Signal generators also know as function generator or test oscillator

Business, Industries

ABSTRACT

Signal generators also know as function generator or test oscillator, have come to be more popular and most used testing device for the engineers especially and also for the medical sector. Signal generator delivers an accurate calibrated range. It provides a signal that can be adjusted according to the frequency, output voltage, impendence, waveform and modulation. It has been in existence and they are used in so many ways before time till present. An American inventor Nikola Tesla has conveyed electricity from one location to another in the form of signal and uses the same frequency.

This report talks about the overview of a signal generator, how they do function using their applications and also describe to us their operating principles using the direct digital synthesis DDS, their types and designs. The Next page gives you a brief introduction about the early days of signal generator and how they are been used in those days.

INTRODUCTION

Before the Initiation of this device called signal generator which is around 1906 to 1920 are regarded to be the early days of radio, the only way for testing of new apparatus or electronic instrument was to use another similar device to create the signal, which was the case of new tools and modulation format in radio. During that time, this basic method of testing worked excellently with minimum percentage errors, but problem arises when there is a circumstance whereby they might be diverse devices under test. To solve this problem, there must be need for so many reference devices. One

radio’s was picked which was used as a performance parameter and was measured which was now used as the standard or “ golden radio” as it has been called.

Even if they are expensive, a regular change in their functioning features either during a short time as a result of warming up or during a long time as an effect of continued use, and for this reason their will be reduction in their accuracy. The need for signal generator that can effectively used to test devices as the field of engineers must be to reduce this flow.

However, we are going to explain the device “ signal generator” in this report and also we will discuss about the operating principles, and also the things I have already mention in the abstract area. In this next page, we will be looking at the overview of this device signal generator.

SIGNAL GENERATOR (Outline and types)

A signal generator also called a function generator or a text signal generator is an electronic device designed to perform a variety of operations which includes band pass filter characteristics, the response of amplifiers to frequency or fault tracing in many electronic equipment and circuits. “ Signal generator is a tool widely used in fields such as industrial electronic instrumentation, medicine, production, communicationand research”, (Alloca and Stuart, 1983).

A signal generator is the stimulus source that pairs with an acquisition instrument to create the two elements of a complete measurement solution. In its various configurations, signal generator can provide stimulus signals in

the form of analog waveforms, digital data patterns, modulation, noise and it may add known, repeatable amount and types of error (distortion) to the signal it delivers. Signal generator can produce the most types of waveforms or signal which are square waves, sine waves and triangular waves over a wide range of frequency. Coombs, (1972) declares that the frequency range of a signal generator maybe less than 1Hzto at least 1MHz. Some other type of signal generators, have the ability to produce pulse, trapezoid and ramp waveforms including the ones mention above. Therefore, there are many types of signal generator designed to a variety of uses which has much possible application meaning that one particular type of signal generator may not be suitable for all purposes.

Here are the two main type of signal generator

Arbitrary waveform generator

Function signal generator

Below is a picture example of a typical function generator:

ARBITRARY WAVEFORM GENERATOR

Arbitrary waveform generators (AWG) are complicated playback system that delivers waveforms based on stored digital data that describes the regularly changing voltage levels of an AC signal. The arbitrary waveform generator can produce any kind of waveform you can think of. You can use many methods to create the needed output (from mathematical formulae to drawing the waveform).

FUNCTION SIGNAL GENERATOR

Function generators are more simple compare to arbitrary waveform generator. They generate simple signal in wave form and this signals are been produce by a circuit which creates the repeating wave which is usually a sine wave. They are most often use in process of designing or repair simples electronics.

DESIGN OF SIGNAL GENERATORS

Before the modern waveform generators were initiated, analog was the mode of operation. In some industries, analog refers both to the circuit technique used to generate signals and to the signal themselves. Functionality, economic feasible, and types of waveform needed have really change the design of signal generator in period of times, although the traditional analog signal generators still exist till date. The analog is a means to represent a material measure, for instance an indicator on a current meter (regulator), by a quantity whose measurement is known. Such measurements, do not really give the accurate result of a particular tool or device under test, as they are prone to having drifts in their working parts.

Most modern signal generators are based on the digital technologies such as the modern function generators which uses atechnologyknown as Direct Digital Synthesis (DDS) which are able to provide a wide range of signal or waveform. The DDS device are more like to generate analog signals via creating a digital output signal that is continuously pulsed by a clock signal and at last translating the digital signal to form an analog signal. Below is the experimental diagram of this process.

