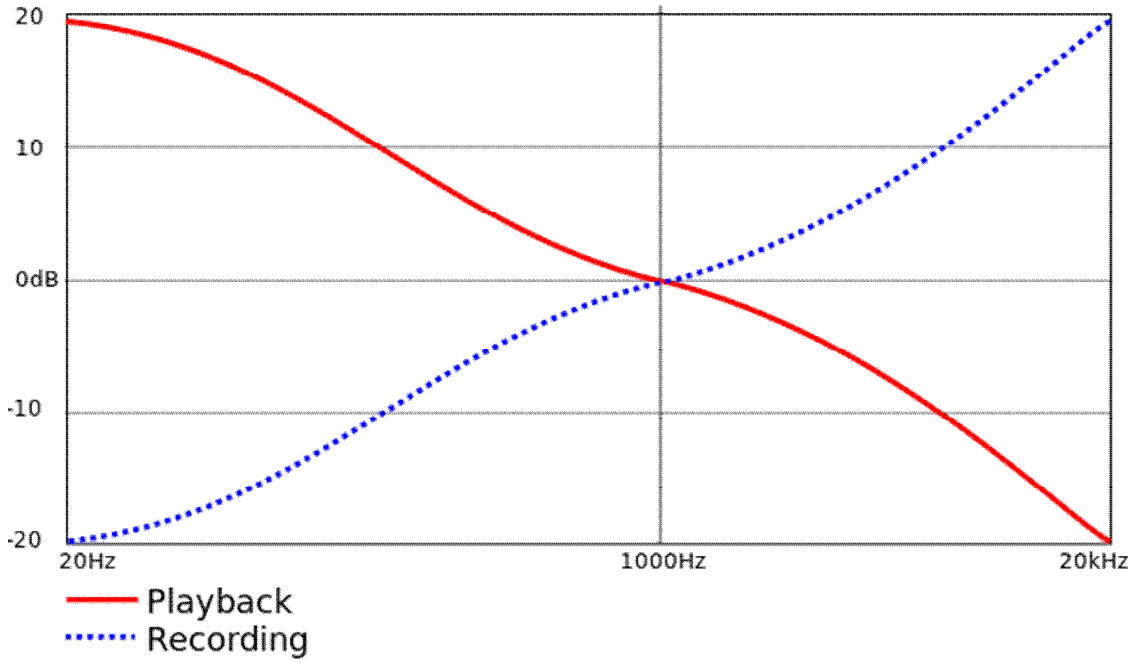
What is Emphasis

With any electrical signals, being the transmission over wires or radio, or the process of converting analog to digital or for whatever purpose, this will require some form of signal conditioning. The reason is that the converting process creates problems either to obtain acceptable signal to noise ratio or signal linearity.
With digital conversion of an analog system the technique is also used to accommodate frequency response as well as dynamic range.
In either case, the conditioning of the incoming signal function must be reversed at the other end, restoring the original signal.

This process is called Emphasis and De Emphasis, this concept was first used in the recording of records, those of you old enough will remember audio amplifiers that had a switch with different equalisation settings.
This is because some studios would use one curve and the opposition another (below)



In the case of recording a signal on a vinyl record, emphasis was so devised to overcome the inertia of the cutting head where its more efficient in the low frequencies, hence the

groove amplitude would reduce as the frequencies got higher so the playback of the recording would require same sort of compensation to restore the linearity of the signal.

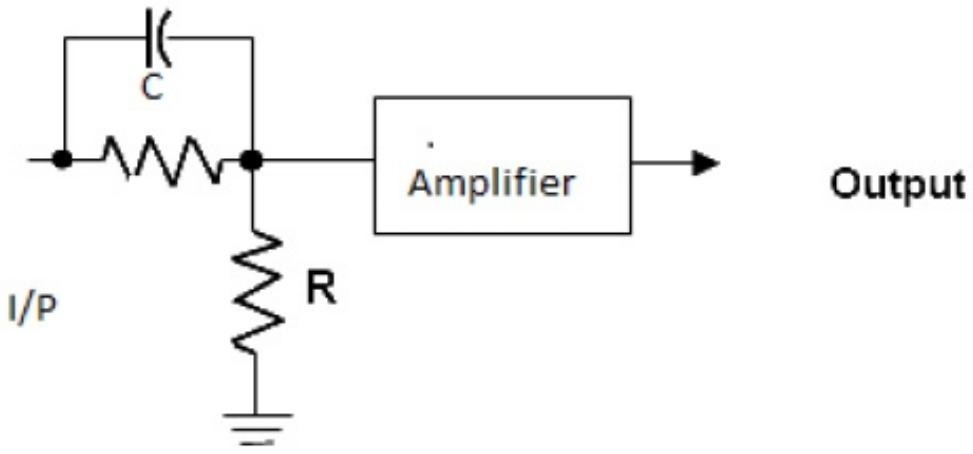
The other consideration was to provide a better signal to noise ratio, that is if the noise is in the high frequencies increasing the signal will give a better signal to noise ratio.
In the playback process, the equalising applied by the De Emphasis, will reduce the amplitude of the wanted signal and at the same time reduce the unwanted noise, giving the better signal to noise ratio in the recording process.

