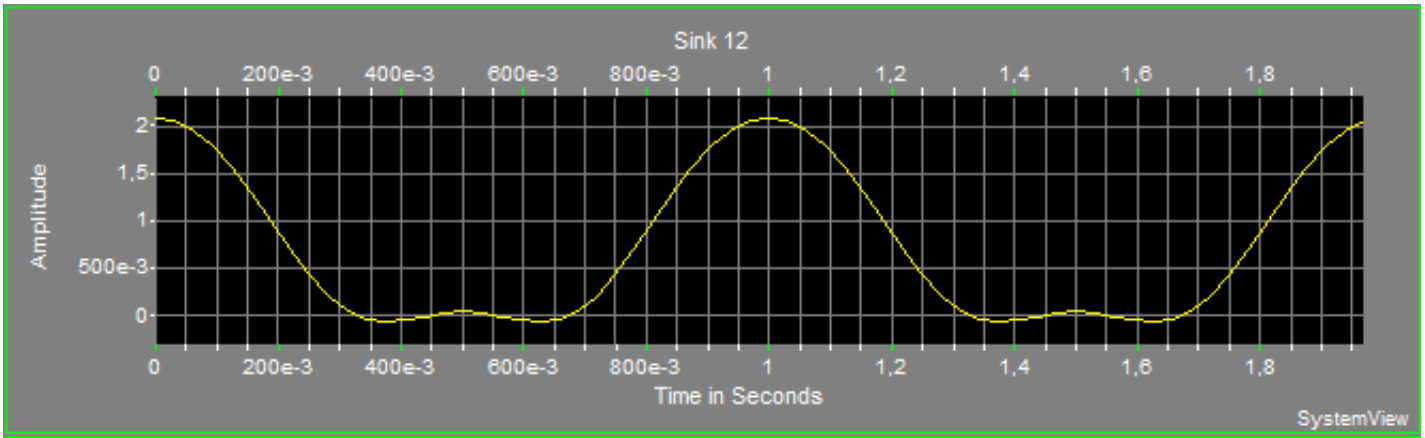


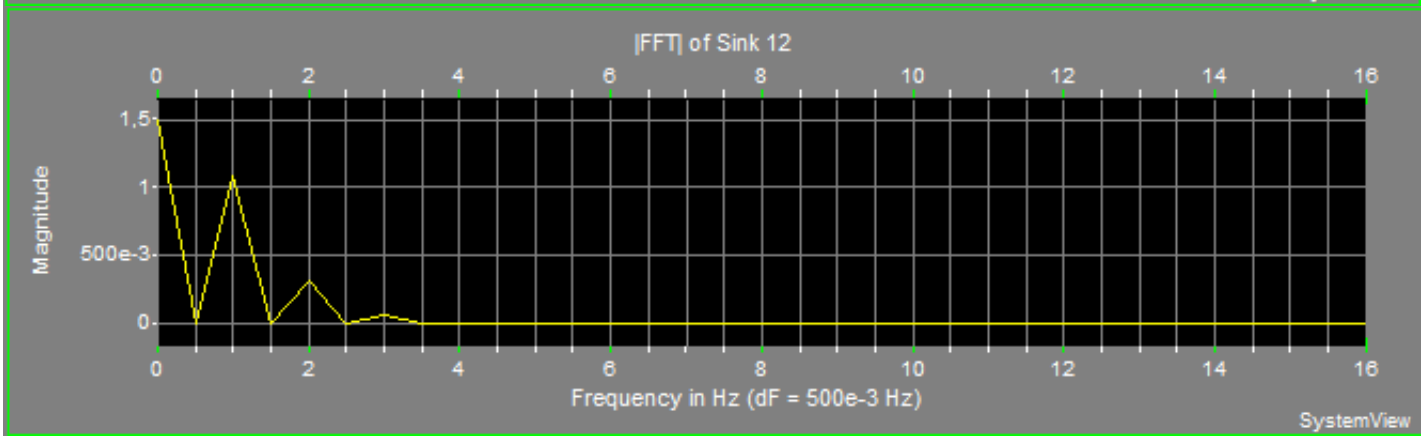

Sink 10
Amplitude
Time in Seconds
SystemView

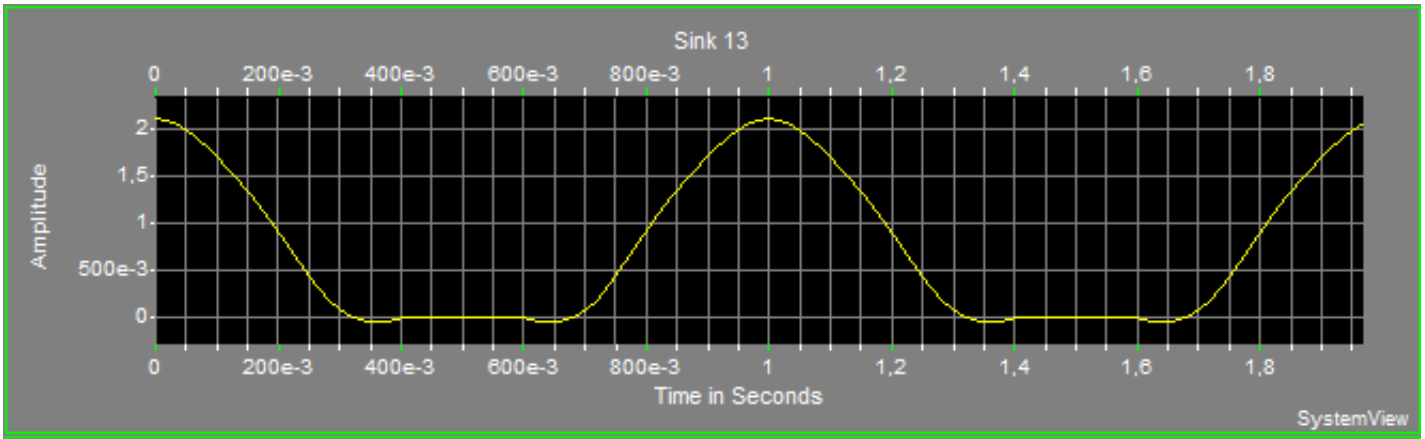

|FFT| of Sink 10
