A combined 5-bit, 1st order noise-shaped quantizer and dynamic element matching (DEM) circuit running at 950 MHz based on a multi-phase voltage controlled oscillator (VCO) is presented. This quantizer structure is the key element in a 3rd-order noise-shaped analog-to-digital converter (ADC) with 2nd order loop dynamics and a single op-amp.

Figure 1 shows the basic operation of the multi-phase VCO-based quantizer. In this circuit, the VCO integrates an input voltage into a phase, and a digital quantizing register captures the phase state of the VCO. The quantization is particularly efficient due to the digital form of the ring oscillator. When the quantized phase is differentiated, a digital output proportional to the input voltage results. However, because the quantization error is also differentiated, the VCO-quantizer achieves first-order noise-shaping.

To improve the linearity and quantization noise performance of the converter, a sigma-delta feedback loop is formed with second-order loop dynamics. Figure 2 shows a simplified block diagram of this architecture. Interestingly, the rotation of the VCO phase can be utilized to perform dynamic element matching on the feedback DAC elements.

The authors wish to acknowledge MIT Lincoln Laboratory for research support through the Lincoln Scholars Program.

REFERENCES

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