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Reference Circuits

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Devices Connected/Referenced

ADF4351	Fractional-N PLL Synthesizer with Integrated VCO
ADCLK948	Clock Fanout Buffer with 8 LVPECL Outputs

Increasing the Number of Outputs from a Clock Source Using Low Jitter LVPECL Fanout Buffers

EVALUATION AND DESIGN SUPPORT

Circuit Evaluation Boards

[ADF4351 Evaluation Board \(EVAL-ADF4351EB1Z\)](#)

[ADCLK948 Evaluation Board \(ADCLK948/PCBZ\)](#)

Design and Integration Files

[Schematics, Layout Files, Bill of Materials](#)

CIRCUIT FUNCTION AND BENEFITS

Many systems require low jitter multiple system clocks for mixed signal processing and timing. The circuit shown in Figure 1 interfaces the [ADF4351](#) integrated phase-locked loop (PLL) and voltage-controlled oscillator (VCO) to the [ADCLK948](#), which provides up to eight differential, low voltage, positive emitter coupled logic (LVPECL) outputs from one differential output of the [ADF4351](#).

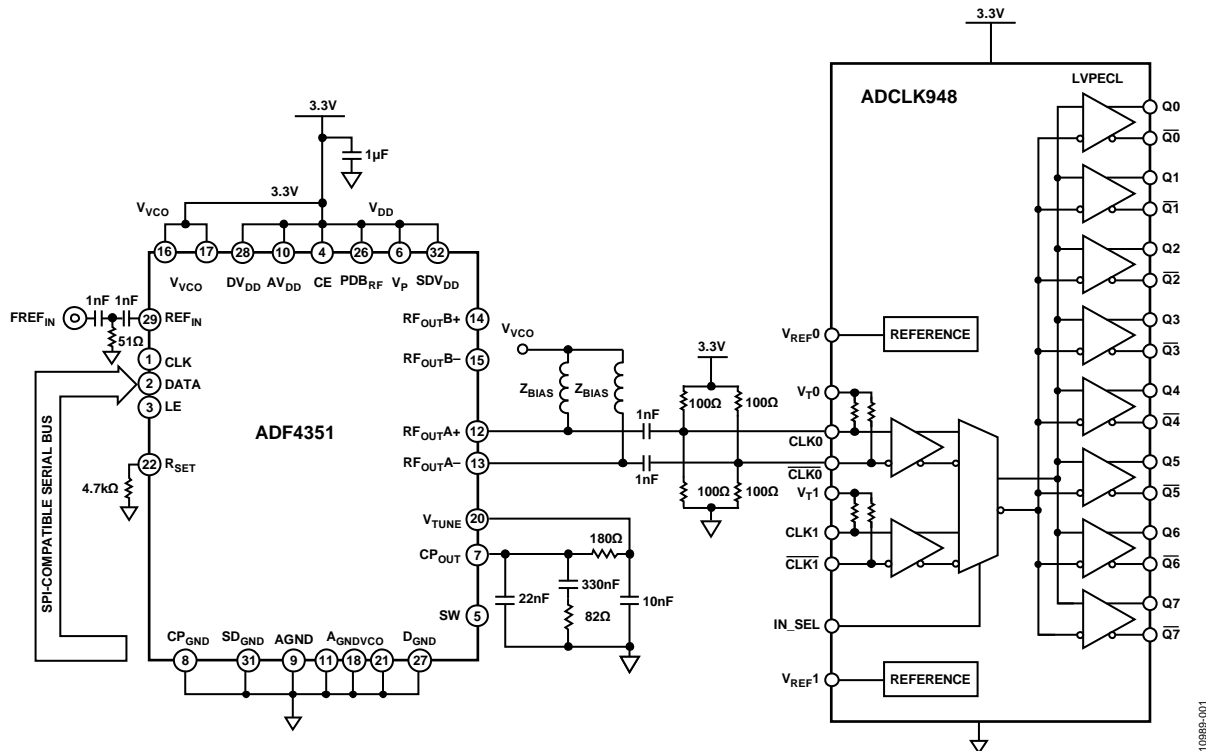


Figure 1. [ADF4351](#) PLL Connected to [ADCLK948](#) Fanout Buffer (Simplified Schematic: All Connections and Decoupling Not Shown)

Rev. 0

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Modern digital systems often require many high quality clocks at logic levels that are different from the logic level of the clock source. Extra buffering may be required to guarantee accurate distribution to other circuit components without loss of integrity. The interface between the [ADF4351](#) clock source [ADCLK948](#) clock fanout buffer is described, and measurements show that the additive jitter associated with the clock fanout buffer is 75 fs rms.