Magnitude
Frequency in Hz (dF = 500e-3 Hz)
SystemView

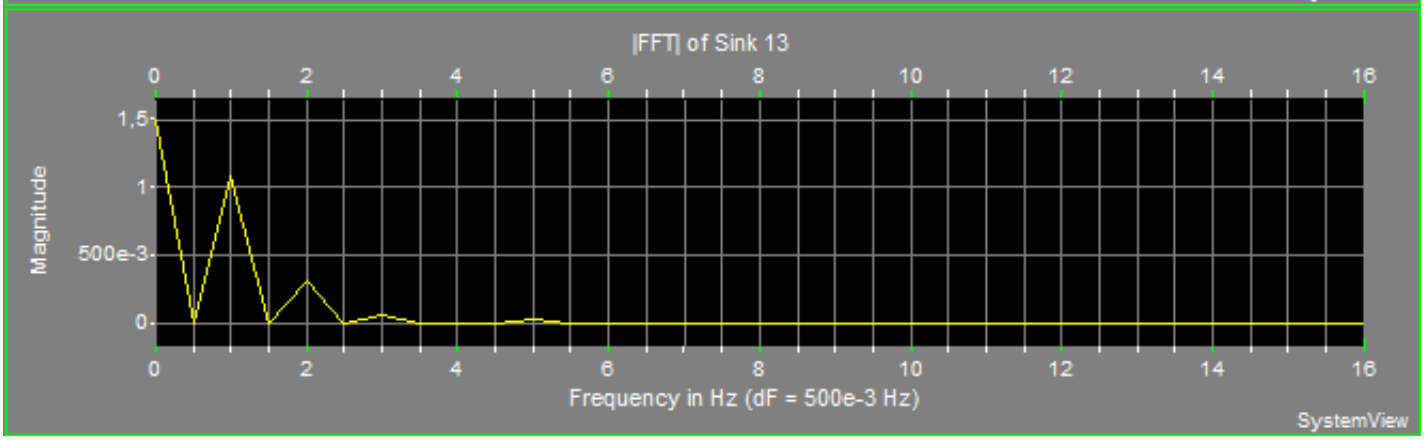

Sink 11
Amplitude
Time in Seconds
SystemView

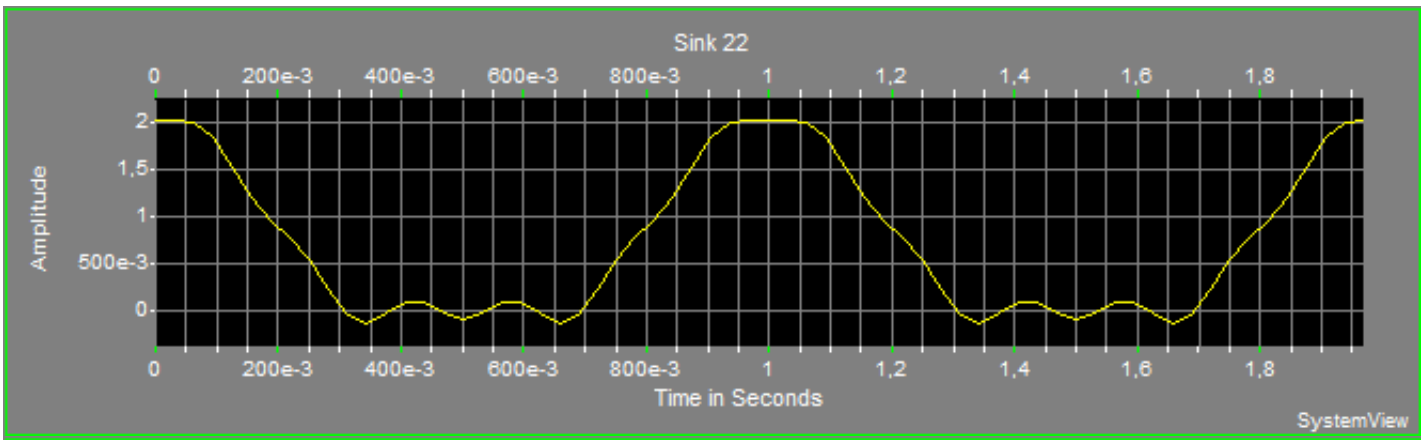

|FFT| of Sink 11
