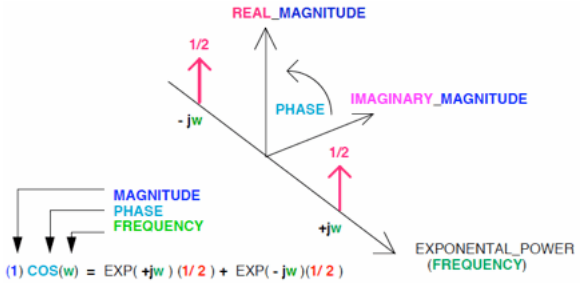
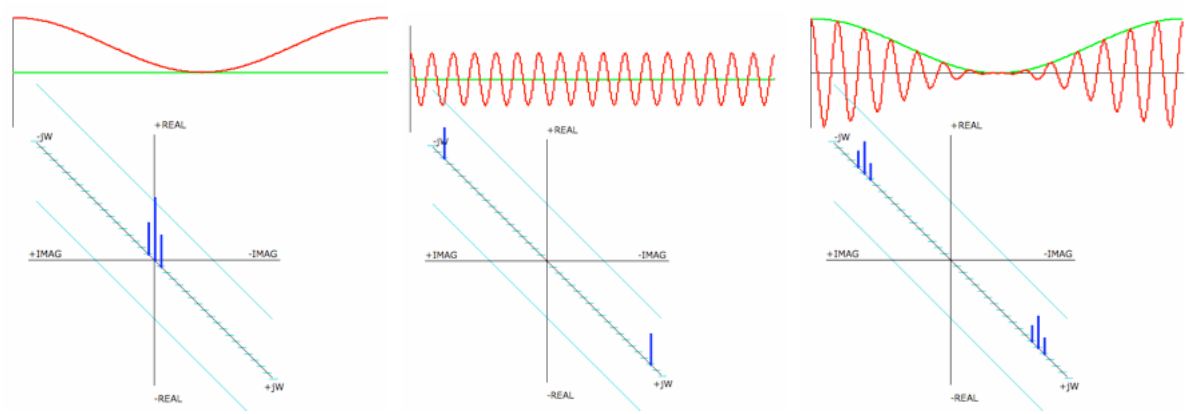
==========Single_Sideband==========



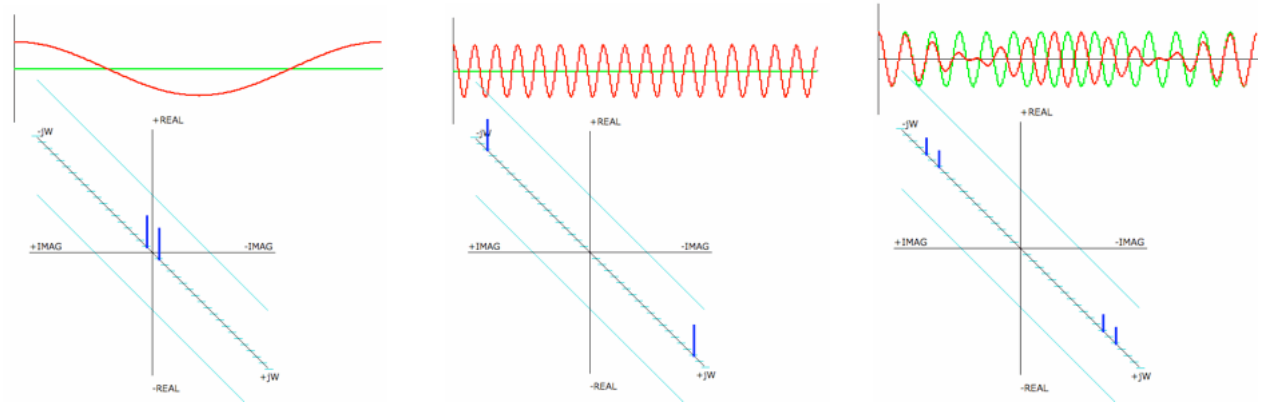
Now and again the need arrises to filter a signal in a way that does not change signal magnitude, but rather changes signal phase. The price of bandwidth has always been expensive. Single sideband modulation is an old method of broadcasting a signal efficiently. The Euler identity equation provides a good way of mapping AC signal into a 3 dimensional graph to make it much easier to see how this is done.



modulation Audio + DC **X** **carrier 1MegHz** **=** **Amplitude Modulation AM Radio station**

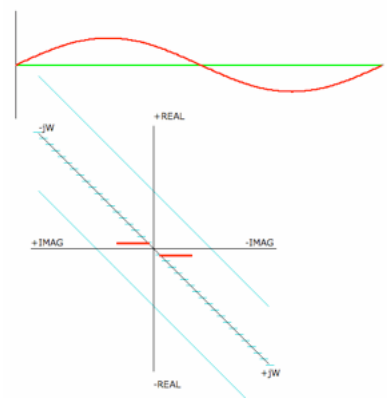
Modulation is multiplying a carrier signal by a modulation signal. Exponentials multiply by summing the power terms. The graph above shows the result of multiplying a cosine wave carrier by a cosine modulation carrier which has DC a value.

