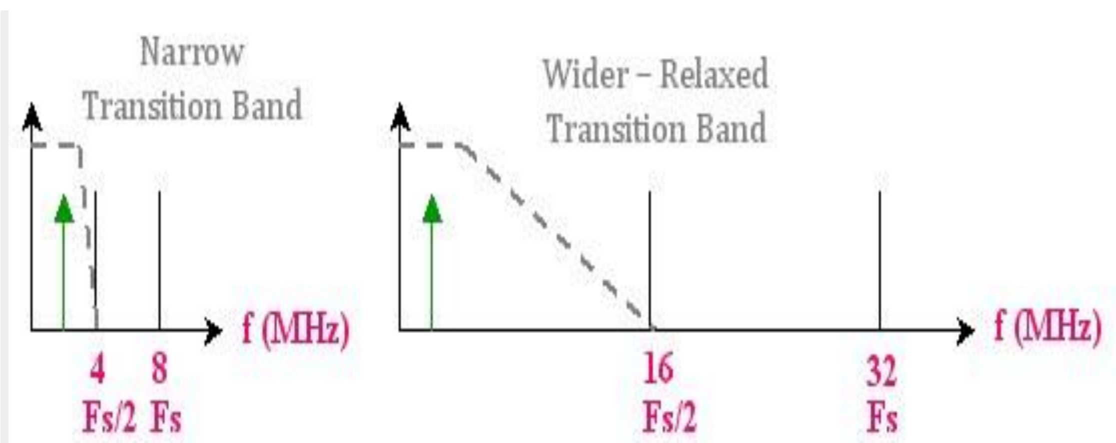
EFFECTS OF SAMPLING RATE

Consider a sinusoidal signal of frequency Fm=2MHz. Lets say that we sample the signal at Fs=8MHz (Fs>=2*Fm). The factor Fs/Fm is called “over-sampling factor”. In this case we are over-sampling the signal by a factor of Fm=8MHz/2MHz = 4. Now the folding frequency will be at Fs/2 = 4MHz. Our anti-aliasing filter has to be designed to strictly cut off all the frequencies above 4MHz to prevent aliasing. In practice, ideal brick wall response for filters is not possible. Any filter will have a transition band between pass-band and stop-band. Sharper/faster roll off transition band (or narrow transition band) filters are always desired. But such filters are always of high orders. Since both the anti-aliasing and reconstruction filters are analog filters, high order filters that provide faster roll-off transition bands are expensive (Cost increases proportionally with filter order). The system also gets bulkier with increase in filter order.Therefore, to build a relatively cheaper system, the filter requirement in-terms of width of the transition band has to be relaxed. This can be done by increasing the sampling rate or equivalently the over-sampling factor. When the sampling rate (Fs) is increased, the distance between the maximum frequency content Fm and Fs/2 will increase. This increase in the gap between the maximum frequency content of the signal and Fs/2 will ease requirements on the transition bands of the anti-aliasing analog filter. Following figure illustrates this concept. If we use a sampling frequency of Fs=8MHz (over-sampling factor = 4), the transition band is narrower and it calls for a higher order anti-aliasing filter (which will be very expensive and bulkier). If we increase the sampling frequency to Fs=32MHz (over-sampling factor = 32MHz/2MHz=16), the distance between the desired component and Fs/2 has greatly increased that it facilitates a relatively inexpensive anti-aliasing filter with a wider transition band. Thus, increasing the sampling rate of the ADC facilitates simpler lower order anti-aliasing filter as well as reconstruction filter. However, increase in the sampling rate calls for a faster sampler which makes ADC expensive. It is necessary to compromise and to strike balance between the sampling rate and the requirement of the anti-aliasing/reconstruction filter.



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Source: http://www.gaussianwaves.com/2011/07/sampling-theorem-baseband-sampling/