Magnitude
Frequency in Hz (dF = 500e-3 Hz)
SystemView

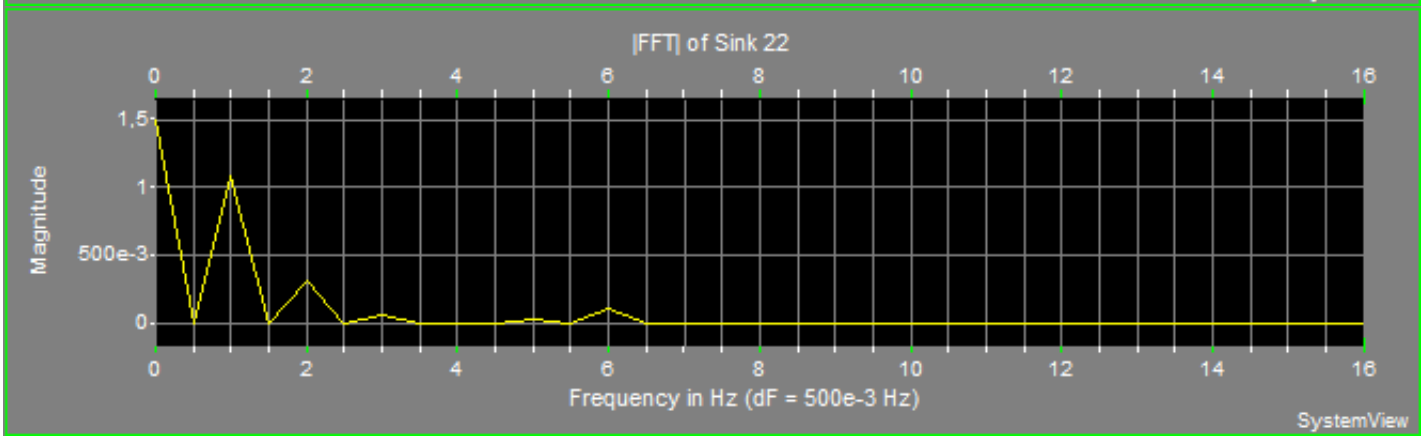

Sink 12
Amplitude
Time in Seconds
SystemView

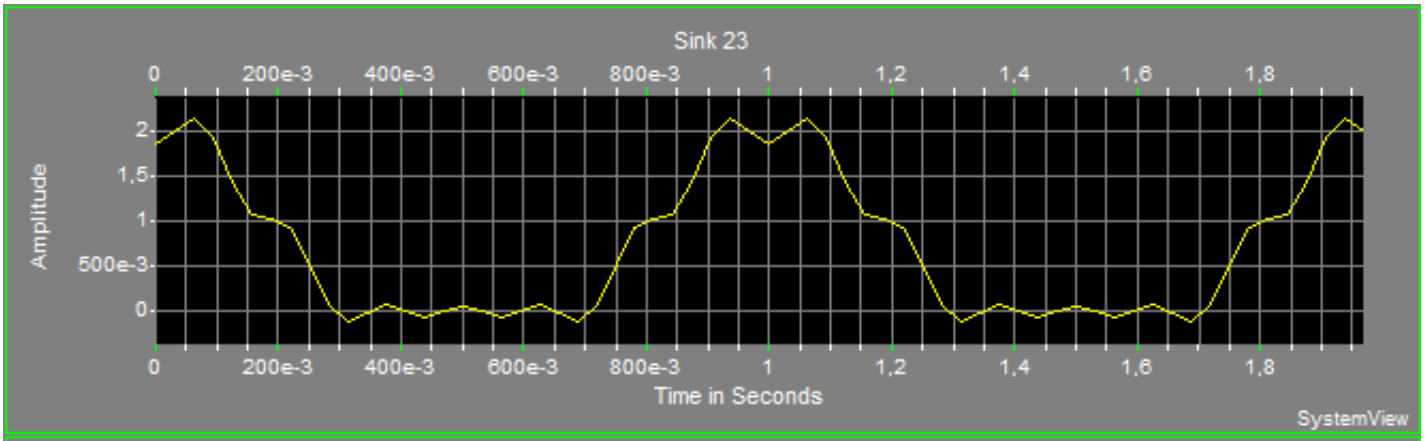

