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Devices Connected/Referenced	
AD9910	1 GSPS Direct Digital Synthesizer (DDS)
AD9520	Clock Generator and Distribution IC
ADCLK846	High Speed LVDS Clock Fanout Buffer

## Synchronizing Multiple AD9910 1 GSPS Direct Digital Synthesizers

### CIRCUIT FUNCTION AND BENEFITS

Synchronization of multiple DDS devices allows precise digital tuning control of the phase and amplitude across multiple frequency carriers. This type of control is useful in radar applications and quadrature (I/Q) upconversion for side-band suppression.

The circuit in Figure 1 demonstrates how to synchronize four AD9910 1 GSPS, DDS chips using the AD9520 clock generator and the ADCLK846 clock fanout buffer. The result is precise phase alignment between the clock and output signals of four AD9910 devices.

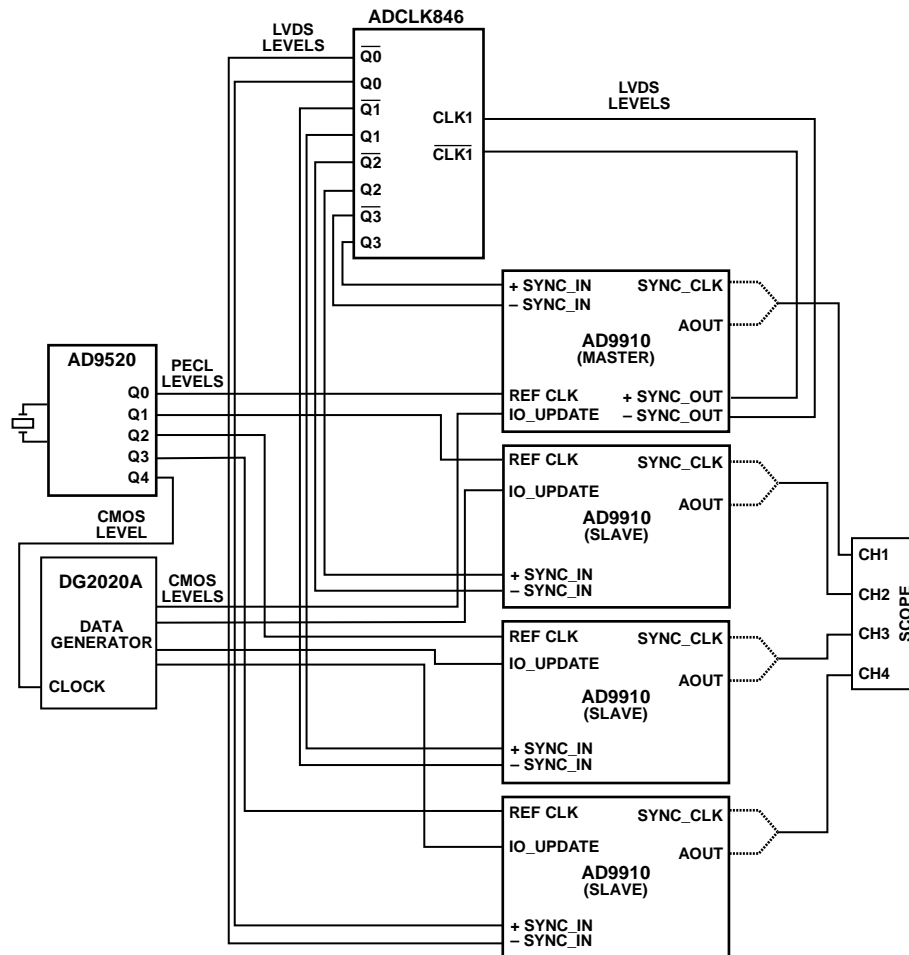


Figure 1. Setup for Synchronization of Multiple AD9910's (Simplified Schematic: Decoupling, Power, and All Connections Not Shown)

Rev. A

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**CIRCUIT DESCRIPTION**

The circuit in Figure 1 was constructed by connecting the respective evaluation boards for the individual products. Connections were made with matched cable lengths. The first of three basic requirements to synchronize multiple AD9910's is to provide a co-incident reference clock (REF CLK).

