# Arduino Nano Controlled AD9850 Based Function Generator

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***Abstract-*** *Function generator is a key component of electronics and electrical research and development process. Different sort of technologies have been developed so as to accommodate each and every aspect of signal generation. A function generator is a universal tool used by every electrical engineer at some point in their Career. Sine, square, and triangle waves of different periods, duty cycles, and amplitudes are required as input to many digital and analog circuits. A function generator creates these input signals which can then be amplified and used in a variety of applications. Thereby, it becomes evident in the world of technology to make way for a better and efficient prospect. This paper covers design and development of function generator which may replace the age old technique of signal or function generation with a more effective means of technology using Arduino and AD9850.*

***Keywords***- Arduino, function generator, sine wave, frequency, amplitude.

## I. INTRODUCTION

The function generator is a device which generates various types of waveforms of different frequency and amplitude. They are basically two types analog and digital. In early days analog function generators were used in research labs and industry to generated various types of sisgnals such as sine, triangular, square, TTL and so on. But these function generator were disadvantageous as its output may be affected by environmental factors such as temperature, humidity, EMI etc. With the advent in the digital technology digital function generators came in to existence and being used in research lab. Digital function generators are very accurate and less prone to noise signal.

The function generator is a very handy device in electronic design, development, testing and troubleshooting. It can generate the required frequencies which can then be applied directly to the target device for testing it. True digital sources are meant to drive digital systems. Their outputs are binary pulse streams. The features of a digital source are optimized for computer bus needs and similar applications. Arduino is an open source physical computing platform. Arduino can be used to develop interactive objects, taking in inputs to control outputs. Projects done with Arduino can be stand alone or they can communicate with software running on a computer. The function generators that we currently use are costly and complicated. A typical function generator does not allow interfacing and combination with other devices. So by using PC as an interface between hardware and software we can generate different waveforms of different frequencies. So, it is necessary to develop a portable and an affordable function generator which can fulfill the basic need of signal generation. For small scale applications, we need a function generator which is comparatively small, cheaper, easy to build and capable enough to generate the basic waveforms like sine, square. These open sourcing platforms provide additional input to the development of modern electronics. With these added benefits of Arduino. We can build a substitute function generator.

This module described here is based on ADS9850, a CMOS, 125MHz, and Complete DDS Synthesizer. The AD9850 is a highly integrated device that uses advanced DDS technology coupled with an internal high speed, high performance, D/A converter and comparator, to form a complete digitally programmable frequency synthesizer and clock generator function.

## II. SYSTEM ARCHITECTURE

The Arduino NANO is a microcontroller board based on the ATmega328, which is a high performance Atmel 8-bit AVR RISC-based microcontroller. The device operates between 5-12V. It has 22 digital input/output pins, 14 of these pins are digital pins,8 analog inputs, a 16 MHz of crystal oscillator, a USB connection, a power jack and a reset button. Flash memory of Arduino NANO is 32kb.It has preinstalled boot loader on it, which takes a flash memory of 2kb.SRAM memory of this Microcontroller board is 8kb.It has an EEPROM memory of 1kb.

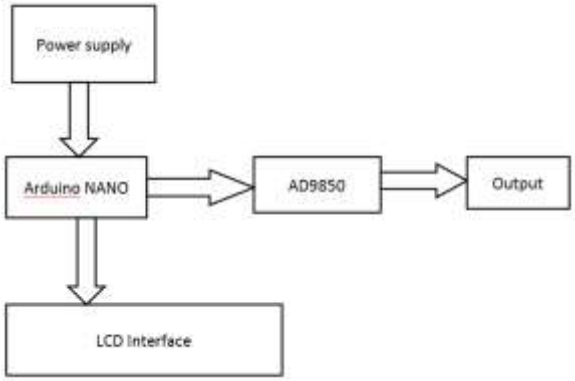


**Figure 1 Block diagram of the system**

The AD9850 is highly integrated device that uses advanced DDS technology coupled with an internal high speed, high performance/A converter and comparator to form a complete digitally programmable frequency synthesizer and clock generator function. When reference to an accurate clock source, the AD9850 generates a spectrally pure, frequency/phase programmable, analog output sine wave.

Features:

1. 125MHz clock rate
2. On-chip High performance DAC and High speed comparator.
3. 32 bit frequency tuning word.
4. Phase modulation capability.
5. 3.3v or 5v single supply operation.
6. 5v-125MHz and 3.3v-110MHz.

Application-

Frequency/Phase-agile sine wave synthesis clock recovery and locking security for digital communication.

Digitally controlled ADC encoder generator agile local oscillator applications.

Pin configuration:

- 4 t0 1,28 to 25-8bit data input.
- 5,24-digital ground.
- 6,23-supply voltage.
- 7-word load clock.
- 8-frquency update.
- 9-referance clock input.
- 10,11-analog ground.
- 11,18-analog supply voltage.
- 22-reset.
- 13(QOUTB)-output complement.
- 14(QOUT)-output true.
- 20(IOUTB)-complementory analog output.
- 21(IOUT)-analog current output of the DAC.

