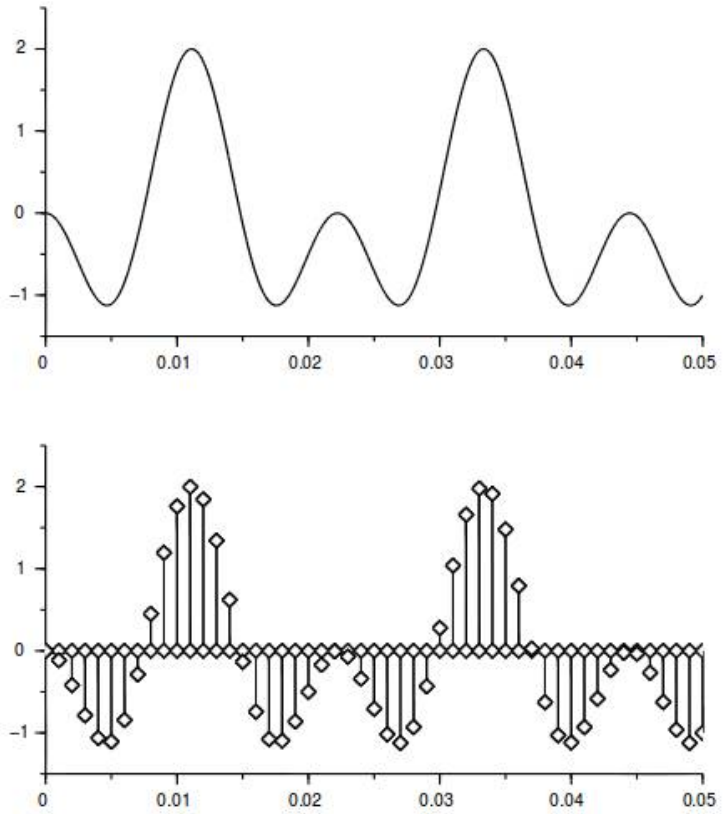
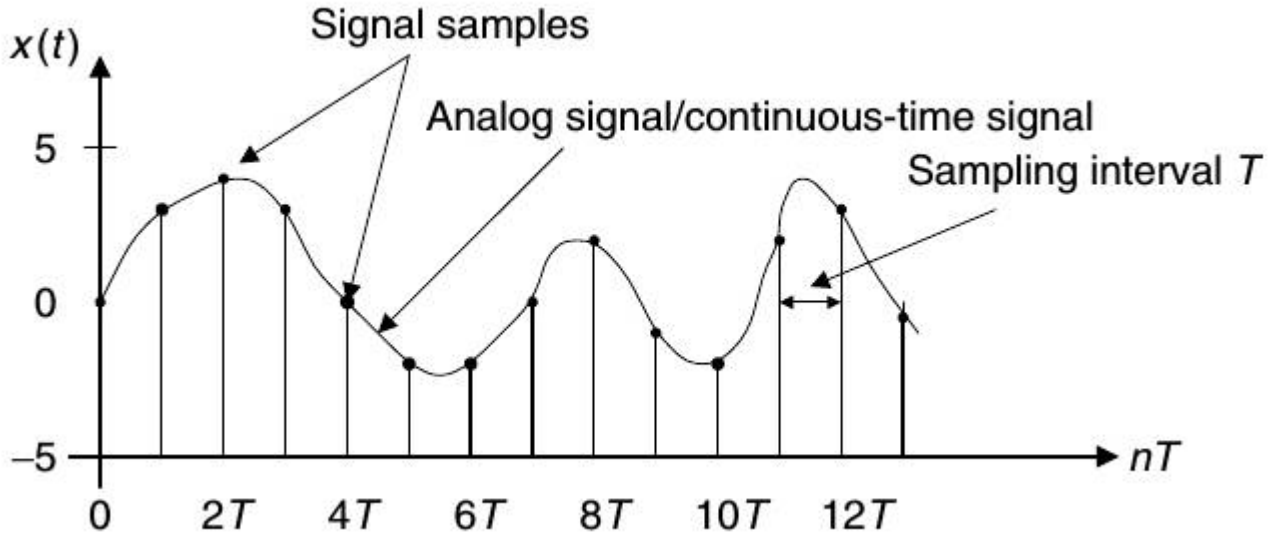
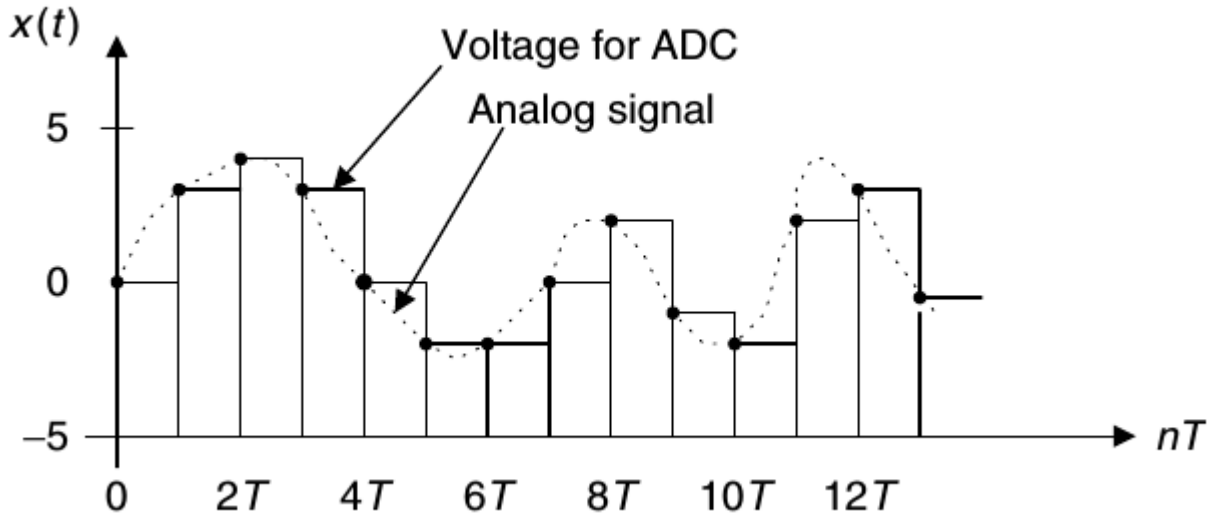
Sampling

