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OD notches measured with the midrange and high-frequency probes

In Figure 1 we show the depth and voltage measurement for the midrange plus-point run at 400 kHz and 300 kHz, using the 60% OD notch. In Figure 2 we show the high frequency probe run at 1000 kHz, 800 kHz, 600 kHz, 400 kHz and 300 kHz. In comparing the two probes, the smaller, high-frequency probe gets a larger signal at the 400 kHz and 300 kHz frequencies than the larger midrange probe. This may be due to the depth of the notch, which at 60 %, is closer to the tube ID.

The phase shift for the OD notches allows them to be better detected above the vertical noise components than does the phase shift for ID notches. The vertical component of the signal is equal to the voltage amplitude when the phase shift is 90 degrees. This occurs at 88% deep for the 1000 kHz and the 800 kHz, at 84% deep for the 600 kHz, at 72% for the 400 kHz and at 64% deep for the 300 kHz.

In Figure 3 we show the depth and voltage measurement for the midrange plus-point as a 40% deep notch is scanned, and the high-frequency probe scan for the same depth is shown in Figure 4. Again, the smaller, high-frequency probe gives a larger signal for the 40% notch. However, the 300 kHz scan is too noisy to make a good measurement on the 40% notch. I believe that this noise is due to the probe resonance being much greater than the operating frequency. A frequency filter of this signal may clean it up somewhat.

The OD generated noise from the tube deposits in the U-bend will decrease with frequency, as will the signal from the notches. A more detailed study ratios of the noise voltages to the signal voltages will be required to completely determine the validity of this statement, but it appears that OD defects in the range of 70% and greater can be detected using the smaller high-frequency probe, operated at a frequency of 600 kHz. I believe that mixing using several frequencies will further increase the detectability of the OD defects.

Figure 5 shows the improvement in signal-to-noise and the decrease in depth measurement error obtained by filtering out the high-frequency noise from the 300 kHz signal.

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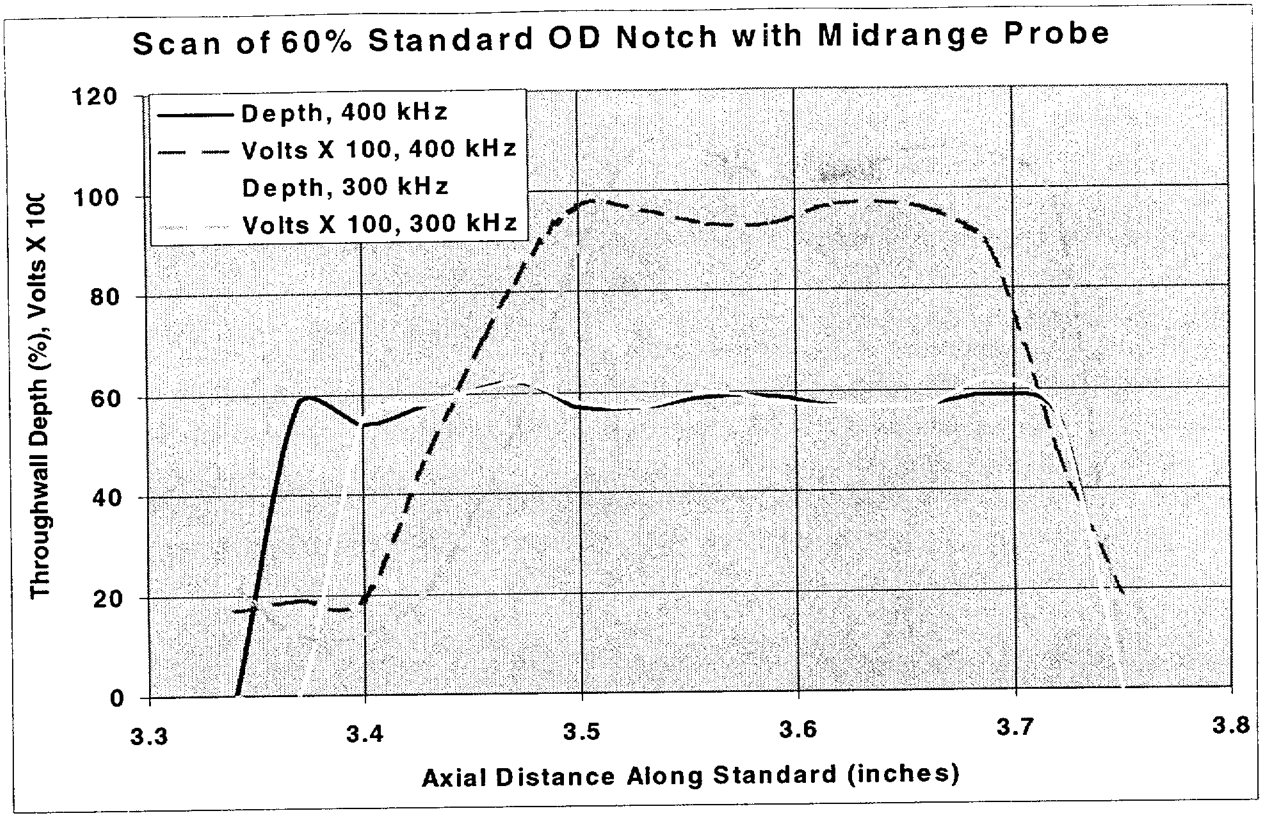