|FFT| of Sink 12
Magnitude
Frequency in Hz (dF = 500e-3 Hz)
SystemView

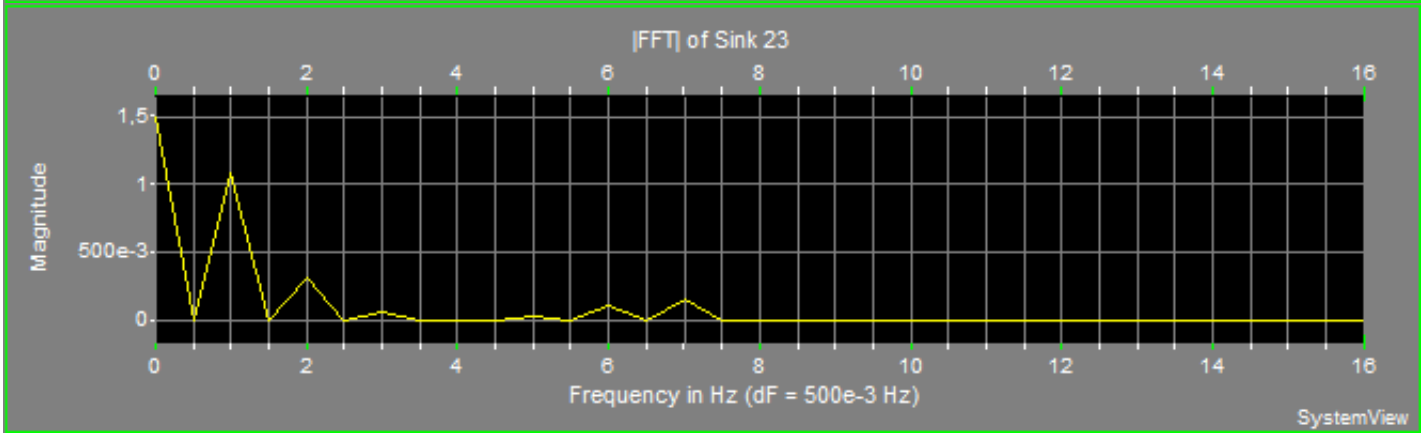

Sink 13
Amplitude
Time in Seconds
SystemView

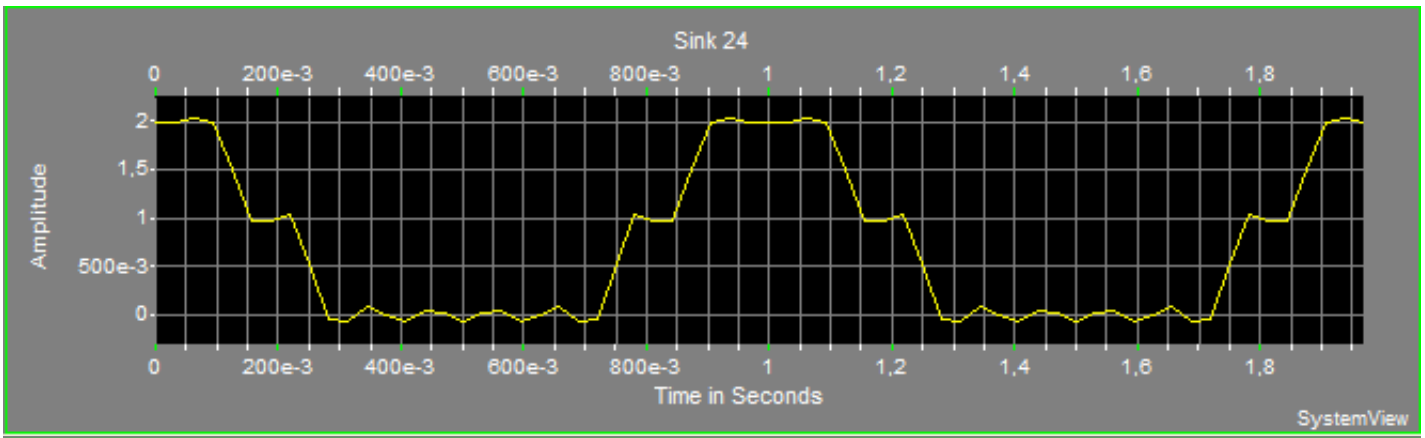

