SENCORE
Means Success In Electronic Servicing
tech tips

Understanding Preemphasis And Deemphasis

Most text books spend little time explaining preemphasis and deemphasis. Therefore, many servicers do not understand these circuits. This Tech Tip will examine preemphasis and deemphasis and then take a brief look at how they affect electronic servicing.

What Is Preemphasis And Deemphasis?

Preemphasis and Deemphasis are ways to reduce noise. Two main uses are in FM broadcasting and TV audio where high fidelity music is transmitted. Preemphasis is done at the FM transmitter. It involves boosting the amplitude of the high audio frequencies before modulating the carrier. Deemphasis, which is done at the receiver, reduces the amplitude of the detected high audio frequencies. Premphasis and deemphasis are equal but opposite processes so the recovered audio signal at the receiver is identical to the original audio signal. The result is a reduction in noise levels at the higher audio frequencies of the receiver. This extends the coverage area of the FM station and produces a more pleasing audio signal for the listener.

Noise Sources Affect All Electronic Systems

Noise is present in every electronic system. It interferes with the reception and reproduction of wanted signals. Nature generates noise in electrical storms, sun activity, and the stars beyond our solar system. Man also introduces noise from engine ignitions, electric motors, power lines, fluorescent lights, etc. Electronic circuits themselves generate noise due to rapid and random motion of electrons in the molecular structure of electronic components and circuits. These noise sources will limit the performance of any electronic system.

Noise Affects FM Reception

In the interval between the time an RF signal carrier is transmitted and detected by the receiver the carrier may be modulated by noise. The largest effect will be in changing the amplitude of the carrier. An indirect effect of noise on the frequency is a small carrier deviation (phase modulation). The limiter stage (before the FM detector) prevents amplitude changes on the carrier from passing to the receiver's detector stage. This is why FM is less affected than AM signals to natural and man-made noise such as lightning storms, electric motors etc. Any phase change of the carrier, however, will be passed to the detector and detected as noise.

Preemphasis Reduces Noise

To minimize these indirect phase modulation effects, the sound level at the output of the FM receiver's detector must be made much larger than the detected noise. The sound volume of an FM detector is proportional to the deviation of the FM carrier. If the audio signals cause a much larger carrier deviation than the indirect noise phase changes (during transmission and reception) the noise will not be as noticeable. Actually, the larger the modulation index at the transmitter, the better this signal to noise ratio will be at the output of the FM receiver. In FM broadcasting, the highest audio frequency will produce a maximum modulation index of 5, but for lower audio frequencies it may be much higher. The signal to noise ratio is proportional to the square of the modulation index. The highest modulation index can increase signal to noise ratio by 14 dB in FM broadcasting. See Figure 1.

Normal audio music signals contain many individual frequencies and harmonics which deviate the FM carrier. The low frequency components of speech and music are much higher in volume or signal amplitude than the higher audio frequency signals. Without preemphasis these higher audio frequencies would cause less carrier deviation and have a lower signal to noise ratio at the receiver. This results in noticeable noise to the listener.

Modulation Index	S/N Improvement
1	Ref.
2	6 dB
3	9.5 dB
4	12 dB
5	14 dB

$$\text{Modulation Index} = \frac{\text{Carrier Deviation}}{\text{Audio Modulating Frequency}}$$

Fig. 1: The signal-to-noise ratio will improve at the FM receiver in proportion to the square of the modulation index.

The Preemphasis Network

Signal to Noise ratios can be improved by increasing the amplification of the higher audio frequencies at the transmitter. This will cause larger carrier deviation, thus better signal to noise ratios at the receiver. A preemphasis network at the transmitter does just that. It adds increasing amplitude to higher audio frequencies conforming to a pre-arranged gain curve established by the FCC. This is referred to as a 75 usec pre-emphasis curve and is shown in Figure 2.

