Application Note

Combining Two LMX2820 Synthesizer Outputs for Improved Phase Noise

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ABSTRACT

This application report investigates improving phase noise performance with the LMX2820 RF synthesizer by combining the outputs of two devices. The expected phase noise improvement varies over frequency offset based on the status of coherent and incoherent noise contributors. The phase noise sweep is broken down into three noise contributor sections. Measured results show the expected improvement over frequency offset by decade.

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Trademarks

1 Introduction

There is an insatiable thirst for improved phase noise performance from clock and LO synthesizer sources in critical radar and communication systems. The LMX2820 integrated PLL/VCO synthesizer is a very low noise synthesizer solution with programmable frequency from 45 MHz to 22.6 GHz. For applications where squeezing every drop of phase noise performance is important, combining the output of two LMX2820 outputs is an easy and straightforward approach to getting a modest phase noise performance improvement.

1.1 Combining theory

Combining two devices to achieve improved noise performance is a common practice. The improvement is possible due to the random nature of noise. When combining two outputs, the signals are correlated meaning they are of equal amplitude and phase. This yields a 6 dB signal increase. The noise is uncorrelated; there are random amplitude and phase differences between the noise signals. The combined incoherent noise yields on average a 3 dB increase. Overall, there is a net 3 dB improvement in signal to noise ratio (SNR) performance.

1.2 Real-World Synthesizer Combining

When combining synthesizer outputs, it is not possible to achieve the ideal 3-dB phase noise improvement across all frequency offsets. The amount of improvement is dependent on the noise coherency of the individual contributing factors. Figure 1-1 shows the breakdown of the phase noise plot into three sections. Section-A, bounded by roughly 1-kHz offset, is dominated by the system reference phase noise performance. The system reference is shared between the two synthesizers so this noise is correlated between the two devices. There is no expected improvement in this section due to the combining. Section-B is dominated by the phased lock loop (PLL) performance, but with contributions from the (correlated) system reference and (uncorrelated) VCO noise. Section-B is approximately bounded by the loop filter bandwidth. The relative contribution level of the reference noise to the PLL/VCO noise determines how much improvement is possible by combining. In general, there should be some, but not near the ideal 3 dB case. The last section-C is dominated by the VCO jitter and thermal noise. This area is primarily uncorrelated noise and should achieve near ideal 3-dB improvement.

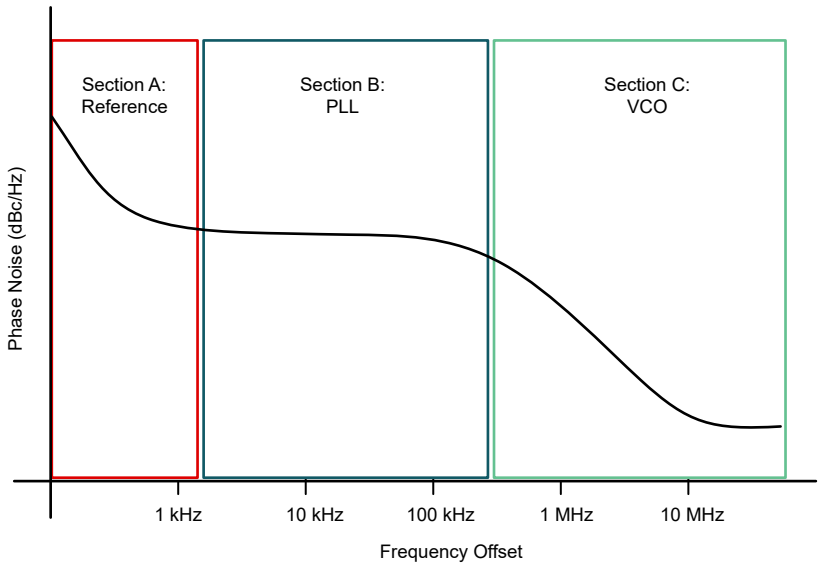

Figure 1-1. Phase Noise Breakdown by Section

2 Measured Performance

The measured performance of combining two LMX2820 is completed on the TIDA-010230 reference design which incorporates two LMX2820 devices on the board. The devices share an external reference frequency. Figure 2-1 shows the block diagram of the set-up.