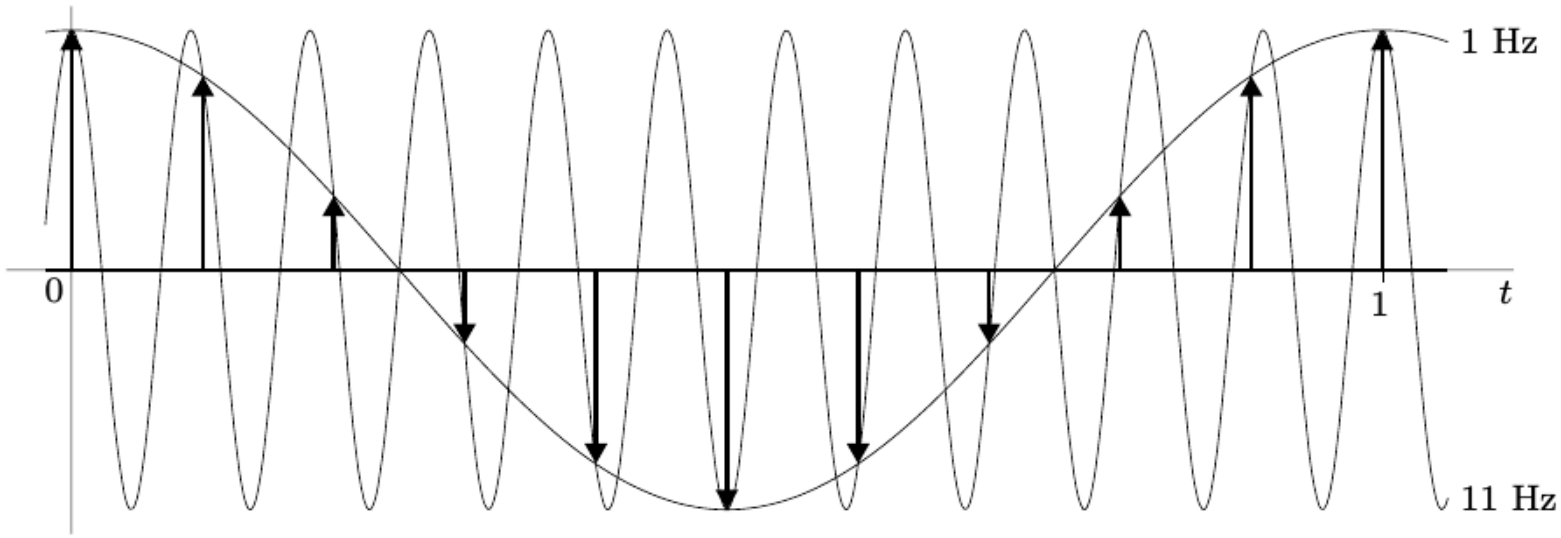


Sampling


x(t)
Signal samples
Analog signal/continuous-time signal
Sampling interval T
5
0
–5
nT
0
2T
4T
6T
8T
10T
12T


x(t)
Voltage for ADC
Analog signal
5
0
–5
0
2T
4T
6T
8T
10T
12T
nT

Aliasing