The preemphasis network at the transmitter may be a simple RC or LR filter network which will alter the gain of an

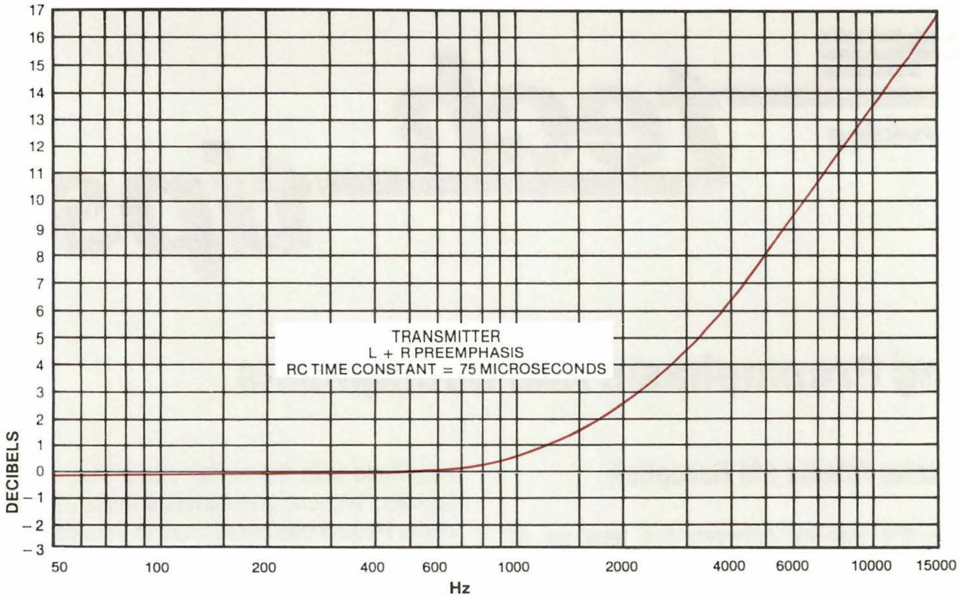


Fig. 2: At the transmitter, audio signals are routed through a 75 microsecond preemphasis network.

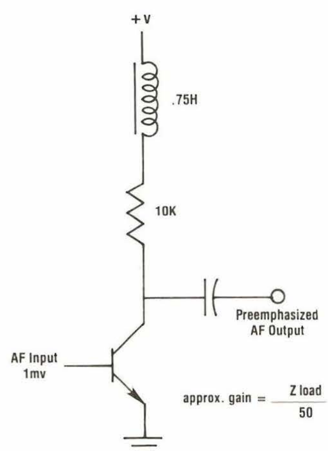
amplifier to conform to the preemphasis curve. The 75 usec is the time constant of the network which will cause an increase of 3 dB at the frequency given by the formula F= 1/2 RC. This frequency will be about 2,120 Hz. Figure 3 shows an example of a preemphasis circuit and a chart to indicate how the output impedance of the amplifier changes the gain of the stage to produce an output that conforms to the 75 usec curve.

The Deemphasis Network

At the receiver it is necessary to reverse the process using a deemphasis network. This is done to recover the audio signal to its original condition. A similar but opposite deemphasis network consisting of an RC low-pass filter with a 75 usec curve is used. Figure 4 shows a typical example of a deemphasis RC circuit and the resulting deemphasis curve. The chart shows how the output voltage decreases higher audio frequencies. Notice how this chart and deemphasis curve are exactly the opposite of the preemphasis curve and chart of Figures 2 and 3.

The Location Of The Preemphasis Network

At an FM broadcast station or TV station you will find the preemphasis network located in the L+R audio signal path as shown in Figure 5. This signal contains the combined left and right channel frequencies which then deviate the carrier. This L+R signal is the main audio channel and provides compatibility with non-stereo (mono) receivers. Since the preemphasis network is applied to the L+R signal at the transmitter, an equivalent deemphasis network is needed by both stereo and mono receivers.



Frequency	Transistor Voltage Gain & Output in mv	Preemphasis gain
300	202	.1 dB
1,000	221	.9 dB
2,120	283	3.0 dB
3,000	346	4.8 dB
5,000	512	8.2 dB
8,000	754	11.8 dB
10,000	964	13.7 dB
15,000	1,428	17.0 dB

Fig. 3: Audio preemphasis requires an RL or RC network to increase the amplification of higher audio frequencies to conform to a 75 usec preemphasis curve.