CIRCUIT DESCRIPTION

The [ADF4351](#) is a wideband PLL and VCO consisting of three separate multiband VCOs. Each VCO covers a range of approximately 700 MHz (with some overlap between the frequencies of the VCO). This permits a fundamental VCO frequency range of between 2.2 GHz to 4.4 GHz. Frequencies lower than 2.2 GHz can be generated using internal dividers within the [ADF4351](#).

For clock generation, the [ADF4351](#) PLL and VCO must be enabled, and the desired output frequency must be programmed. The output frequency of the [ADF4351](#) is available at the open-collector outputs at the RF_{OUT} pins, which require a shunt inductor (or resistor), plus a dc blocking capacitor.

The [ADCLK948](#) is a SiGe low jitter clock fanout buffer that is ideally suited for use with the [ADF4351](#), because its maximum input frequency (4.5 GHz) is just above that of the [ADF4351](#) (4.4 GHz). Broadband rms additive jitter is 75 fs.

It is necessary to add a dc common-mode bias level of 1.65 V to the CLK inputs of the [ADCLK948](#) to mimic LVPECL logic levels. This is accomplished by the use of a resistor bias network. Omission of the dc bias circuit results in degraded signal integrity at the [ADCLK948](#) outputs.

COMMON VARIATIONS

Other possible synthesizers with integrated VCOs are the [ADF4350](#) fractional N (137 MHz to 4400 MHz) and the [ADF4360](#) integer N series.

Other possible clock fanout buffers in the same family as the [ADCLK948](#) are the [ADCLK946](#) (6 LVPECL outputs), [ADCLK950](#) (10 LVPECL outputs), and the [ADCLK954](#) (12 LVPECL outputs).

CIRCUIT EVALUATION AND TEST

The circuit is evaluated using the [EVAL-ADF4351EB1Z](#) board for a clock source, with some minor modifications. The [EVAL-ADF4351EB1Z](#) board uses the standard [ADF4351](#) programming software contained on the CD that accompanies the evaluation board. The [ADCLK948/PCBZ](#) is also required and can be used out of the box without modification.

Equipment Needed

The following equipment is needed:

- The [EVAL-ADF4351EB1Z](#) evaluation board kit with programming software
- The [ADCLK948PCBZ](#) evaluation board
- A 3.3 V power supply
- Two cables to connect the 3.3 V supply to the [ADCLK948PCBZ](#)
- Two short equal length SMA coaxial cables
- A high speed oscilloscope (2 GHz bandwidth) or an equivalent
- The R&S FSUP26 spectrum analyzer or an equivalent
- A PC with Windows® XP, Windows, Vista (32-bit), or Windows 7 (32-bit)

The SMA coaxial cable is required to connect the $RF_{OUT}A+$ and $RF_{OUT}A-$ pins of the [EVAL-ADF4351EB1Z](#) to CLK0 and CLK0 pins of the [ADCLK948PCBZ](#).

Functional Block Diagram

For this experiment, the [ADCLK948PCBZ](#) and the [EVAL-ADF4351EB1Z](#) are used. The boards are connected via a SMA cable to the [ADCLK948PCBZ](#), as shown in Figure 1.

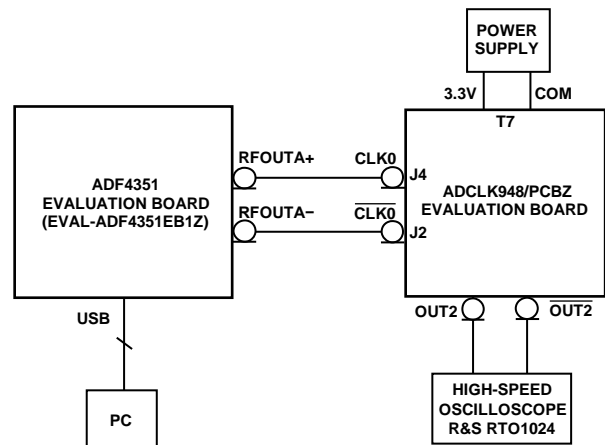


Figure 2. [ADF4351](#) Logic Level Measurement Setup

Getting Started

The [UG-435](#) user guide details the installation and use of the [EVAL-ADF4351EB1Z](#) evaluation software. [UG-435](#) also contains board setup instructions and the board schematic, layout, and bill of materials. Necessary modifications to the board are the insertion of 100 Ω resistors after the dc blocking capacitor. The resistors are connected to 3.3 V and to GND. This should be done to both the $RF_{OUT}A+$ and $RF_{OUT}A-$ pins to provide a common-mode voltage of 1.65 V (above the minimum required 1.5 V). This may necessitate scraping off the solder mask near these transmission lines.

