MATEC Web of Conferences **79**, 01015 (2016) DOI: 10.1051/matecconf/20167901015
IME&T 2016

TESTING SYSTEM FOR ANALOG DEVICES DIRECT DIGITAL SYNTHESIZER

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Abstract. The paper is devoted to the setup for controlling and testing of Direct Digital Synthesizer (DDS) Integrated Circuits (ICs). Control and measurement setup is designed on the basis of National Instruments module equipment PXI-4110, PXI-7841R and LabVIEW development environment. Block diagram of the developed system and software structure are depicted as well as test results for several ICs.

1 Introduction

Different electronic devices often need an IC that generates signals of various frequencies and allows controlling parameters of such a signal [1]. Direct Digital Synthesizer IC can play the role of the generator of this kind. The device produces analog signal by means of generating series of samples in digital form and then converting these to the analog signal using ADC [2, 3]. The main blocks of DDS are phase accumulator, phase-to-amplitude converter (PAC), DAC and low-pass filter. Block diagram of the simplest DDS IC is presented on Figure 1. Adjustment of the IC's parameters (settling the desired frequency, phase, amplitude, form etc.) is made by means of special build-in registers. These registers are available for read and write to via different interface protocols, e.g. SPI.

One of the features of DDC ICs is high frequency setting resolution and high precision of frequency rendering. Some modern digital synthesizers are capable of generating signals with frequency of 1 Hz up to 400 MHz with the step size of 0.00001 Hz.

At the moment DDS are applied in two main areas: signal generation in communication systems and signal analysis in industrial and biomedical applications.

While developing devices of various purposes, often raises an aim to test the functionality of its separate components. Thus, for example, it is necessary to test the functionality of the DDS ICs. This paper concerns the design of the control and measurement setup [4, 5] for Analog Devices DDS ICs.

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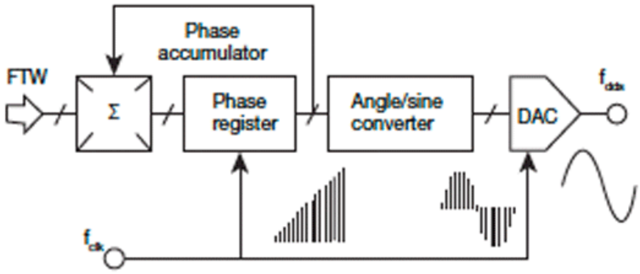

Figure 1. DDS block diagram.

2 Device under test and setup requirements

Devices Under Test (DUTs) were AD9851, AD9910 and AD9912 Analog Devices DDS IC.

AD9851 is a device that is capable to operate in voltage supply range from 2.7 V to 5.25 V; clock frequency can be up to 180 MHz. AD9851 also includes a high-speed 10-bit DAC.

AD9910 and AD9912 are ICs with integrated 14-digit DAC; voltage lies within range of 1.8 V to 3.3 V; output frequency is up to 400 MHz [6].

One of the distinctive features of the abovementioned ICs is a similar SPI communication interface that has made possible to design universal control and measurement setup.

3 Solution

Control and measurement system was designed on the basis of automated setup that included National Instruments PXI module devices and software developed in LabVIEW development environment [7–14].

Hardware included following components:

- PXI-1033: 5-slot chassis (data transfer rate of 110 MB/s, noise less than 38 dB, power 400 W).
- PXI-4110: programmable power supply (three channels with a voltage range from 0 V to 6 V, from 0 V to 20 V and from 0 V to -20 V accordingly).
- PXI-7841R: multifunction input/output board (based on Virtex-5R FPGA, 96 bidirectional digital ports, 8 analog inputs, 8 analog outputs) [7].
- universal communication PCB.
- PCB with the IC.
- Agilent 54642D oscilloscope.

PXI-4110 module allowed controlling supply voltage and measuring supply current in range up to 1 A and with precision of 0.02 mA.

