

DDS based Transceiver for wireless communication of low VHF

Introduction

The AD9854 Direct Digital Synthesizer (DDS) is a highly integrated device that uses advanced DDS technology. It is coupled with two internal high speed, high performance quadrature digital-to-analog converters (DACs) to form a digitally programmable I and Q synthesizer function. The applications of AD9854 are such as programmable clock generators, amateur RF exciters, and quadrature LO frequency synthesis (ANALOG DEVICES, 2018). For this individual project, this AD9854 DDS will be used in combination with Raspberry Pi and RTL-SDR for building a radio transceiver, a device that comprised both a transmitter and receiver. Raspberry Pi is a single board computer, whereas RTL-SDR is a software defined radio (SDR) that uses cheap DVB-T TV tuner dongle. Through special drivers, the dongle can be turned into a wideband SDR for various application.

Research Question/Topic

The aim of this project is to design a low-cost radio transceiver of 70MHz, using the AD9854 Direct Digital Synthesiser and Raspberry Pi. The programming of synched signal will be done in C language. The transmission of samples is uniform in time.

The I and Q synthesizer function, or the RF signal, used for this research topic is:

$$I(t)\cos\omega t + Q(t)\sin\omega t$$

For signal receiver, the version 3 RTL-SDR radio receiver dongle will be used, which samples a radio frequency signal from 50 MHz to 1700MHz and outputs interleaved 8-bit IQ samples at a symbol rate up to 2.4Msps.

Scope

This project is focused on implementing a transceiver with the mentioned components using knowledge on how an IQ modulator works and how to program the synched signals in C.

There was no previous attempt on using AD9854 DDS in combination with the Raspberry Pi to implement a transceiver, hence this might be the biggest challenge. The feasibility of this design is to be analysed

during the progress. There may be incompatibility between Raspberry Pi and AD9854 and this will be determined whether an issue in primary stages.

Previous Work

There are many existing methods and combination of building low cost transceiver using RTL-SDR and Raspberry Pi with other components, but not with AD9854 DDS in particular. The following are several relating previous works to refer to:

DDS Synthesizer 0-70Mhz on Raspberry Pi and AD9851 DDS (Techniline.com, 2018)

This work is presents the method to run a very precise sinewave generator with a range of 0-70MHz on the chip AD9851 controlled by Raspberry Pi. The implementation is very basic with just several wire connections between the GPIO connectors Raspberry Pi-2 computer and AD9851 module.

Ham-transceiver with an RTL-SDR, Raspberry Pi and RPITX (RTL-SDR.com, 2015)

This work is based on RpiTx, which is a piece of software that allows you to turn your Raspberry Pi into a multi-purpose transmitter by modulating the output on one of the GPIO pins.

Transmitting FM, AM, SSB, SSTV, and FSQ with just a Raspberry Pi (RTL-SDR.com, 2015)

Raspberry Pi itself is capable of modulating and transmitting FM, AM, SSB, SSTV and FSQ signals anywhere between 130 kHz to 750 MHz. In order to transmit with the Raspberry Pi, a wire antenna is plugged in to Pin 12 (GPIO 18) on the GPIO port and the PiTx software is ran by piping in an audio file or image for SSTV.

Key Materials

Other key materials are the datasheet of AD9854 and official site for Raspberry Pi and RTL-SDR respectively. The community forum for Raspberry Pi provides variety of useful resource and problems previously identified.

Plan

This is a normal lord project starting Semester 1, 2018, and ending at the end of Semester 2, 2018. The first half of the project is devoted to learning to program the Raspberry Pi and AD9854 and analysis the feasibility of such design. The second half is mainly to integrate these components to achieve the goal and test the outcome.

Reference

Analog.com. (2018). AD9854 Datasheet and Product Info | Analog Devices. [online] Available at: <http://www.analog.com/en/products/clock-and-timing/direct-digital-synthesis/ad9854.html#product-overview> [Accessed 24 Mar. 2018].

Techniline.com. (2018). DDS SYNTHESIZER 0-70MHz ON RASPBERRY PI AND AD9851. [online] Available at: <http://www.techniline.com/index.php/en/concepts/item/39-dds-synthesizer-raspberry-pi-ad9851> [Accessed 25 Mar. 2018].

rtl-sdr.com. (2018). Transmitting FM, AM, SSB, SSTV and FSQ with just a Raspberry Pi - rtl-sdr.com. [online] Available at: <https://www.rtl-sdr.com/transmitting-fm-am-ssb-sstv-and-fsq-with-just-a-raspberry-pi/> [Accessed 24 Mar. 2018].

rtl-sdr.com. (2018). Building a Ham Transceiver with an RTL-SDR, Raspberry Pi and Rpitx - rtl-sdr.com. [online] Available at: <https://www.rtl-sdr.com/building-a-ham-tranceiver-with-an-rtl-sdr-raspberry-pi-and-rpitx/> [Accessed 24 Mar. 2018].