Figure 1 Scan of the 60% notch standard with the midrange probe

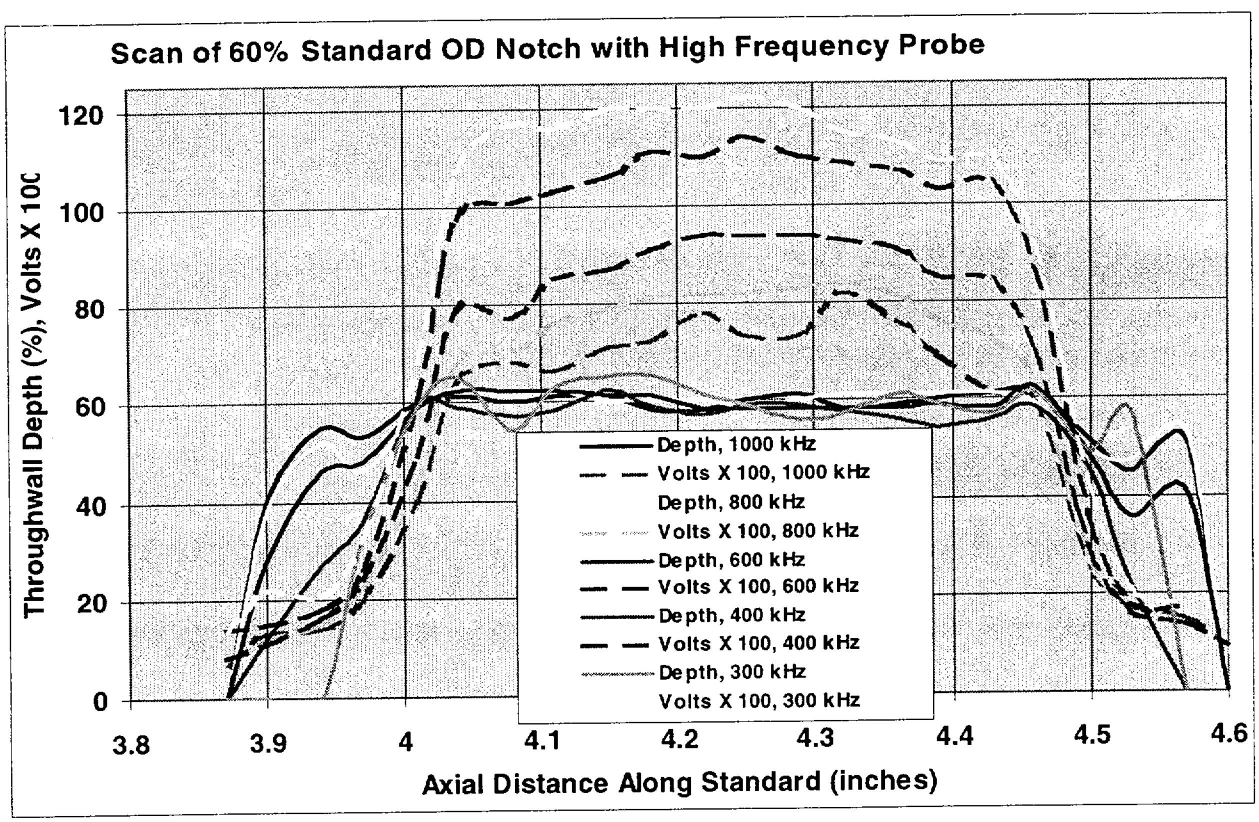

Figure 2 Scan of the 60% notch standard