|FFT| of Sink 13
Magnitude
Frequency in Hz (dF = 500e-3 Hz)
SystemView

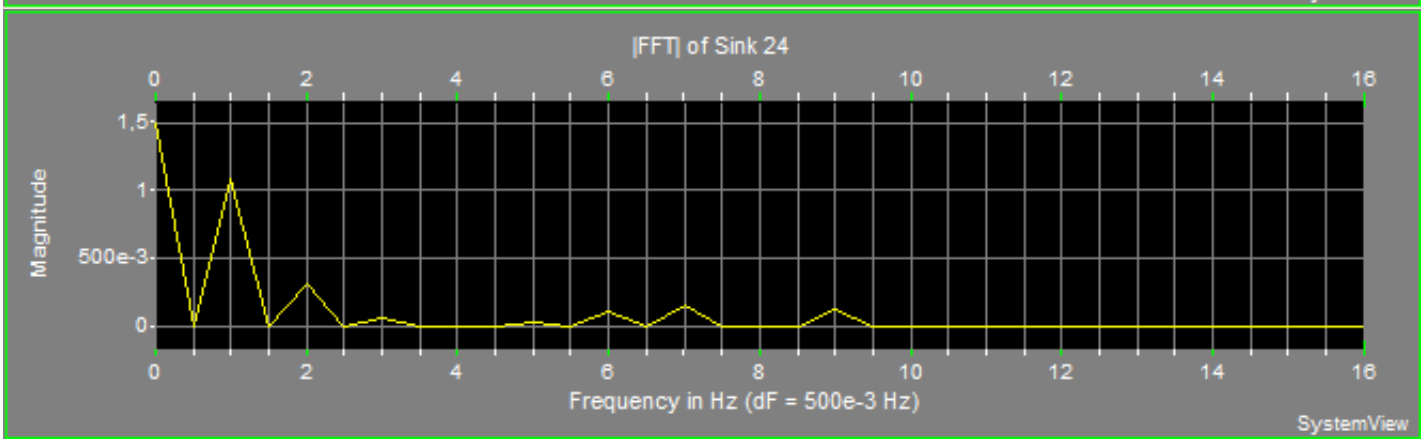

Sink 22
0
200e-3
400e-3
600e-3
800e-3
1
1,2
1,4
1,6
1,8
2
1,5
1
500e-3