Nyquist Theorem (sampling theorem)

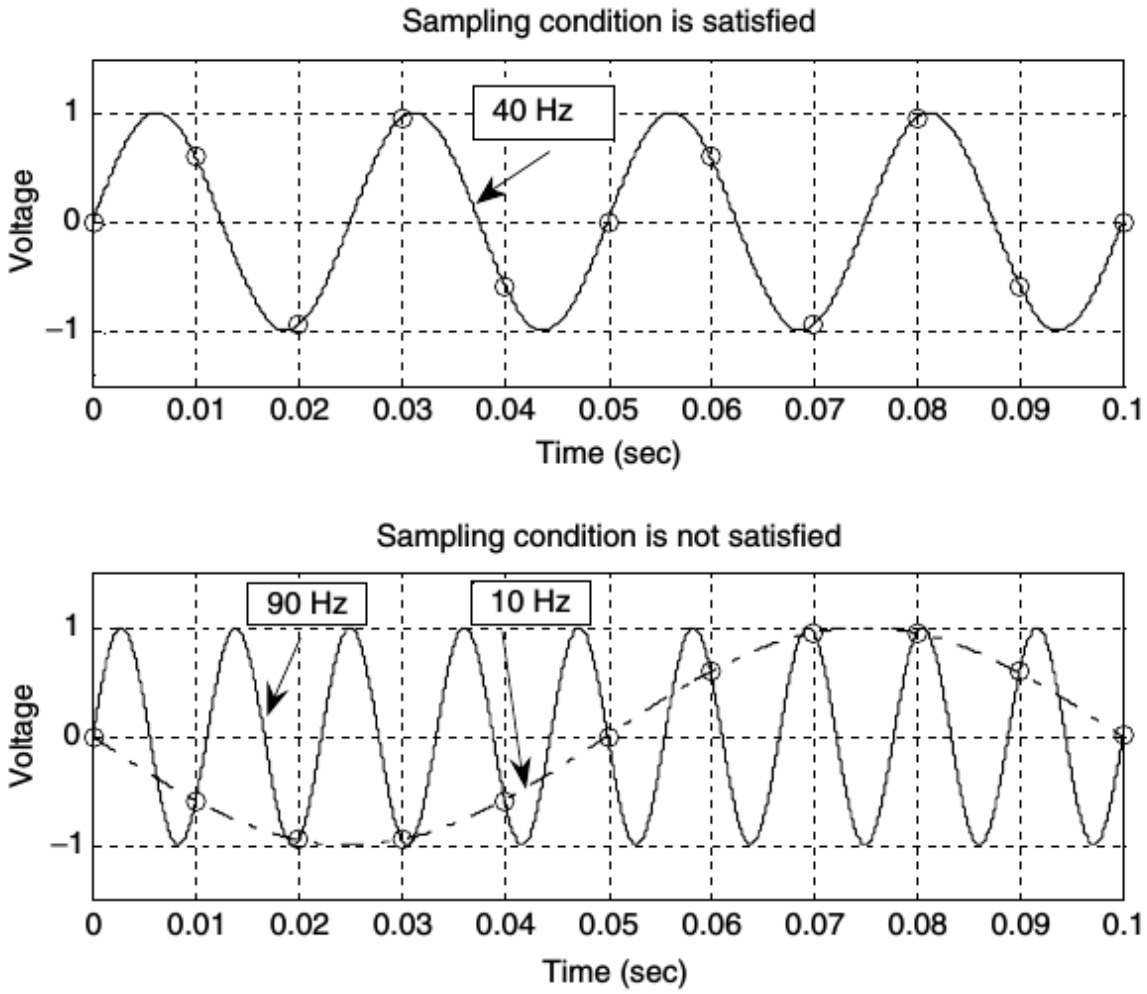
- A real signal whose spectrum is bandlimited to *B* Hz can be reconstructed exactly, without any error, from its samples taken uniformly at a rate *Fs* > 2*B* Hz