with the smaller, high-frequency probe.

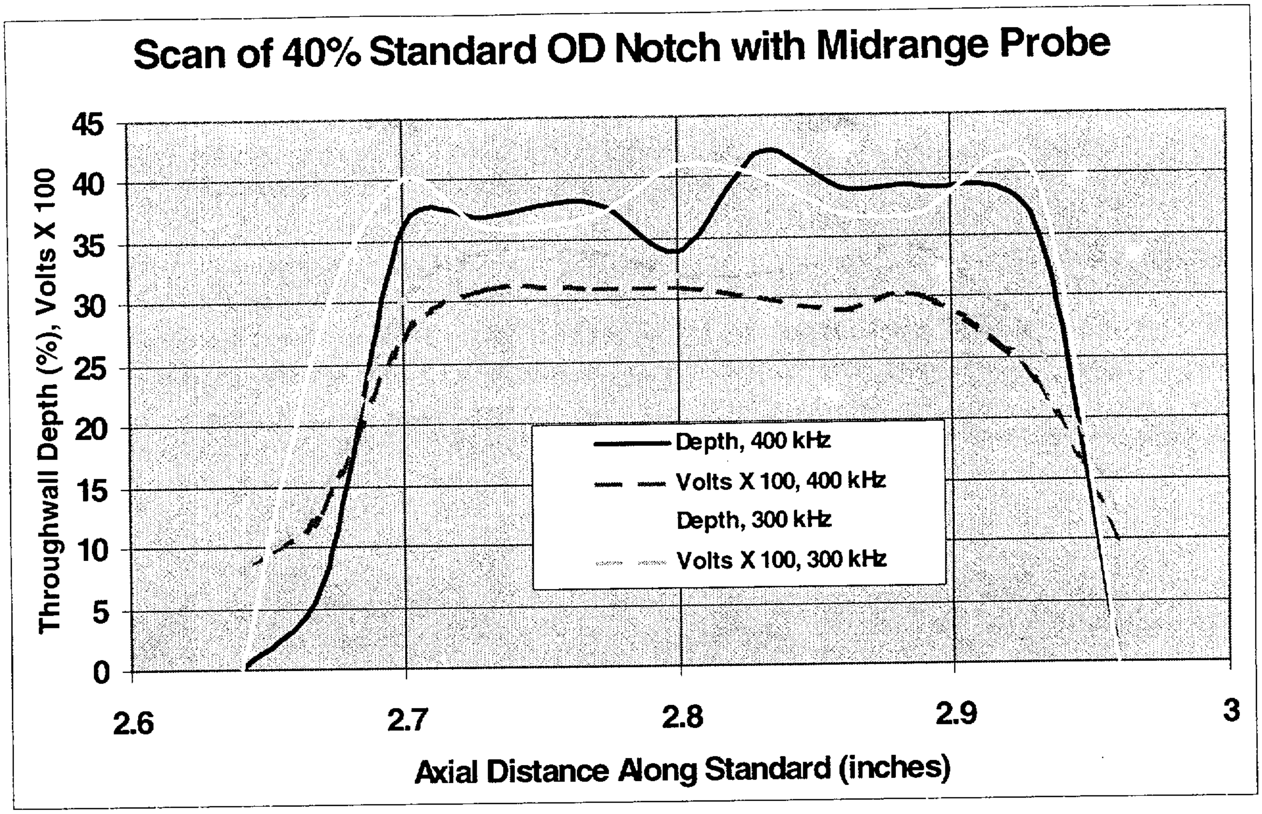

Figure 3 Scan of 40% notch standard with the midrange probe.