The setup uses the AD9520 as the REF CLK source for each AD9910 DDS. The AD9520 runs off an external crystal and the internal PLL. The AD9520 distributes phase aligned 1 GHz REF CLKs (PECL outputs) to all four AD9910 evaluation boards. It also provides a CMOS output clock to the Tektronix DG2020A data pattern generator for the IO\_UPDATE.

The next step for synchronization is to align the rising edge of SYNC\_CLK for all four AD9910's. The SYNC\_CLK provides the reference for a co-incident IO\_UPDATE. SYNC\_CLK alignment is accomplished using the internal synchronization capability of the AD9910. The ADCLK846 distributes phase aligned SYNC\_INs to all four AD9910s. See the AD9910 data sheet for more details on synchronization capability.

Figure 2 shows all four SYNC\_CLKs with the AD9910 internal synchronization circuit disabled. Note that the SYNC\_CLKs are not inherently aligned even when the REF CLKs are phase aligned.

To phase align the SYNC\_CLK rising edges, one AD9910 is programmed as the master device and the others as slave devices. The SYNC\_OUT of the master device is an LVDS signal buffered and distributed by the ADCLK846 to all AD9910 evaluation boards. The SYNC\_IN signal (LVDS) must meet internal setup and hold time requirements of each device's system clock. To help support this timing requirement, the AD9910 features the ability to delay the SYNC\_OUT of the master. For further flexibility, the internal SYNC\_IN path of each device can be independently delayed.

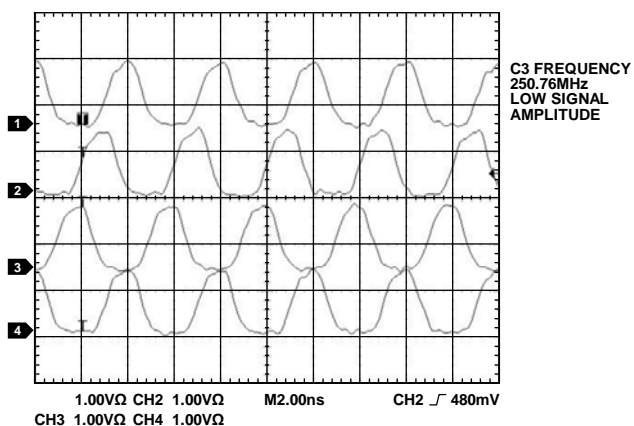


Figure 2. SYNC\_CLKs Are Not Aligned.

In the setup of Figure 1, connections between boards were made using matched cables, making it possible to use the internal default delay values to phase align the SYNC\_CLKs. Figure 3 shows SYNC\_CLK phase alignment via the using the synchronization procedure described.

The last requirement to synchronize multiple DDS devices is a co-incident IO\_UPDATE. The IO\_UPDATE must meet setup and hold times to SYNC\_CLK. The IO\_UPDATE shown in Figure 1 is sent synchronously to the SYNC\_CLK. The last requirement now enables the DDS outputs to be controlled.

Figures 4 and 5 show the DDS outputs in phase alignment. Having the devices synchronized to one another now enables predictable phase and/or amplitude adjustment between DDSs.

Note, in Figure 5 the system clock was reduced to 100 MHz operation, and the outputs were unfiltered to display each DDS raw output. Figure 5 also shows the value of synchronization with each device outputting the same signal.

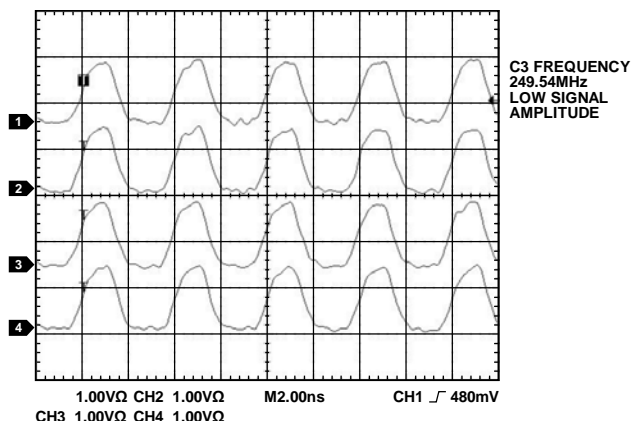


Figure 3. SYNC\_CLK Are Aligned.