This method is not efficient in that less than half of the broadcast energy is composed of signal energy. But a crystal radio can detect this type of signal.

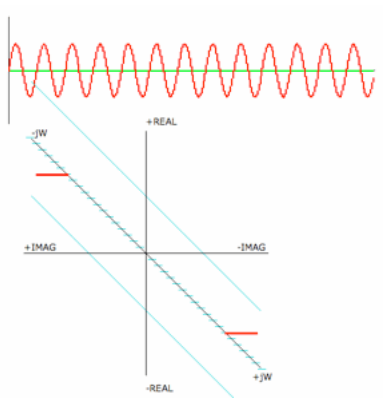


modulation 2KHz Cosine **X** **carrier 1MegHz Cosine** **=** **Pair of Cosines 1002KHz + 998KHz**

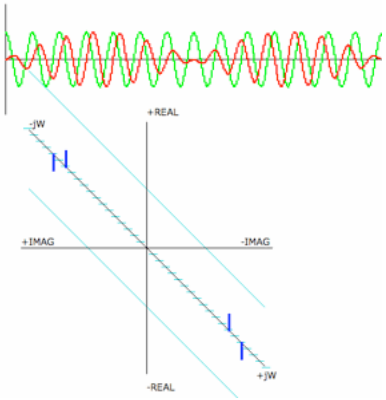
The result of multiplying a cosine wave carrier by a modulation carrier which has no DC a value is shown above. Now 100% of the broadcast energy is due to the modulation signal. The only problem is that a 2KHz bandwidth audio signal is requiring +/- 2KHz bandwidth of the broadcast band.



modulation X
2KHz Sine



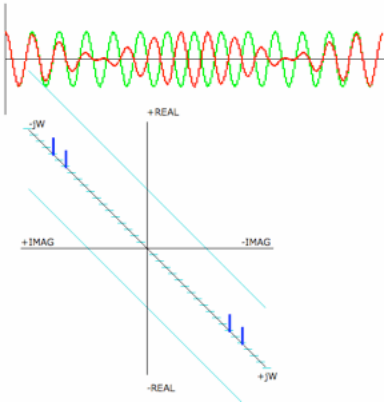
carrier =
1MegHz Sine



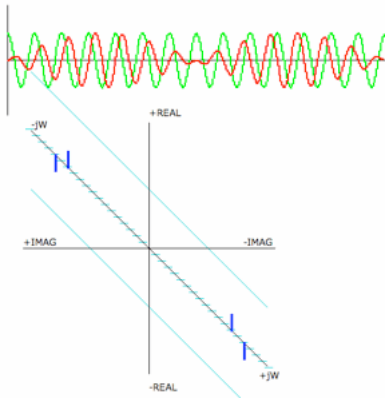
Inverted Pair of Cosines
1002KHz + 998KHz

It is easy to come up with a carrier signal which is a sinewave. Suppose a filter exists that can translate any cosine audio signal into a sinewave for all frequencies.

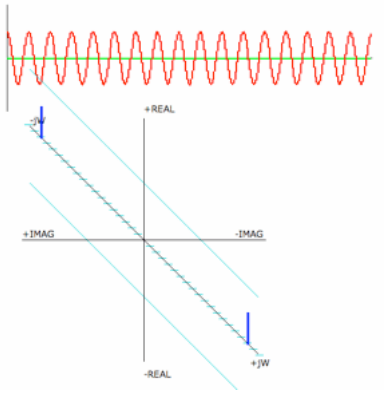
The result of multiplying a sine wave carrier by a sinwave modulation carrier produces the spectrum above.



Pair of Cosines +/-



Inverted Pair of Cosines =



1002KHz or 998KHz

Adding or subtracting the two spectrums is going to cause one of the sidebands to cancel out. Now a 2KHz bandwidth audio signal is being broadcast over a 2KHz bandwidth at 100% efficency.

The only trick to doing this is providing a way to 90 degree phase shift all frequencies of an audio signal. The linear world has been doing this using all pass filters. The digital world can provide some additional methods.

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