The AD9850 uses direct digital synthesis (DDS) technology, in the form of a numerically controlled oscillator, to generate a frequency/phase-agile sine wave. The digital sine wave is converted to analog form via an internal 10-bit high speed D/A converter, and an on-board high speed comparator is provided to translate the analog sine wave into a low jitter TTL/CMOS compatible output square wave. DDS technology is an innovative circuit architecture that allows fast and precise manipulation of its output frequency under full digital control. DDS also enables very high resolution in the incremental selection of output frequency; the AD9850 allows an output frequency resolution of 0.0291 Hz with a 125 MHz reference clock applied. The DDS circuitry is basically a digital frequency divider function whose incremental resolution is determined by the frequency of the reference clock divided by the 2N number of bits in the tuning word. The phase accumulator is a variable-modulus counter that increments the number stored in it each time it receives a clock pulse. When the counter overflows, it wraps around, making the phase accumulator's output contiguous. The frequency tuning word sets the modulus of the counter, which effectively determines the size of the increment (Δ Phase) that is added to the value in the phase accumulator on the next clock pulse.

The relationship of the output frequency, reference clock, and tuning word of the AD9850 is determined by the formula

$$fout = (\Delta Phase \times CLKIN)/2\text{^}32$$

where: Δ *Phase* is the value of the 32-bit tuning word. *CLKIN* is the input reference clock frequency in MHz.
*fout* is the frequency of the output signal in MHz.

## III. HARDWARE AND RESULTS

The hardware setup is shown the figure 2 and figure 3. The Arduino nano is interfaced with the AD9850 and LCD module. The output signal of the AD9850 is applied to the DSO. The output sinewave and square wave at different frequency is shown in the figure 4 to figure 7. The output frequency and amplitude can be varied using rotary encoder connected to Arduino nano. Two switches are provided to select modes of frequency variation and amplitude variation. Arduino nano programmed to communicate with AD9850 frequency generator. It communicates with AD9850 using 8 bit data lines and control lines. The complete program is is written, compiled using Arduino open source software.

Sample code and help was also available free which help make the system successful.

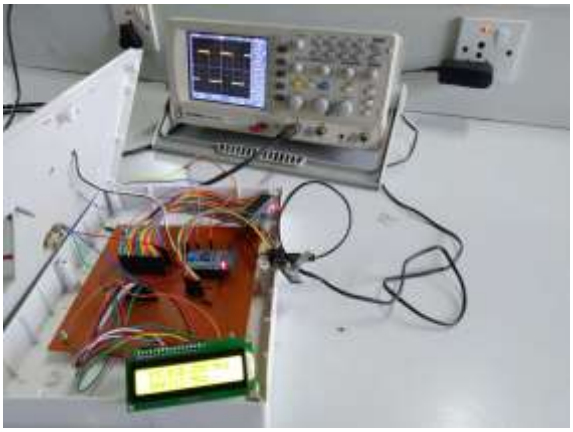

Figure 2 Hardware with square wave output on DSO

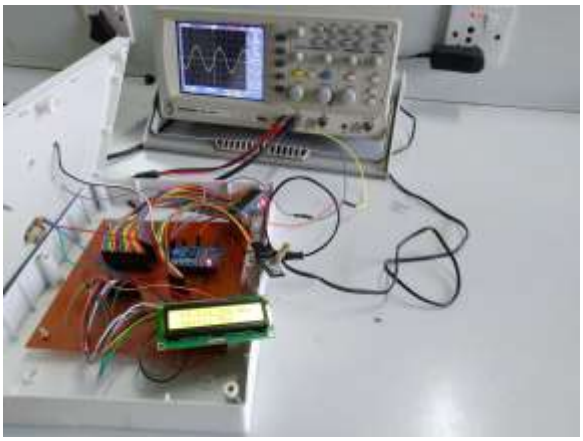

Figure 3 Hardware with sinewave output on DSO

The output results are shown in the figure 4 to 7. Figure 4 and figure 5 shows output sinewave at two different frequencies. Since this waveform digitally generated the peak to peak amplitude is limited to less than 5V. Same is true for square wave output waveform shown in figure 6 and figure 7. The output waveform should be amplified in case of larger amplitude required.