Desired communication interface between test equipment and ICs was implemented by means of the PXI-7841R module. PXI-7841R embedded Programmable Logic Device (PLD) has a high operation rate; base frequency is 40 MHz that can be altered due to build-in Phase-Locked Loop (PLL). The module also includes analog lines (8 analog inputs and 8 analog outputs). This gives the opportunity to measure logical output signal level with precision of 0.3 mV.

Universal adapter PCB has pins for all PXI-7841 digital and analog signal lines and channels of PXI-4110 power supply module.

DUT PCBs were developed for each DDS type according to the reference schematic presented in technical documentation. The photo of the universal communication board and printed circuit board for testing is shown on Figure 2.

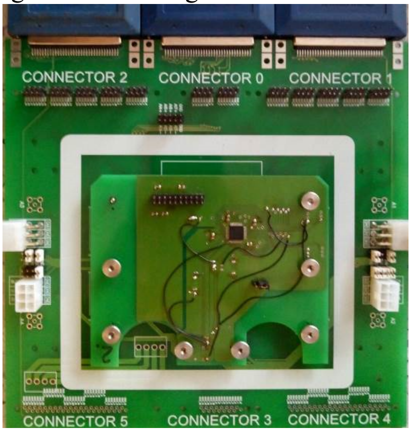

Figure 2. Appearance of the universal communication board and board with the PCB.

Agilent 54642D oscilloscope was used to control output signal's frequency. Block diagram of the measurement setup is presented on Figure 3.

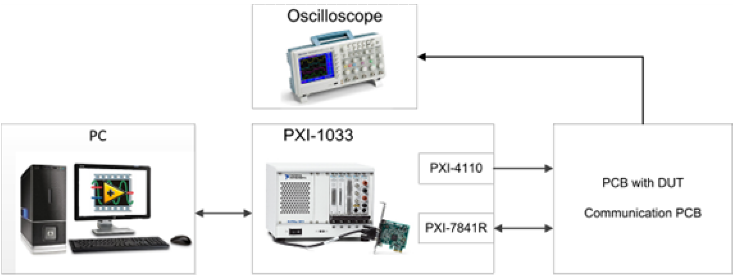

Figure 3. Hardware structure with DUT.

Software part was made in LabVIEW 2013 development environment.

This software allowed controlling PXI-4110 and PXI-7841R modules, as well as create user interface.

The program was divided into two main parts: HOST part and FPGA part. The first one was run on PC with relatively slow execution rate and provided the automatization of testing process; it set supply voltage levels, logged the results and initialized the FPGA module [8].

The second part was programmed into PLD and had a high operation rate. Its task was to set the clock frequency, transmit and receive data [9–18].

To run the DDS IC one often needs a reference frequency; PXI-7841R module allowed to generate such high-frequency periodic signal. Block diagram of the Virtual Instrument (VI) that is responsible for frequency generation is shown on Figure 4 [9].

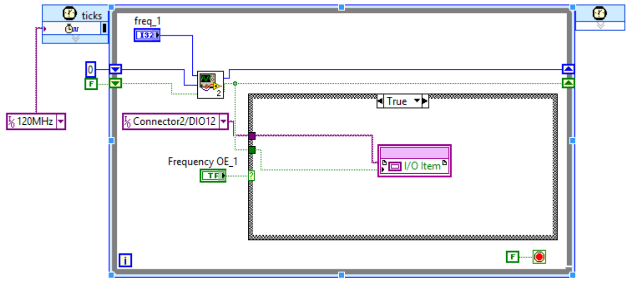

Figure 4. PXI-7841R frequency generator block diagram.

Prior to test procedure user is asked for communication interface parameters, such as register address, byte number, transfer direction, bits order and timing parameters. The example of write timing diagram is presented on Figure 5.

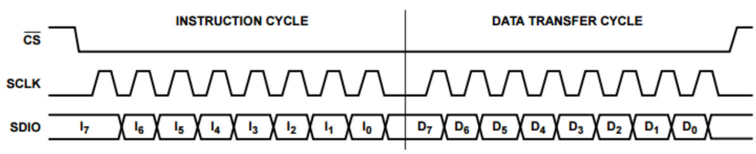

Figure 5. Data write timing diagram for AD9910 IC.