In practice, where filters are not ideal, sampling rates are usually chosen modestly above the Nyquist rate; a rate 20% greater is common.

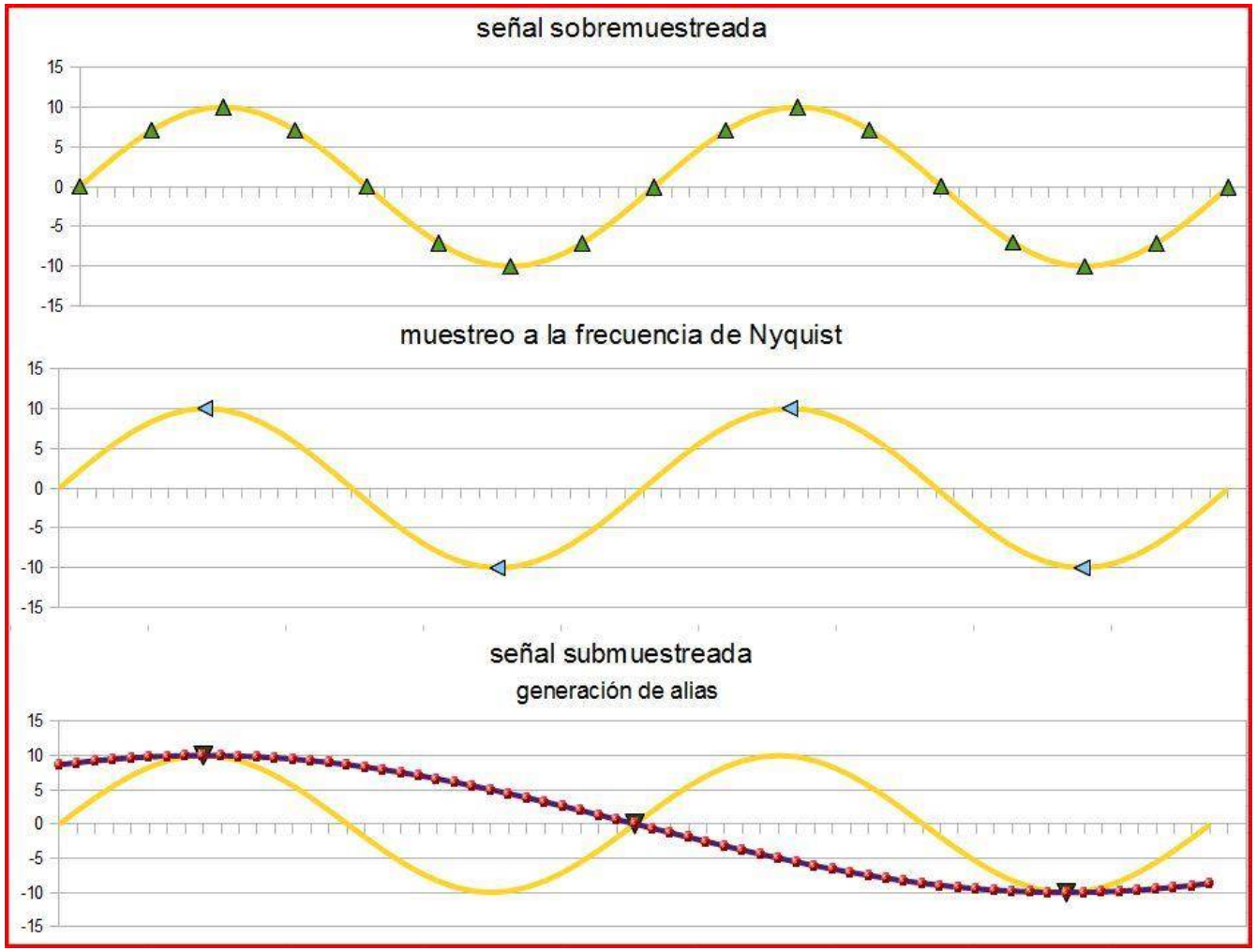
Excercise

- A sample speech signal contains frequencies up to 4 kHz, which is the minimum sampling rate?