0
Amplitude
Time in Seconds
SystemView

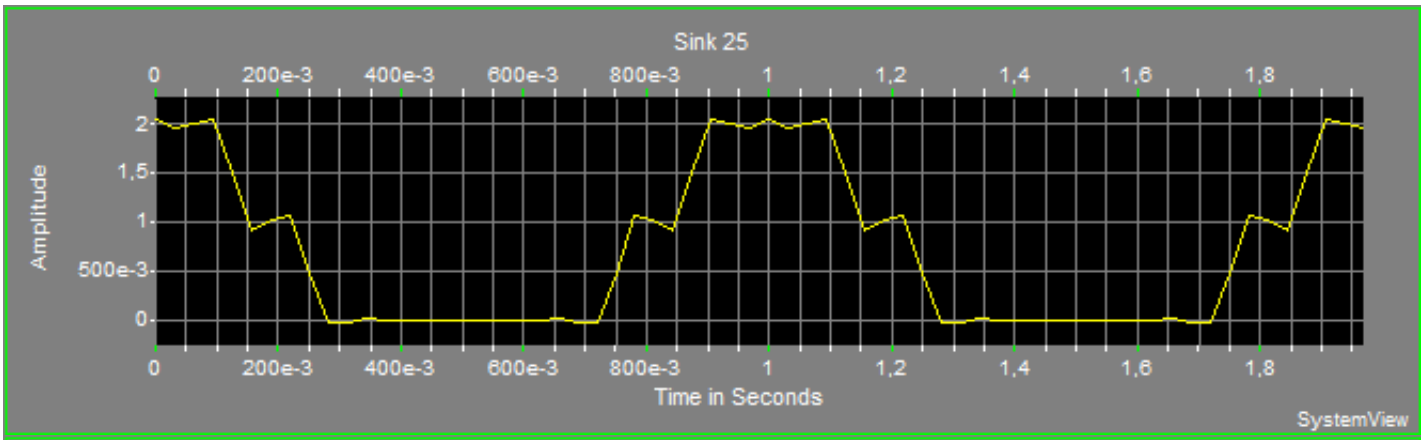

|FFT| of Sink 22
0
2
4
6
8
10
12
14
16
1,5
1
500e-3
0
Magnitude
Frequency in Hz (dF = 500e-3 Hz)
SystemView