The [UG-068](#) user guide contains similar information relevant to the operation of the [ADCLK948/PCBZ](#) evaluation board

Logic Level Measurement

In this example, the Rohde & Schwarz RTO1024 oscilloscope is used together with two RT-ZS30 active probes to accurately measure the high speed logic levels.

Install the ADF435x software to PC by doing the following:

1. Connect the [EVAL-ADF4351EB1Z](#) to the PC, follow the hardware driver instructions as per [UG-435](#).
2. Program the [ADF4351](#) PLL as per the screenshot of the ADF435x software (see Figure 3). In this example, an RF frequency of 1 GHz is chosen.

3. Using two equal length short SMA cables, connect the RF_{OUT}A+ and RF_{OUT}A- SMA connectors from the [EVAL-ADF4351EB1Z](#) board to the CLK0/CLK0 SMA connectors of the [ADCLK948/PCBZ](#) board.
4. Connect the differential output OUT2/OUT2 of the [ADCLK948/PCBZ](#) to the high speed oscilloscope. See Figure 4 for typical waveforms for a 1 GHz output.

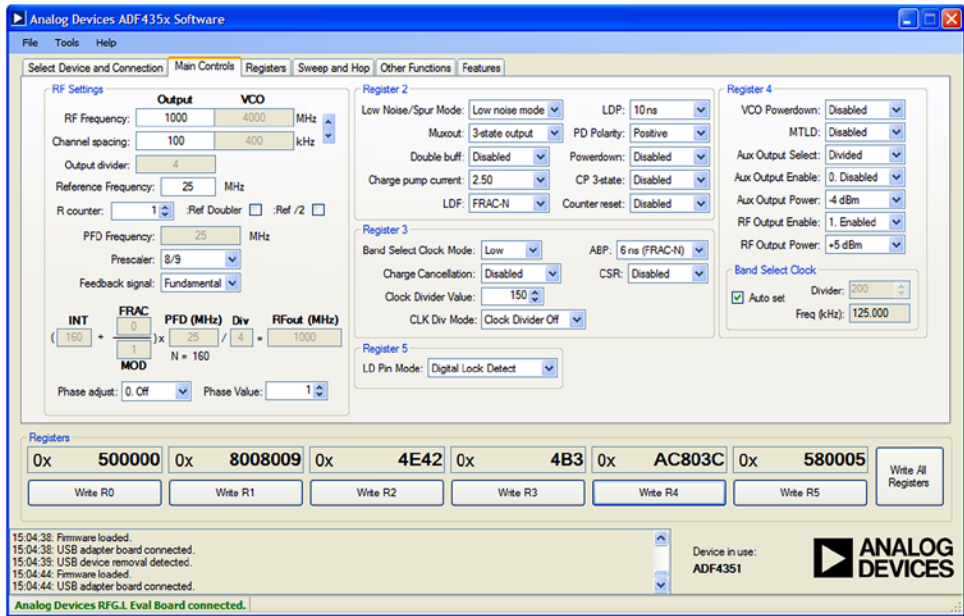


Figure 3. ADF4351 Software Settings

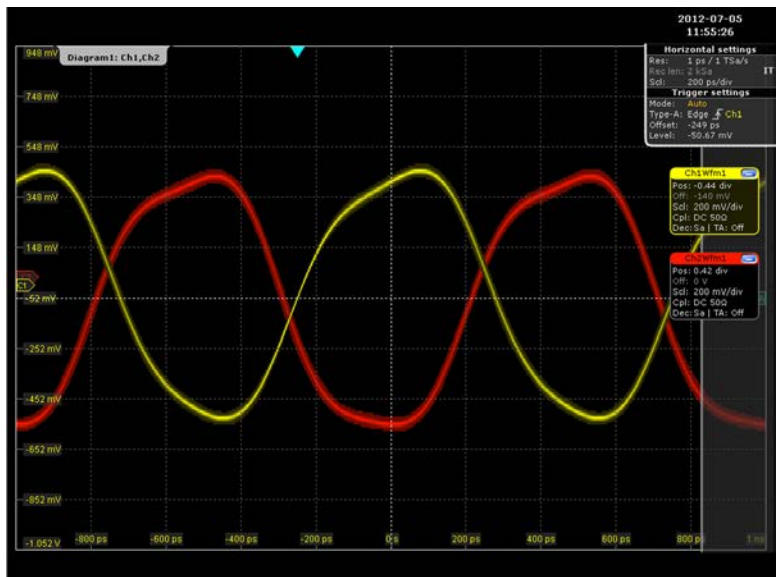


Figure 4. ADCLK948 Oscilloscope Output for 1 GHz Logic Signal, Horizontal Axis: 200 ps/DIV, Vertical Axis: 200 mV/DIV

