To answer this question, two cases must be considered :
--> Sampling for further calculation
--> Sampling for further re-collection

SAMPLING FOR FURTHER CALCULATION :

This case applies, for instance, for the calculation of Fast FOURIER Transform. The SHANNON theorem can be fully implemented here.

$$Fe \geq 2 \times F$$

SAMPLING FOR FURTHER RE-COLLECTION :

The SHANNON theorem also applies in that case but in an approximate way.

What must be known in practice is the minimum time between two consecutive samples in order to be able to re-collect the signal by a fairly simple interpolation.

The sampling rate therefore will depend on the allowable deviation from these samples to the re-collected signal and will also be affected, of course, by the signal's shape.

$$Fe > \frac{2,2}{\sqrt{\varepsilon}} \times F$$

ε is the allowable deviation

Example :

for 0.1 % of allowable deviation
$Fe \geq 70\ F$
or 35 times the SHANNON frequency

Nyquist Rule

Sampling frequency must be at least 2X of input bandwidth
Nyquist sampling theory is an excellent rule of thumb, but deviations from the rule are possible which can both extend and enhance performance.

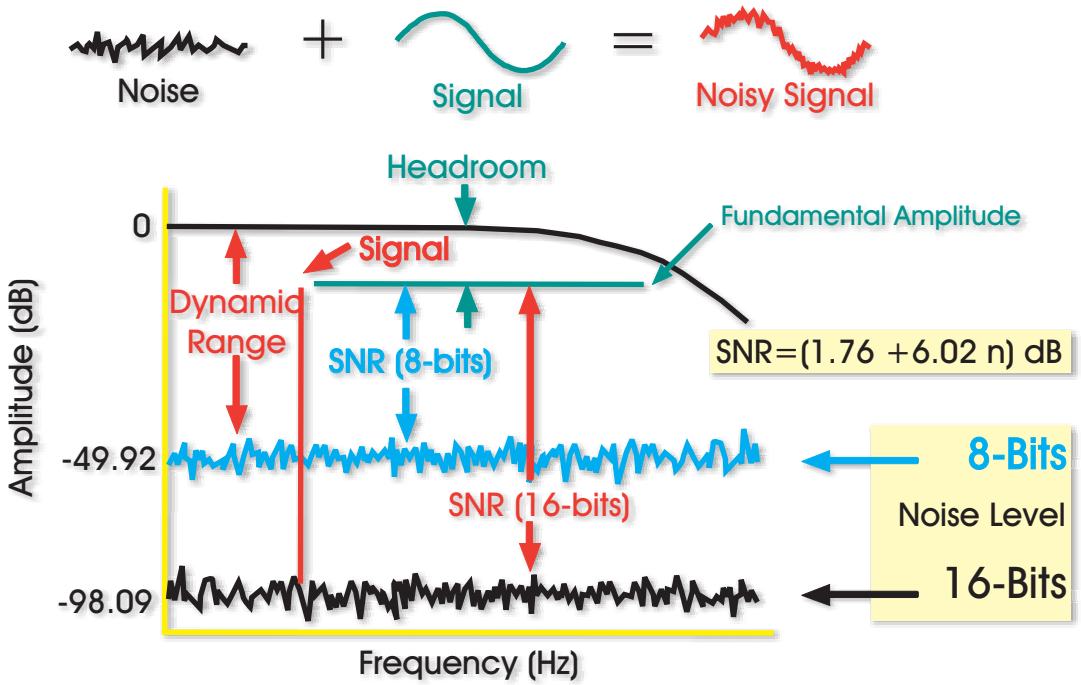
Undersampling

Possible with "intelligent" system
= Sample input signals which are above Nyquist rate
= Requires prior knowledge of input signal
= Input frequency components must lie between adjacent integer multiples of fs/2
= Requires adequate full-power bandwidth
= Input signal bandwidth must be less than fs/2

Oversampling

Reduces aliasing problems
Sampling faster than the required Nyquist rate
= the oversampling ratio R = fs/2fin (where R = 1 for Nyquist rate Sampling)
= The expression of full-scale SNR (**S**ignal to **N**oise **R**atio) for oversampling conditions is given by :

SNR = 6.02n (number of bits of resolution) + 1.76dB + 10 log 10 (fs/2fin)



An advantage of oversampling is improved SNR

WE CAN SEE NOW, for a given input bandwidth, doubling the sampling frequency can increase SNR by 3dB, and increase effective bits by ½ bit.

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