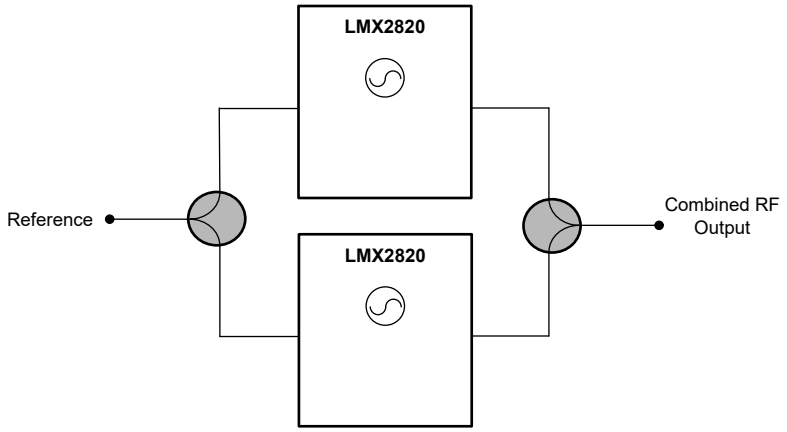

Figure 2-1. Combined LMX2820 Block Diagram

As an example, the LMX2820 is tuned to 5.6 GHz. This is a fundamental VCO frequency within the device. Figure 2-2 shows the phase noise plot of each LMX device independently and then summed together.

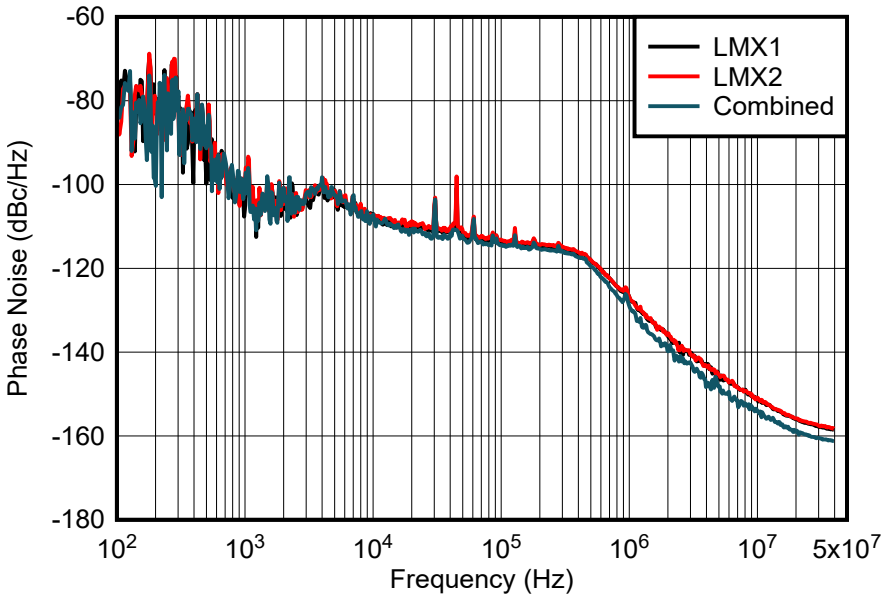

Figure 2-2. Combined LMX2820 Phase Noise Performance

To get a feel for the expected performance improvement, Table 2-1 shows the average phase noise improvement by decade.

Table 2-1. Average Phase Noise Performance Improvement by Decade

100 Hz - 1 kHz	0.27 dB
1 kHz - 10 kHz	1.15 dB
10 kHz -100 kHz	1.81 dB
100 kHz - 1 MHz	2.14 dB
1 MHz- 10 MHz	2.98 dB

3 Summary

Combining two LMX2820 devices does improve phase noise performance. Performance improvement in section-B is about 1-dB. This is not much, but may be beneficial for critical systems. In section-C, the phase noise improvement is near the ideal 3-dB improvement. This is especially useful for communication systems where low spot phase noise at 1 MHz offsets and higher are critical for eliminating interference threats. The penalty of course is the need for two devices and thereby doubling the power consumption. The full feature set of the LMX2820 provides the ability to synthesize a wide frequency range and to adjust phase to ensure proper synchronized combining for this application.

4 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision * (January 2022) to Revision A (March 2022)	Page
• Updated the numbering format for tables, figures and cross-references throughout the document	2
• Update was made in Section 1.1	2
• Update was made in Section 1.2	2

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