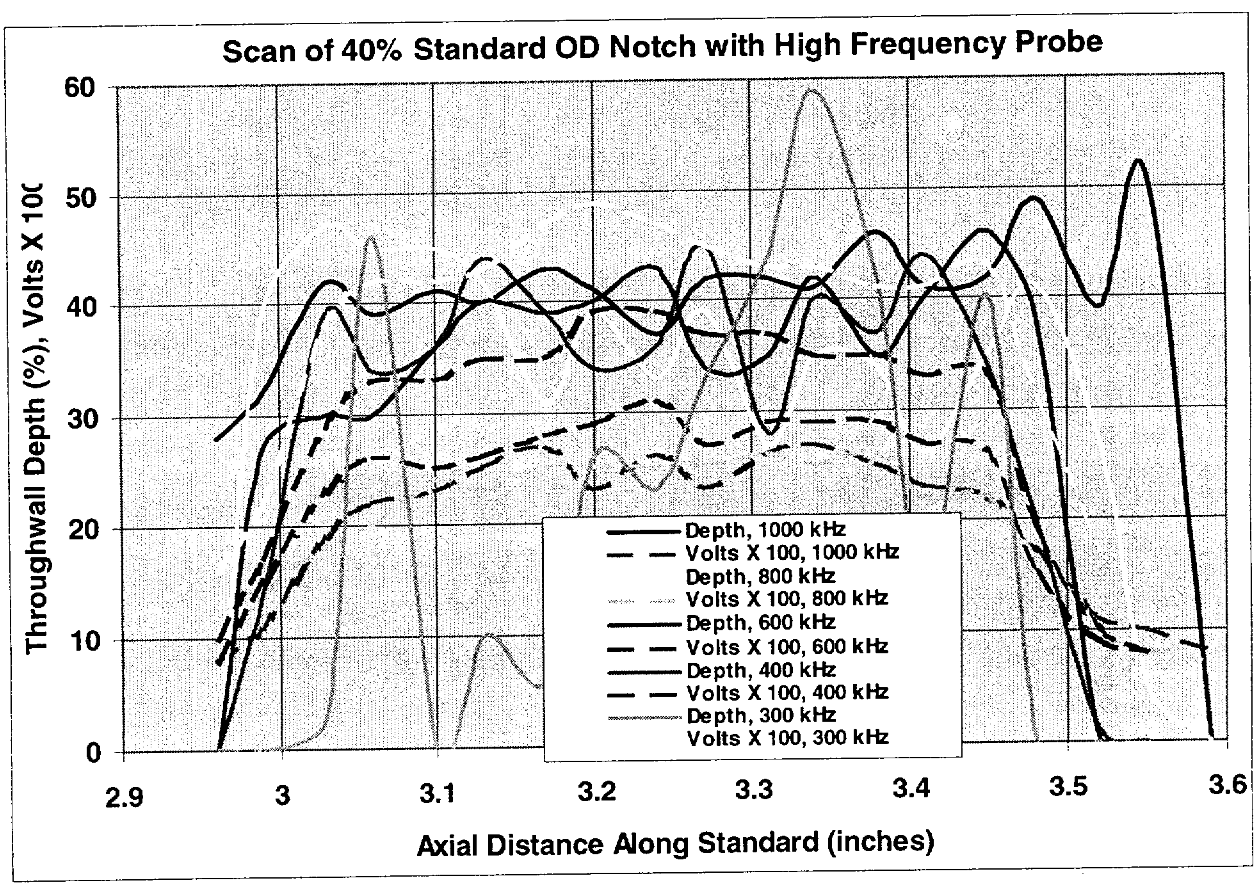

Figure 4 Scan of the 40% notch standard with the smaller, high-frequency probe.