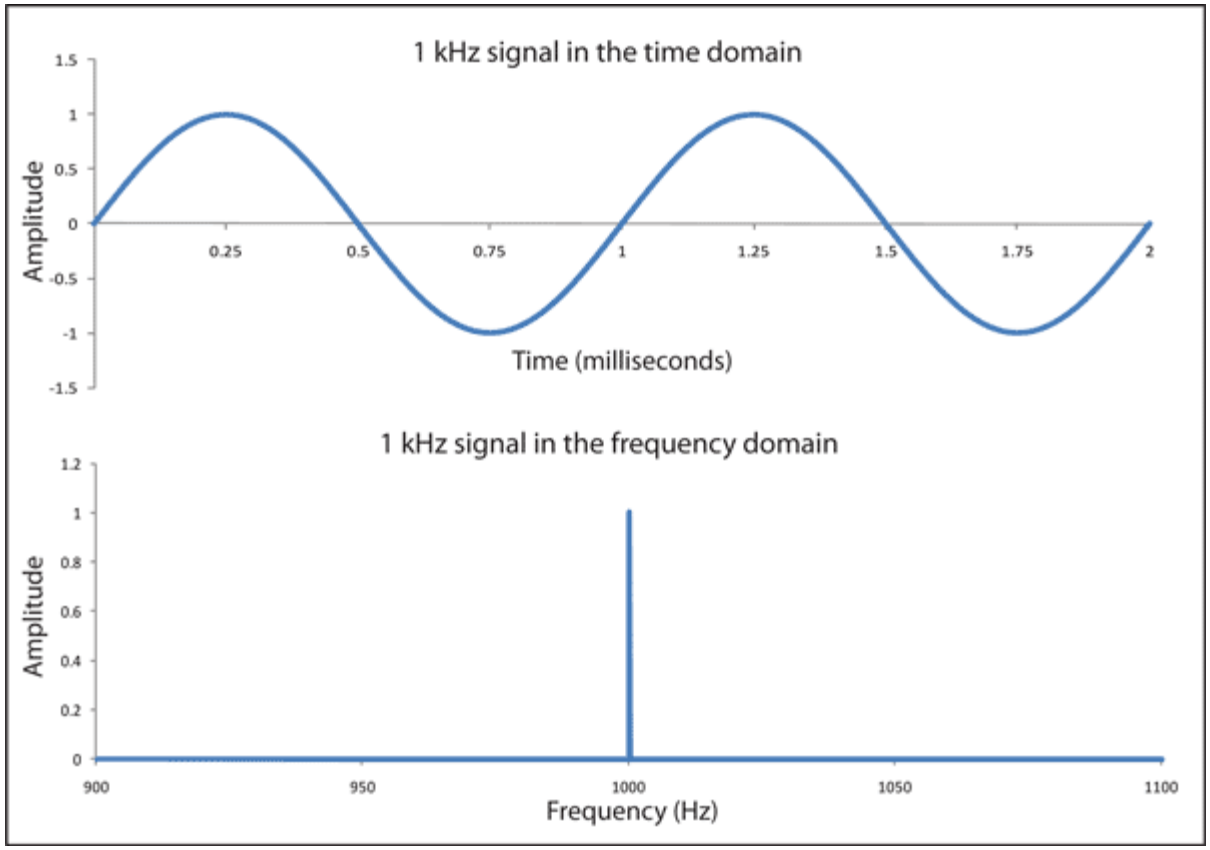
Is the Nyquist Theorem satisfied?