Emphasis in Radio Communication

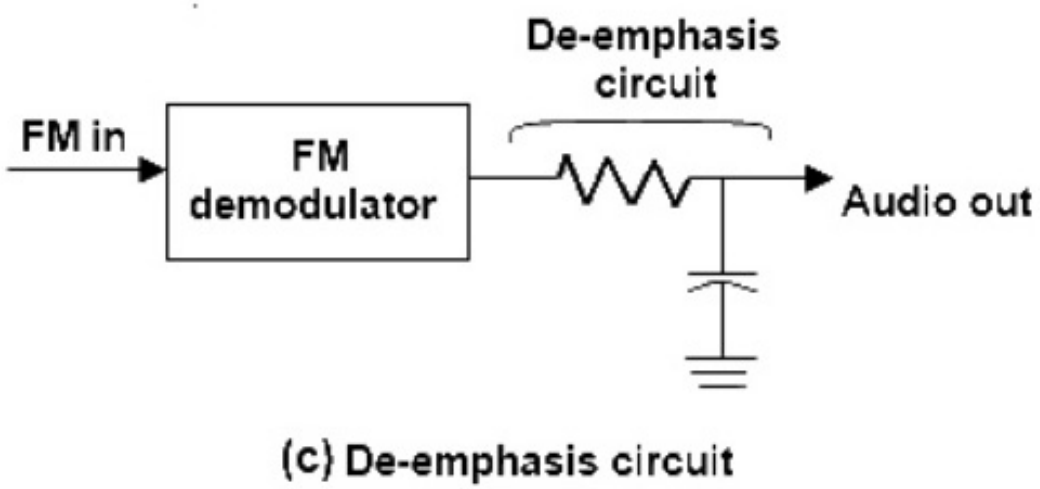
The technique can compensate for things like dynamic range, frequency linearity and signal to noise ratio with digital signals to accommodate the best fit for the available bits in the Analog to Digital converter. This is a very important process in the conditioning of signals to provide the best result, with radio communication and telephony.
To select that part of a speech pattern (range of complex frequencies) that carries the clarity, its not necessary to have the full spectrum as in HiFi of up to 20Khz, in fact a long time ago it was accepted that a frequency bandwidth from 300Hz to 3KHz provided all the tonal clarity to converse over that medium. The rest of the spectrum could be deleted without loss of intelligence.

Emphasis in FM

One of the downsides of FM (Frequency Modulation) is that the receiver FM detector is inherently noisy, so to compensate the transmitter modulation is emphasised with a 6db per octave filter. What it does is to increase the power in a logarithmic function of the wave every time the frequency doubles, resulting in more deviation in the higher frequencies. So, when the signal is demodulated the receiver filter reduces the higher frequencies by 6db per octave reducing the detector noise and further restoring the original signal.



Emphasis



(c) De-emphasis circuit

Radio Amateurs and its implications

Upon my return to the hobby after some 17 years absence, I have noted that the art of clean audio has considerably fallen by the wayside. Thus, I am prompted to write this article informing as to why we have specifications in the manner that we modulate our signals.
Often, I hear the term of arm chair listening, well its not the case, radio communication receivers are designed with an audio frequency response of 300 to 3000Hz, the filters are designed with this in mind, enter DSP and this will make things even worse if one modulates outside the spectral range. Clearly those doing so, have a misunderstanding of what is involved.

Linking of Computers to Radios

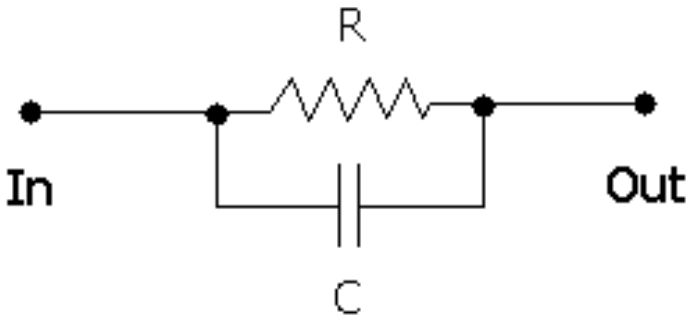
There are many options available today to link the audio from a computer to a radio, this transmission creates its own set of problems, to do with audio quality.
The spectral response can suffer usually making the resulted sound at the receiver end sound heavy with lots of lows, this detracts from the clarity of the signal and for those in a mobile reception mode makes it unreadable.

Remember that the signal to noise ratio is what makes that signal readable, consider mobile flutter a signal with lots of base will be unreadable. Yet if the high frequencies are lifted the readability will proportionately increase, this applies to FM as well as to SSB.

The other problem is that usually the computer audio that is linked to the radio is connected via the most convenient method, the microphone input, and on most FM 2 way radios today which use condenser microphone and don't run the required emphasis but place this as an audio characteristics of the microphone.
The other problem is that the impedance mismatch is likely to reduce any of the highs in the inputting audio.
Both need to be compensated providing the best possible audio for readability.

Calculating the filter value

This web site will take the pain out of the mathematics
http://www.sengpielaudio.com/calculator-timeconstant.htm



Pre-Emphasis

This is as simple as it gets to apply some emphasis to your computer radio linkup
The R attenuates all frequencies from 300 to 3000Hz where the capacitor reactance decreases as the frequency raises, providing a high frequency boost as a function of capacitive reactance, this equates to a 6db increase per octave, the amplitude doubles every time the frequency doubles.
Approximately 50us setting for the above, (while 75us is more for wide band FM)

Concluding

This is very important technique if you build a repeater or link your radio to a computer, the simple addition of a resistor and capacitor will increase the readability of your signal.