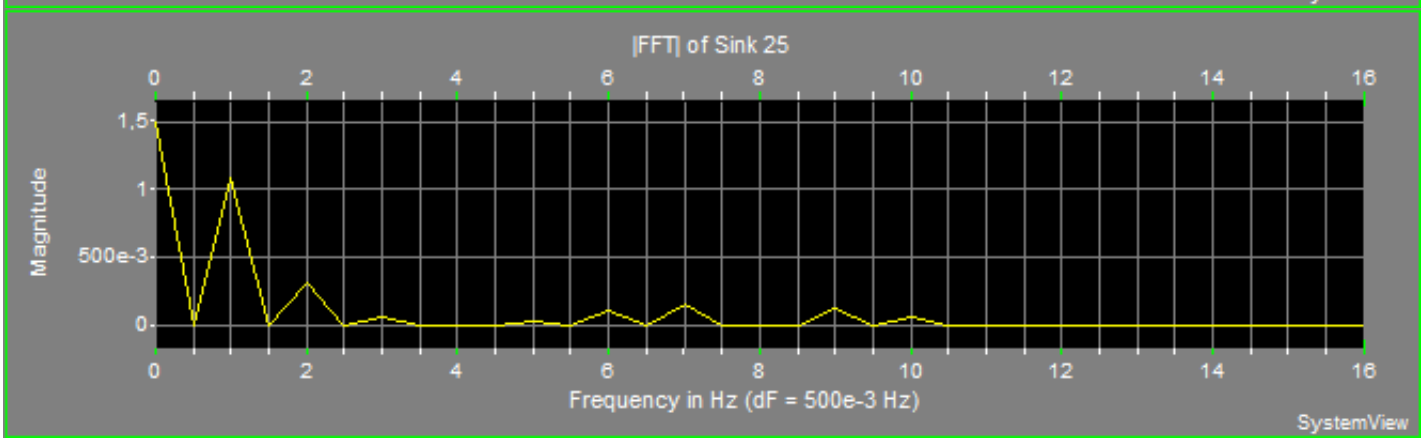

Sink 23
0
200e-3
400e-3
600e-3
800e-3
1
1,2
1,4
1,6
1,8
2
1,5
1
500e-3
0
Amplitude
Time in Seconds
SystemView


|FFT| of Sink 23
0
2
4
6
8
10
12
14
16
1,5
1
500e-3
0
Magnitude
Frequency in Hz (dF = 500e-3 Hz)
SystemView


Sink 24
Amplitude
0
200e-3
400e-3
600e-3
800e-3
1
1,2
1,4
1,6
1,8
2
1,5
500e-3
Time in Seconds
SystemView


|FFT| of Sink 24
Magnitude
0
2
4
6
8
10
12
14
16
1,5
1
500e-3
Frequency in Hz (dF = 500e-3 Hz)
SystemView


Sink 25
Amplitude
0
200e-3
400e-3
600e-3
800e-3
1
1,2
1,4
1,6
1,8
2
1,5
500e-3
Time in Seconds
SystemView


|FFT| of Sink 25
Magnitude
0
2
4
6
8
10
12
14
16
1,5
1
500e-3
Frequency in Hz (dF = 500e-3 Hz)
SystemView

Secinājumi

Laboratorijas darbā trigonometrisku funkciju Furjē rinda tika izmantota signālu formēšanai. Šim nolūkam tika izmantoti sinusoidāla sprieguma avoti ar amplitūdām vienādām aprēķinātiem Furjē rindas koeficientiem. Pēc summēšanas ir iegūts izejas spriegums, kas tuvināti atbilst sintezējamam signālam. Pēc oscilogrammām var redzēt, ka jo lielāks locekļu skaits, jo labāka atbilstība.

Amplitūdu spektrs iegūtais ar SystemView atbilst apreķinātam. Atšķirība ir tikai nulltās harmonikas vertībai, jo spektra iegūšanai programma izmanto Furjē transformāciju.