The Location Of The Deemphasis Network

The location of the deemphasis network will be slightly different between a stereo and a mono receiver. In a monaural receiver you will find the deemphasis network at the output of the FM detector before the first audio amplifier. In the older FM receivers, it would be on the output of the discriminator or ratio detector. In modern integrated circuit FM and TV mono receivers, an external capacitor or RC network to the IC provides the deemphasis. These components are associated with the IC at the output of the detector. Consult IC literature to confirm which component is responsible for deemphasis.

In FM stereo receivers used in FM and TV audio reception you will find a deemphasis network located in the L+R signal path. This network is found after the low pass filter separates the L+R stereo signal from the other stereo information and before the stereo matrix stage recovers the separate left and right audio signals. Figure 6 shows examples of deemphasis networks.

Deemphasis and the Technician

The RC deemphasis network plays a vital role in accurately reproducing the high fidelity FM and TV audio signal. Failure of this network, such as a bad capacitor, will alter the audio frequency response of the receiver. Knowing how to determine if the deemphasis network is working can save valuable servicing time.

Testing the Deemphasis Network

For example, testing the audio section of a TV receiver requires an FM carrier generator and output indicator. The

Frequency	RF out (mv)	dB reduction in gain
300	99.0	−.1 dB
1,000	90.4	−.9 dB
2,120	70.7	−3.0 dB
3,000	57.6	−4.8 dB
5,000	38.9	−8.2 dB
8,000	25.6	−11.8 dB
10,000	20.7	−13.7 dB
15,000	13.9	−17.0 dB

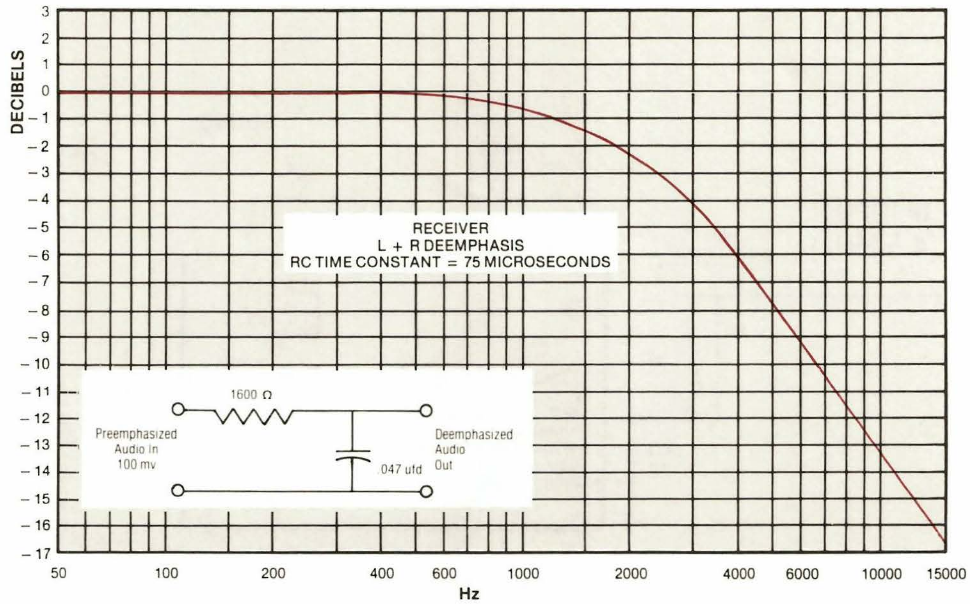


Fig. 4: An RC filter at the receiver provides deemphasis or reduction of signal voltages at the higher audio frequencies. It is exactly the opposite of the transmitter preemphasis curve.