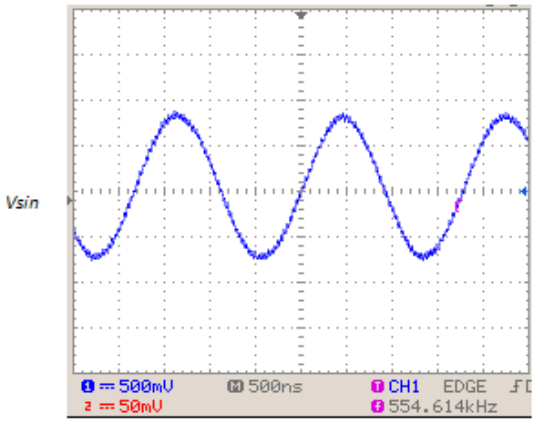


**Figure 4 output sinewave 554.614KHz**

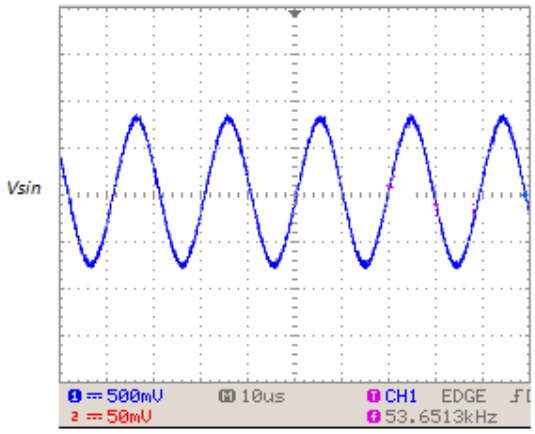


**Figure 5 Output sinewave 53.6513KHz**

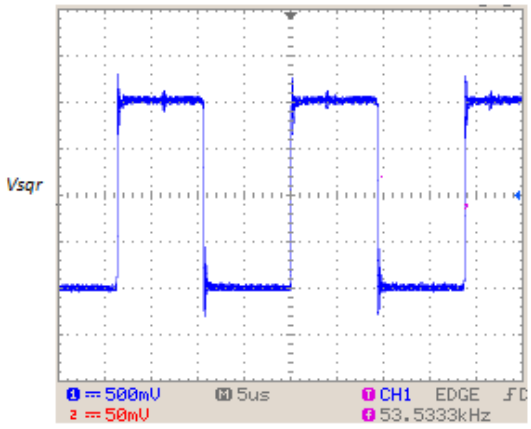


**Figure 6 Output squarewave 53.5333KHz**

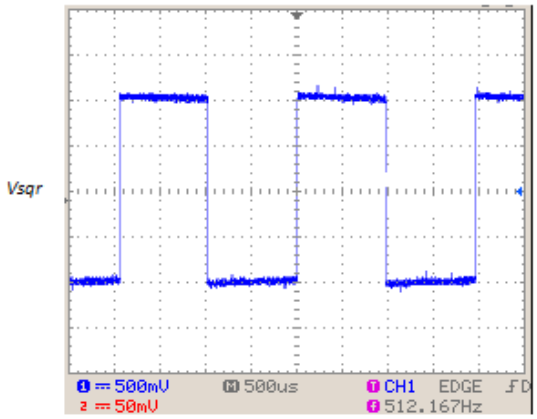


**Figure 7 Output square wave 512.167Hz**

## IV. CONCLUSION

The Arduino NANO based function generator is a type of digital frequency generator. The waveform is generated in the form of binary stream and then it is converted into analog waveform by using digital to analog converter. On comparing with analog frequency generator which requires number of passive circuits such as integrator, differentiator and level corrector, it requires only microcontroller. This function generator is low cost, portable and is easy to build and use. With this project work got the possibility to implement a DDS synthesizer on an ordinary microcontroller. In practical signal generator applications it is common to use complete DDS synthesizer devices which architecture is developed for the DDS algorithm.

## REFERENCES

[1] Liuyng .Limin , Suzhihua, " Function Signal Generator " , fourth International Conference On Digital Manufacturing and Automation 2013.

[2] Hitesh Mandaliya, Parthesh Mankodi, Bhumika Makwana, " Microcontroller Based DDS Function Generator ", International Journal of Engineering Science and Innovative Technology (IJESIT), Volume 2, Issue 1, January 2013.

[3] Yusuf Abdullahi Badamasi, " The Working Principle of an Arduino ", Nigerian Turkish Nile University Abuja, Nigeria.

[4] E. G. C. Burt and O. H. Lange, "Function generators based on linear interpolation with applications to analog computing", an institution monograph June 1955 monograph no.137M.

[5] Mahesh Bilagi, Manjunath Lakkannawar, " Microcontroller Based Direct Digital Synthesizer and FSK Modulator ", ISSN: 2249 - 8958, Volume-3, Issue-1, October 2013.

[6] Visa M. Ibrahim, Oni Taiwo, Uyoata E. Uyoata, " Microcontroller Synthesized Function Generator ", International Journal of Engineering Research and Development, Volume-2, Issue 7 (August 2012), PP. 19-25.

[7] Arduino programming notebook by Brian W. Evans.

[8] Ahmad Adamu Galadima, " Arduino as a learning tool ", Nigerian Turkish Nile University Abuja, Nigeria.

[9] Website: www.arduino.com.

[10] Datasheet of AD9850.