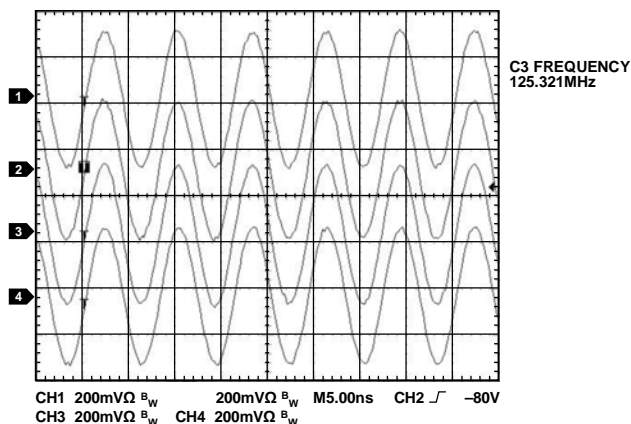


Figure 4. Filtered DDS Outputs Phase Aligned Using the Setup in Figure 1.

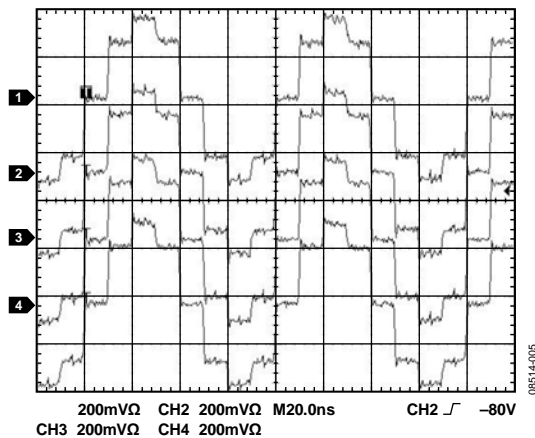


Figure 5. DDS Unfiltered Outputs Phase Aligned Using the Setup in Figure 1.

## COMMON VARIATIONS

Analog Devices offers a variety of direct digital synthesizers, clock distribution chips, and clock buffers to build a DDS-based clock generator. Refer to [www.analog.com/dds](http://www.analog.com/dds) and [www.analog.com/clock](http://www.analog.com/clock) for more information.

## LEARN MORE

- [AN-823 Application Note, \*Direct Digital Synthesizers in Clocking Applications\*. Analog Devices.](#)
- [AN-837 Application Note, \*DDS-Based Clock Jitter Performance vs. DAC Reconstruction Filter Performance\*. Analog Devices.](#)
- [Kester, Walt. 2005. \*The Data Conversion Handbook\*. Analog Devices. Chapters 6 and 7.](#)
- [Kester, Walt. 2006. \*High Speed System Applications\*. Analog Devices. Chapter 2, "Optimizing Data Converter Interfaces."](#)
- [Kester, Walt. 2006. \*High Speed System Applications\*. Analog Devices. Chapter 3, "DACs, DDSs, PLLs, and Clock Distribution."](#)
- [MT-031 Tutorial, \*Grounding Data Converters and Solving the Mystery of AGND and DGND\*. Analog Devices.](#)
- [MT-085 Tutorial, \*Fundamentals of Direct Digital Synthesis \(DDS\)\*, Analog Devices.](#)
- [MT-086 Tutorial, \*Fundamentals of Phase Locked Loops \(PLL\)\*, Analog Devices.](#)
- [MT-101 Tutorial, \*Decoupling Techniques\*. Analog Devices.](#)

## Data Sheets and Evaluation Boards

- [AD9910 Data Sheet.](#)
- [AD9910 Evaluation Board.](#)
- [AD9520 Data Sheet.](#)
- [AD9520 Evaluation Board.](#)
- [ADCLK846 Data Sheet.](#)
- [ADCLK846 Evaluation Board.](#)

## REVISION HISTORY

- |                                   |   |
|-----------------------------------|---|
| 12/09—Rev. 0 to Rev. A            |   |
| Changes to Figure 1 .....         | 1 |
| 10/09—Revision 0: Initial Version |   |

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