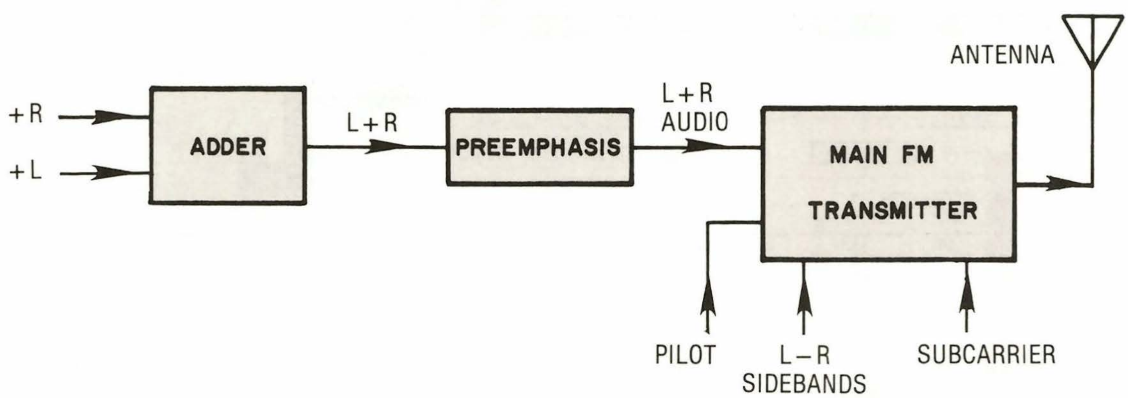
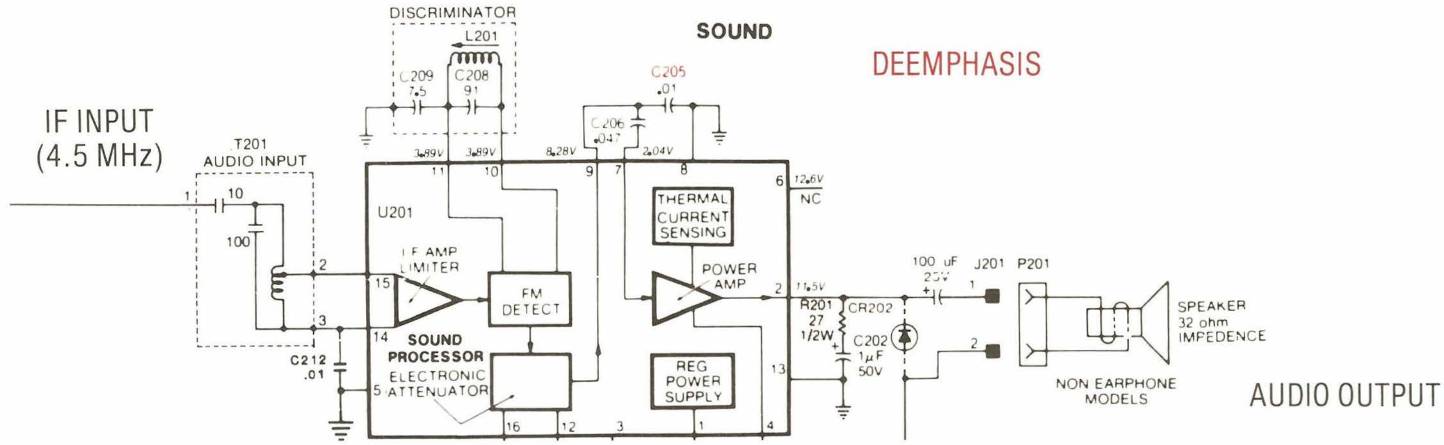


Fig. 5: The preemphasis network at the transmitter is located in the L + R audio path. This requires that both mono and stereo receivers have a deemphasis network.