Low level on CS indicates the beginning of data communication. SDIO line is used to transfer 8-bit address first and then 8 bits of data; the state of the line is latched at the rising edge on the SCLK line. The transmission ends after sending a high level on CS.

Block diagram of the LabVIEW virtual instrument that implements sending the data via SPI interface is presented on Figure 6. One should notice the use of cluster data type, which allows fast digital lines reconfiguration.

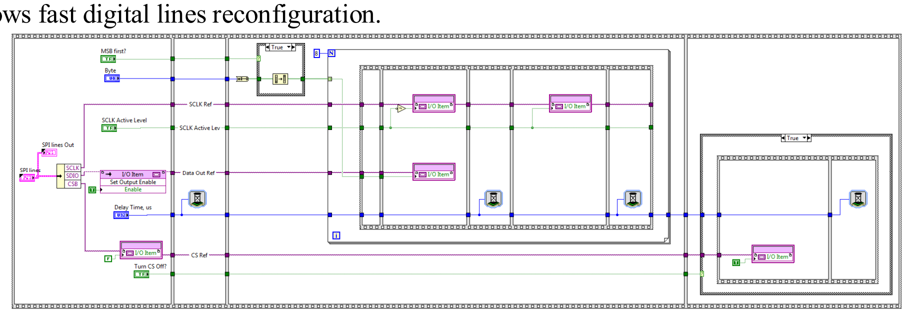

Figure 6. Block diagram of the VI that sends one byte via SPI communication interface.

Test procedure consisted of the following steps:

- IC current supply control by means of ammeter embedded in NI PXI-4110 module.
- Output logic levels control.
- Writing and reading the control registers.
- Taking measurements of the output frequency with certain base frequency division and multiplication coefficients. An example of the output signal is presented on Figure 7.

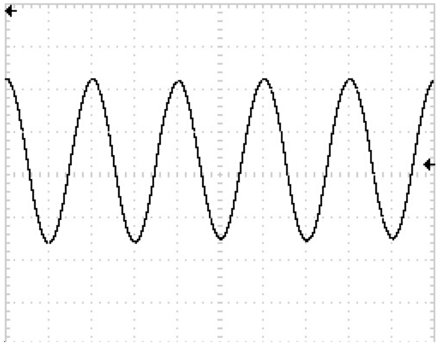

Figure 7. Waveform of the output signal. Scales: 1ns/div; 1V/div.

Convenient user interface (Figure 8) made the system easy to use.

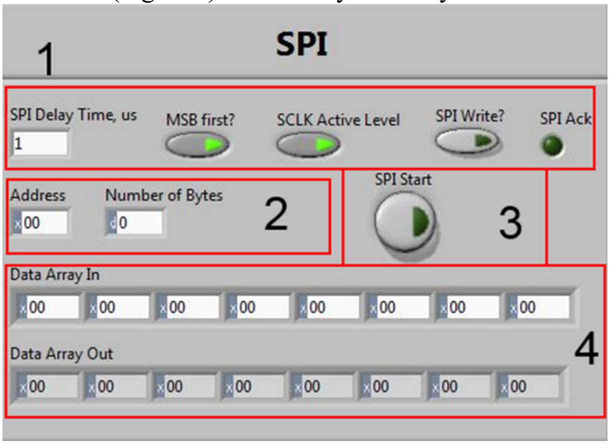

Figure 8. User interface of the control system:1 – primary interface settings; 2 – controls for entering register address and byte number to receive or transmit; 3 – communication start button; 4 – received and transmitted data.

4 Conclusions

AD9851, AD9910, AD9912 ICs were successfully tested by means of foregoing measurement setup. Measurement setup has made possible to fulfill the functional and parametrical testing. It is planned to add several other standard interface libraries such as 1-wire, I2C etc. that will allow controlling and testing other devices.

Acknowledgements

The work was performed as part of the grant of Russian Ministry of Education and MEPhI № 14.578.21.0075.

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