The Method above, illustrate that the input is supplied into the 8bit counter which evaluate the input with an analog, (Q5 to Q0). The matching analog now is been verified with an already stored address which is the ROM (Read Only Memory) 256 x 8. As the counter cycles through the 256 different addresses, which the ROM has for each analog, the ROM counter now picks out a digital value corresponding to that address which sequentially represents the input. This information is then processed and outputs the 256 data points to the DAC (Digital to Analog Converter) which is the 8bit converter. The analog signal obtain is then shown as a waveform. An example of a generator that uses this method illustrated above is the 20MHz sweep function generator from BK Precision (model 4040DDS) image is shown below.

According to BK Precision (2010), this sweep generator is a full featured DDS generator, the unit generate superb quality waveforms with a high signal precision and stability and it provides sine and square wave outputs over the frequency range from 0. 1Hz to 20 MHz in one extended range. Most of the DDS generator today are dedicated instrument, simple and comfortable, and are at low cost from a few tens of dollars to tens of thousand of dollars. In the next section, we are going to look at how this device operates.

OPERATING PRINCIPLES OF SIGNAL GENERATOR

In this 21st century, most of the modern function generators use Direct Digital Synthesis (DDS) technology to generate output wave forms. BK Precision sweep function generator (model 4040DDS) happens to be among

one of this generators. This section describes how DDS technology works. There are two fundamental ideas of DDS technology which includes:

Producing an arbitrary waveform that can be in various waveforms or not assigned a particular value from a periodic ramp signals.
Producing a digital ramp.

First, consider producing wave function that can be in various waveforms or not assigned a particular value from a periodic ramp signal. To make this explanation more simple and understandable, imagine the ramp period (t) is greater than or equal to 0s (t ? 0), then lets call the recurring ramp function R(t) as shown in the diagram below.

This ramp function R(t) as shown in figure 1 differs linearly or oscillate between 0 and 1 with period T. Now, suppose their is a new function F(t) that is defined on the interval 0? t ? 1, in mathematical terminology, the domain of the function which is the values assigned to the independent variables of F(t) is the half-closed interval. Imagine to construct another wave function of period T which is similar to R(t) with the shape of F(t) and assuming again that the period is 4s using the diagram shown in figure 4, we will notice that as the time increases from t0 to t4, which is equal to one period, there is a sequence which implies that their will be a gradual rise in the function until t4, therefore calculating the corresponding value of each time and removing the integer part of it. For instance, tn= – . The calculation for t0 to t8 is shown in the table below using the figure 4 diagram.

The illustration shows that there is a rise in the time value, in the sense that when one period is reach, it will start over again until another period is reached. This is how it works continuously for the defined time interval. This means that it resets after each successive cycle.

On the other hand, the resetting of the time interval is carried out by a phase accumulator which is the first time interval that is the t1 = frequency. In the above example, the waveform that was created has a frequency of 0. 25Hz and a phase angle of 90 that means the frequency is x360

As BK precision (2010) guild book instruct that to produce a digital ramp, as an alternative of increasing the time intervals by 1s, let the increment be in terms of ?, the phase angle, by the digital clock and for an N-bit counter, it will count from 0 to 2N – 1, then reset to 0 again. For example, let the value of be N = 4, which will be (24), therefore the counter result is 16 bits. When a signal is received, it will only match up to one of the bits frequencies and the waveform of that frequency will be generated.

Lastly, the generated waveform might be displayed as a square or triangular signal using the control buttons on the device. This is made possible by including an operating amplifier (op-amp) in the circuit. Assume the received input signal was a sine wave, it can be converted to a square waveform; an op-amp acts as a comparator that gives and output signal of “ 1” only when the amplitude of the sine wave is greater than 0 and a “-1” when the amplitude is less than 0. According to Floyd (2009), this change was essential because digital data processing and transmission can be more

effective and dependable than analog data and it’s of advantage when data storage is needed.

FUNCTIONS AND APPLICATIONS

Signal generators have hundreds of different applications and function that are suited for variety of use in many fields but in electronics measurement context, they fall into three basic types:

Verifications

Characterization

Stressand margin testing

VERIFICATION

In the world of electronic and technologies, wireless equipment designers that are building new transmitter and receiver hardware must stimulate baseband I and Q signals (with or without impairments), to verify some wireless standards, a high performance arbitrary waveform generators can provide the needed low-distortion, high-resolution signals at rates up to 1GB/secs.