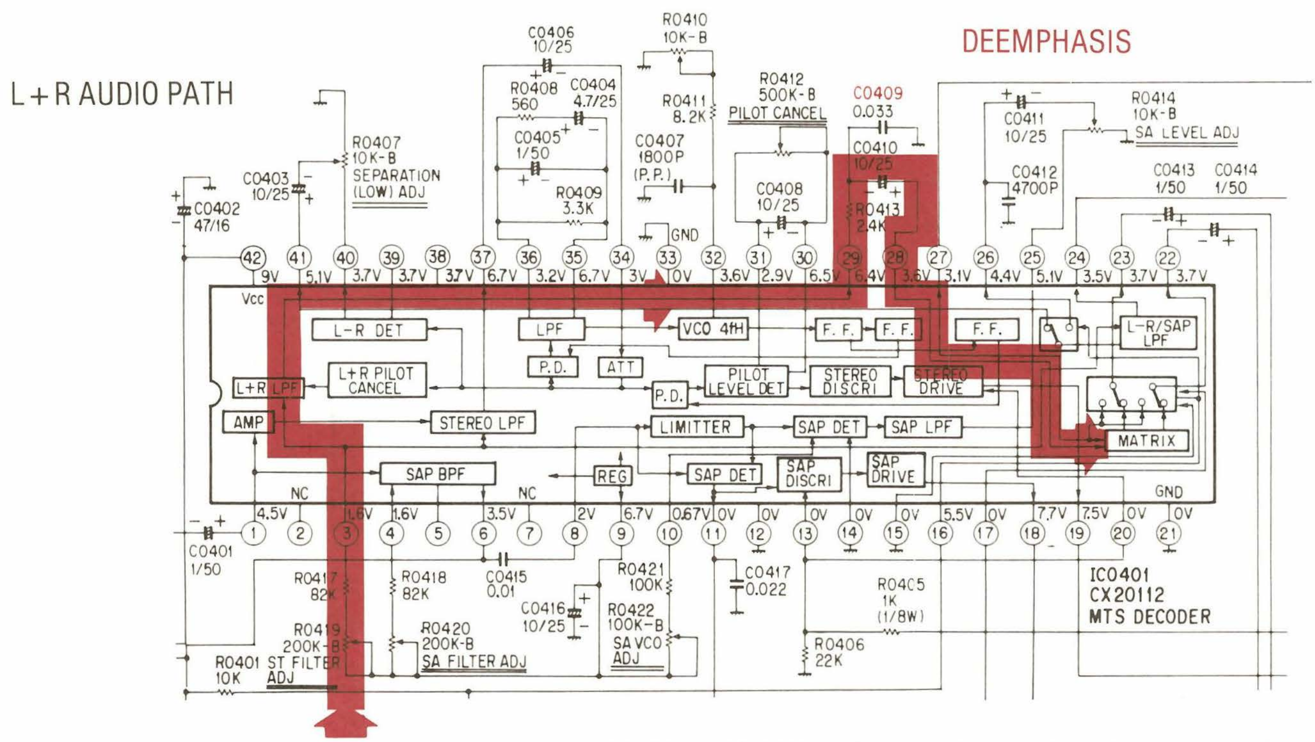
Sencore VA62A Video Analyzer generates 4 audio frequencies at 333 Hz, 1 kHz, 5 kHz and 7 kHz which can be used to modulate its FM audio carrier. The 333 Hz and 1 kHz are not affected by the deemphasis network so are ideal in troubleshooting the receiver. The 5 kHz and 7 kHz can be used to test the higher audio frequency response and the deemphasis network.

To test the output signal power of the receiver you must monitor it with an oscilloscope or output power meters such as the Sencore SR68 Stereo Readout. When switching the audio output on the Sencore VA62A Video Analyzer from 1 kHz to 5 kHz you should see a reduction in output audio power of 7 dB. A change from 5 kHz to 7 kHz should result in an additional reduction of 3 dB in audio power. These are normal decreases in receiver audio output power due to the response of the deemphasis network. These values should closely follow the deemphasis curve of figure 4.

If the output levels do not conform to the deemphasis curve you should check the output of the deemphasis network. Monitoring the output power from the deemphasis circuit should also show reductions in audio power. If this output is not seen you should check the deemphasis network and detector circuit. If the response is normal at the output of the deemphasis but not on the output of the receiver the audio amplifier is not working properly.



A. Many IC audio systems include IF, discriminator and audio amplifier. In the RCA CTC108 chassis, C205 provides deemphasis.



B. This MTS circuit is found in the RCA PPR400. R0413 and C0409 form the deemphasis network in the L+R audio path.

Fig. 6: Deemphasis components are located external to the integrated circuit in the TV sound system (A) and multichannel television sound system (B).