Sampling comparation



Time and frequency domain



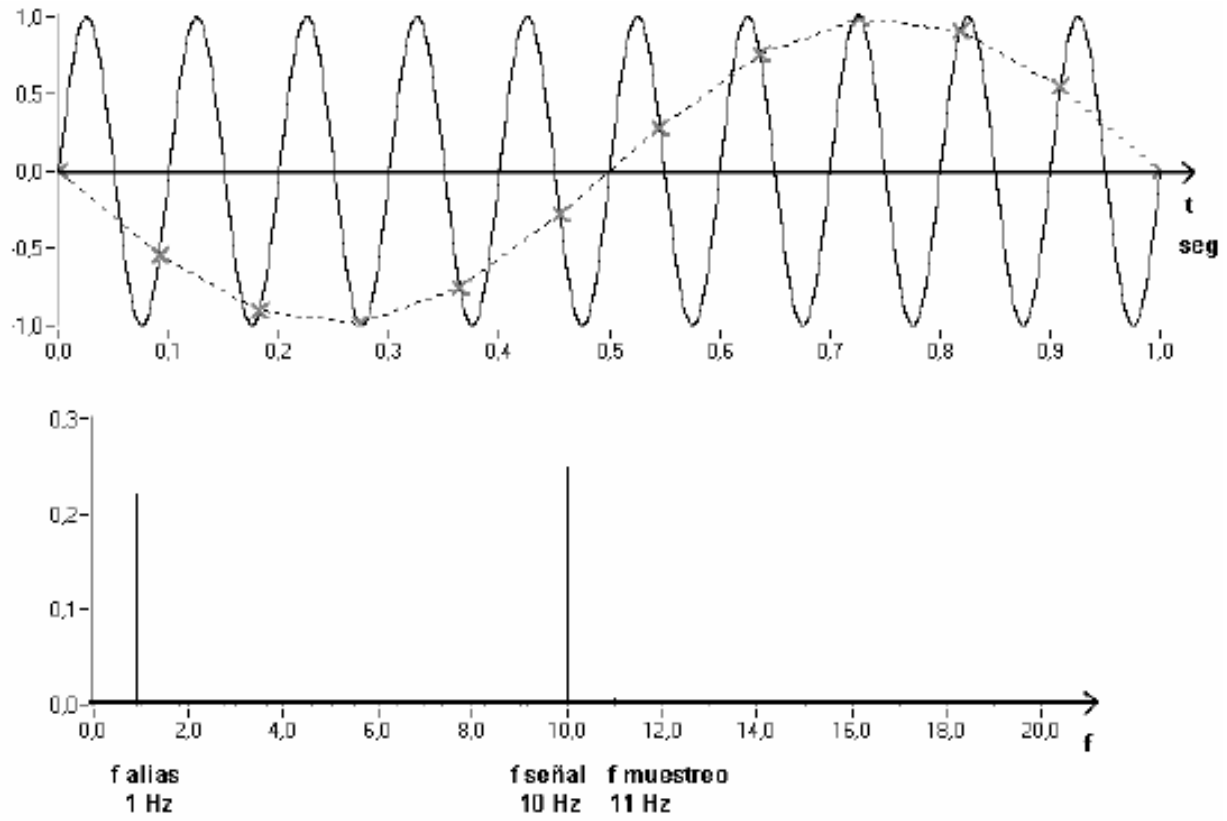
Video

- time2freq.ogv

Frecuencia alias

Otro ejemplo: si tenemos una señal de 10 Hz y se muestrea a 11Hz tendremos una señal debido al efecto de aliasing de:

Frec Alias = (11 – 10) = 1 Hz



Frecuencia alias

Frec Alias = ABS (Múltiplo entero frec. de muestreo – frecuencia de la señal)

Ejemplo:

Supongamos una señal de 25 Hz con componentes de ruidos en 70, 160 y 510 Hz y se muestrea a una frecuencia de 100 Hz. Tenemos por tanto una frecuencia de Nyquist de 50 Hz, por lo que las componentes inferiores a esta frecuencia es muestreada correctamente desde el punto de vista frecuencial. Pero las frecuencias superiores a 50 Hz producen frecuencias alias de valor:

Para 70 Hz : Alias = | 100 – 70 | = 30 Hz
Para 160 Hz: Alias = | 2 (100) –160 | = 40 Hz
Para 510 Hz: Alias = |5 (100) – 510 | = 10 Hz