Phase Noise and Jitter Measurement

1. Repeat Step 1 to Step 4 from the Logic Level Measurement section.
2. Terminate the unused CLK2 output of the [ADCLK948/PCBZ](#) with a 50 Ω load (see Figure 5).
3. Connect the CLK2 output via a SMA cable to the signal source analyzer (see Figure 5).
4. Measure the jitter performance of the signal.

Figure 6 shows the phase noise at the output of the [ADF4351](#), and the rms jitter is 325.7 fs. Figure 7 shows the phase noise at the [ADCLK948](#) output. The rms jitter is 330.4 fs.

The additive jitter of the [ADCLK948](#) can be calculated as $\sqrt{(330.4^2 - 325.7^2)} = 55.5$ fs rms. The specified value from the [ADCLK948](#) data sheet is 75 fs rms.

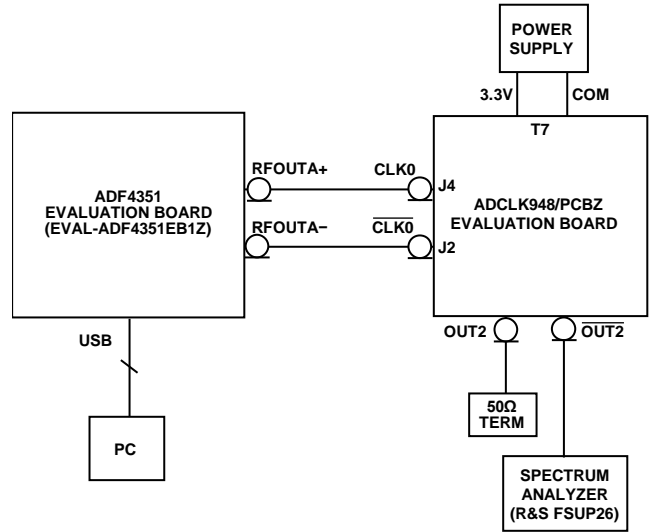


Figure 5. [ADF4351](#) Phase Noise and Jitter Measurement Setup

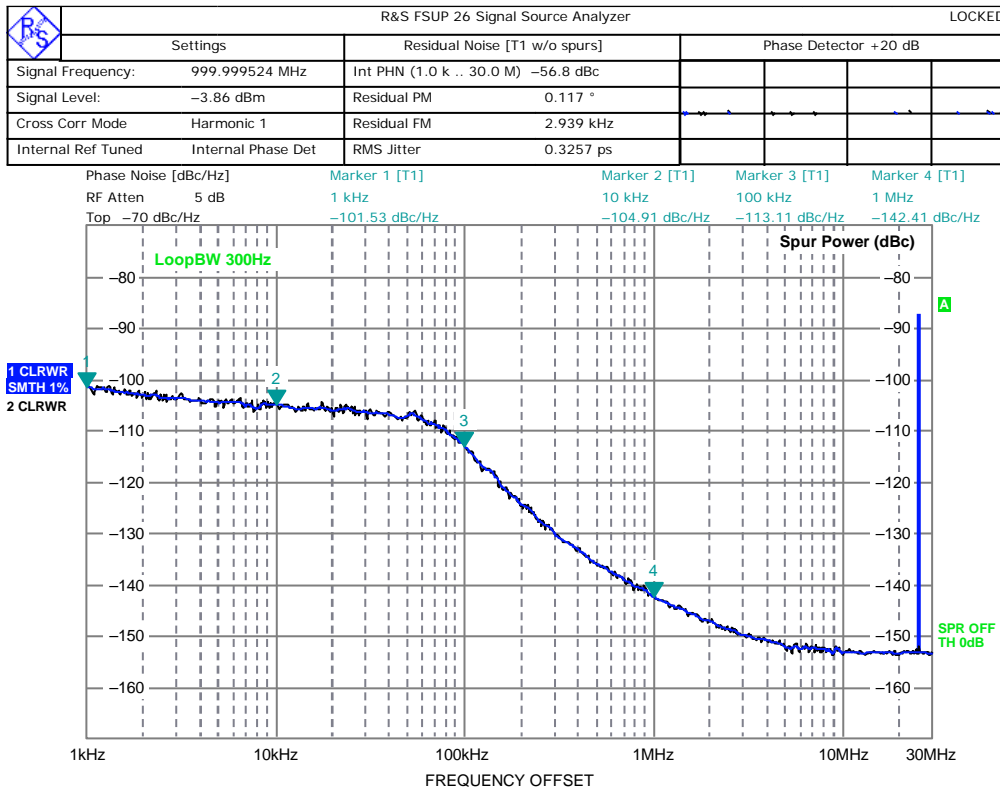


Figure 6. [ADF4351](#) Output Phase Noise Measurement Showing 325.7 fs rms Jitter