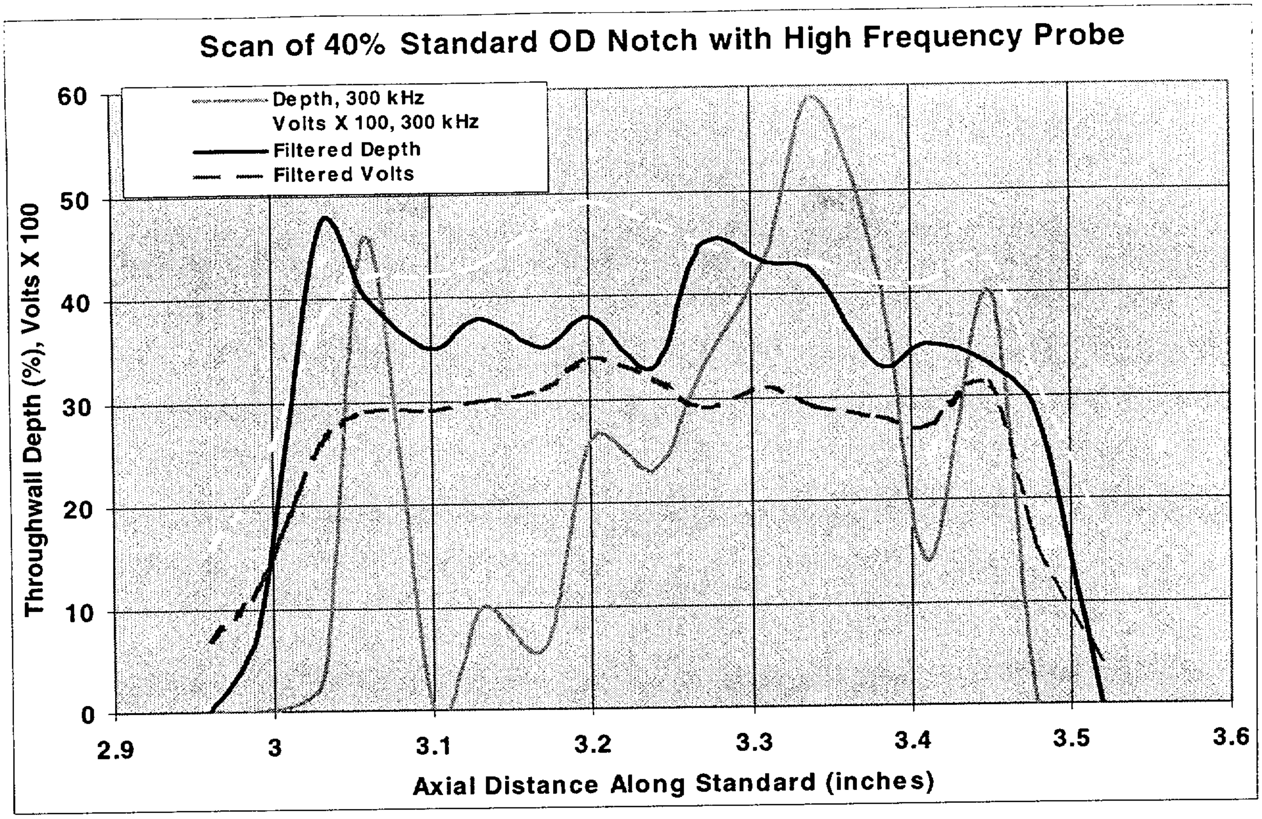

Figure 5 40% OD notch scanned at 300 kHz with the high frequency probe, with and without filtering.

The 300 kHz measurement of defect depth is shown with and without filtering out the high frequency noise. This is automatically done by the midrange probe by the lower resonant frequency of the probe. There is also an improvement in the signal-to-noise in the C-scan of the standard. With the filter, the 20% OD notch can be detected on the standard.