CHARACTERIZATION

This is a state whereby the newly developed digital to Analog converter (DAC) and the Analog to digital converters (ADC) must be systematically tested to determine their limits of undeviating, distortion and so on.

STRESS AND MARGING TESTING

Advanced signal generators, save the engineers hours of calculation by providing efficient built- in jitter editing and generation tools because engineers that works with the serial data stream architectures; commonly used in digital communications buses and disk drive amplifiers, need to stress their devices with impairment especially jitter and timing violations so engineers must characterize their emerging designs to ensure that the new hardware meets design specifications across the full range of operation and more.

However, using this device, much difficulty in electronics and also field like the medicine can now be resolute easily.

To design an assorted signal and a high speed low filter data, an arbitrary waveform generator can be used. They are specifically design for it.
Radio frequency signals are used to achieve tests on radio transmitters and receivers. (Theraja and Thereja, 1959)
Signal generators that are connected to oscilloscopes can be use in testing faults in electronic equipment and devices.
In telecommunications today phones functions using signals, for example: the process, transmit and receive data.
Devices for example: digital X-ray appliances, brain mapping system and advanced cardiology uses signal in most medical field today.

CONCLUSION

The modern DDS generators have some advantages and disadvantages of it depict that they help in solving solutions in various fields. Describing about the advantages of DDS, you discover that their frequency is tuneable with sub-Hertz resolution; their phase angle is digitally adjustable, as long as the clock is stable, they don’t go with the flow due to temperature changes or aging of components, addition of arbitrary waveform generator is not theoretically difficult and lastly they have simple design and low parts count which help to keep cost down.

However, describing the disadvantages of this machine has to do with the negative aspect which is their output frequency is ? ? the clock frequency, their amplitude is also fixed that is; they need external circuitry to change, sine wave is sampled and not spectrally pure; distortion is present at that moment. But this disadvantages, does not cost more harm the technology is still the best and with more careful design in future, these advantages can me minimized.

REFERENCES

Floyd, L. (1977) Digital Fundamentals. 10th Edn. Upper Saddle River, New Jersey: PearsonEducation

Ifeachor, E. and Jervis, B. (2002) Digital Signal Processing. A Practical Approach. 2nd Edn. Harlow, England: Pearson Education

Hill, A. (2010) What is signal generatorAvailable at: http://www. wisegeek. com/what-is-a-signal-generator. htm (Accessed 15 March 2011.)

Nashedky, B. (1996) Electronic Devices and Circuit Theory. 6th Edn.

Englewood Cliffs, New Jersey: Prentice-Hall.

Peterson, D. and BK Precision (2010) Function Generator and Arbitrary Waveform Generators Guidebook. Available at: http://www. bkprecision. com/support/downloads/guides/Function_and_Arbitrary_Waveform_Generator_Guidebook/BK-Function-Generator-and-AWG-Guidebook. pdf. (Accessed: 25 March 2011)

Alloca, J. and Stuart, A. (1983) Electronic Instrumentation. Reston, Virginia: Prentice-Hall.

Crecratf, D. et al (1990) Analogue and Digital Electronics. Great Britain: The Open University

Referencec. com (2010) Signal generators. Available at: http://www. reference. com/browse/signal+generator (Accessed: 14 April 2011)

Theraja, B. And Theraja, A. (1959) A Textbook of Electrical Technology. 23rd Edn. Reprint 2003. Ram Nagar, New Delhi: S. Chand & Company Ltd.

Coombs, C. (1972) Handbook of Basic Instrumentation. New York: Mc Graw-Hill

Yourdictionary. com (2010) Nikola Tesla Biography. Available at: http://biography. yourdictionary. com/nikola-tesla (Accessed 18 April 2011)

Tektronics (2008) Signal generator fundamentals Guidebook. Available at: http://circuitslab. case. edu/manuals/Signal_Generator_Fundamentals-_Tektronix. pdf (Accessed 20 April 2011)

ZTech Instruments (2010) Waveform Generator Fundamentals. Available at: http://www. ztecinstruments. com//applications/waveform-generator-fundamentals. php (Accessed: 6 April 2011)