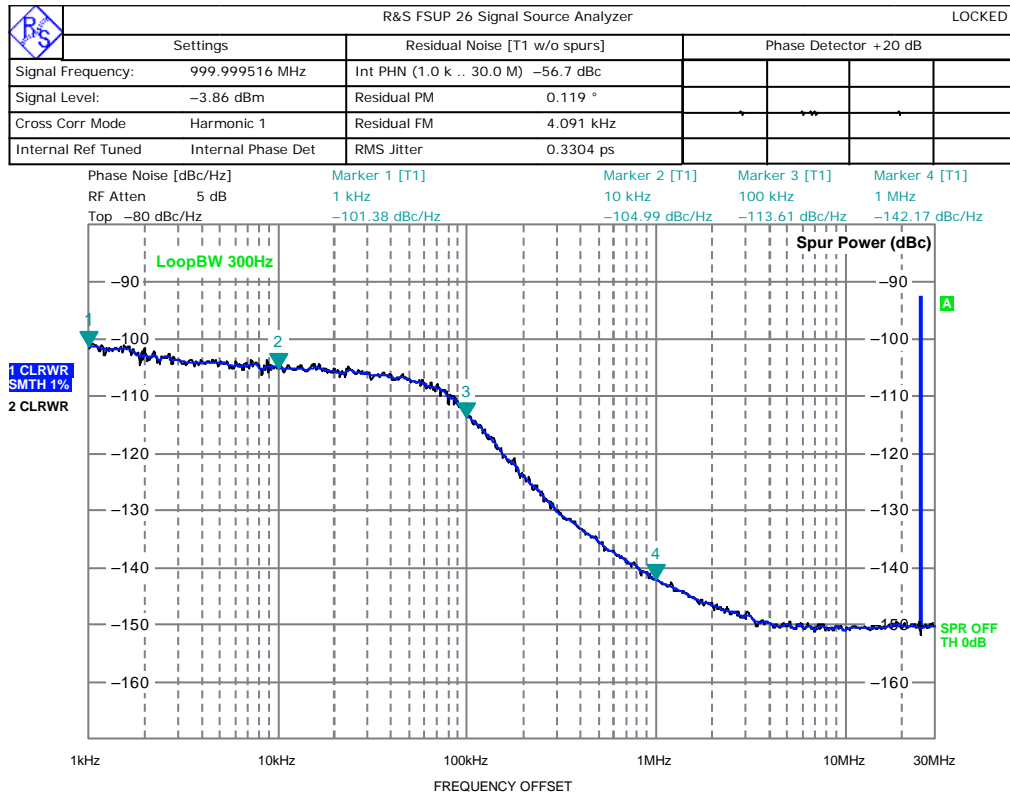


Figure 7. ADCLK948 Output Phase Noise Measurement Showing 330.4 fs rms Jitter

LEARN MORE

CN0232 Design Support Package:

<http://www.analog.com/CN0232-DesignSupport>

UG-435 User Guide for the EVAL-ADF4350EB1Z board

UG-068, User Guide for the ADCLK948/PCBZ board

MT-031 Tutorial, *Grounding Data Converters and Solving the Mystery of "AGND" and "DGND"*, Analog Devices.

MT-086 Tutorial, *Fundamentals of Phase Locked Loops (PLLs)*, Analog Devices.

MT-101 Tutorial, *Decoupling Techniques*, Analog Devices.

ADIsimPLL Design Tool

Data Sheets and Evaluation Boards

[ADF4351 Evaluation Board \(EVAL-ADF4351EB1Z\)](#)

[ADCLK948 Evaluation Board \(ADCLK948/PCBZ\)](#)

[ADF4351 Data Sheet](#)

[ADCLK948 Data Sheet](#)

REVISION HISTORY

9/12—Revision 0: Initial Version

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