PC Based Wave Form Generator Using Labview

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***Abstract*--A Personal Computer (PC) based wave form generator for laboratory applications has been thought and developed which is generating Sine, Square and Triangular waves in the range of 1 Hz to 20 MHz. The generation, recording and monitoring of wave forms, controlled through USB Data Acquisition system (DAS) connected to computer which is having 14-bit ADC, 10-bit DAC and 12-I/O lines. In the present work National Instrument's USB DAS 6009, Maxim Company's Max038 waveform generator are used for Hardware development. Higher level Graphical language such as 'LabVIEW' is used to develop the software. The experimental study reveals that the developed system is quite suitable to perform laboratory applications accurately. The results obtained from system are in agreement with results of standard instruments.**

***Index Terms*-- Wave Form, LabVIEW, DAS, FLC**.

I. INTRODUCTION

A Waveform generator is widely used for experimental work in all electronics labs [1,2,3]. It generates various types of wave forms like sine, square, triangle, etc., with a particular frequency, amplitude and duty-cycle. Currently, most waveform generators in the laboratory made use of manual control and these are not programmable. Usually, the manual function generators do not provide feedback to the user regarding the condition of the output. Therefore, the user will never know whether the required waveform is available at the output or not unless they measure it by suitable equipment. Although software controlled waveform generators are available in the market, they are not widely used, because of their high cost. To overcome this problem, A Low cost PC based wave form generator for laboratory application has been thought and developed in our lab. This is generating sine, square and triangle wave forms in the range from 1Hz to 20 MHz. The present work deal with designing and building a programmable waveform generator in LabVIEW plot form. The block diagram of the system is shown in figure-1.

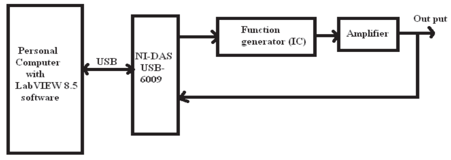

Figure 1. Block diagram of PC based waveform generator system.

II THE DESIGN OF PC BASED WAVEFORM GENERATOR

A. *Personal Computer*

Computer plays a pivotal role in instrumentation in field of data acquisition; instrument control and data processing [4]. To measure and control any instrument it is to be interfaced with a personal computer. For this we need interface ports like Serial, Parallel and Universal Serial Bus (USB) ports. In present study, a powerful 32-bit Intel® core™2 Duo CPU processor based Acer personal computer is used. It consists of a system unit of CPU, clock speed 2.80 GHz, 360 GB hard disk, internal memory 2GB RAM, 105 key-full function keyboard and color monitor. The mother board consists of two PCI slots, four USB ports, two serial and one parallel ports to interface Data Acquisition Systems (DAS). The system is compatible to Windows-7, Unix Operating System and Linux OS etc. also compatible to a vast variety of popular application PC software packages and all language compilers. However, the software and the interface are designed such that it can work in any advanced computer environment.

B. *NI DAS USB-6009*

To measure and control the hardware frequency of the output of Max-038 function generator, it is to be interfaced with a PC. It requires one ADC Input channel, one DAC output channel, four I/O lines. The DIOT/DAS card provides these requirements. In present study, DAS of National instruments USB-6009 is used. It is having 14-bit ADC with 8-single ended or 4-dual ended channels, two 10-bit DAC channels, 12-I/O lines and two counter/timers [5]. This fulfils the present system requirements.

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C. Max038 Waveform Generator IC

Advancement in Integrated Chip technology brings tremendous changes in simplification of hardware design. Single chip incorporating much integration of required tasks. Maxim has produced a family of high quality and reliable one-chip waveform generator ICs. The IC MAX-038 is one best among them [6], with accurate, high frequency, precision function generator producing triangle, sine, square, and pulse waveforms with a minimum of external components. It generates 0.1Hz to 20 MHz range of Independent frequency and Duty-Cycle adjustments with 15% to 85% Variable Duty Cycle.. are some of the important features. It is a 20-pin IC, works with +5V supply and features a parallel digital interface that connects easily to most systems like Microprocessors/microcontrollers or PCs.

The desired output wave form is selected under logic control by setting the appropriate code at the A0 and A1 inputs. The wave form selection table is shown in table-1. The basic oscillator is a relaxation type. The operates by alternately charging and discharging a capacitor, 'CF' with constant current, simultaneously producing a triangle wave and a square wave.

TABLE 1.
Waveform Selection

A0	A1	Waveform
X	1	Sine wave
0	0	Square wave
1	0	Triangle wave

D. BB PGA103

The PGA 103 is a Programmable gain amplifier having gains of 1, 10 and 100 which are digitally selected by two compatible inputs. It is high speed circuitry provides fast settling time. It operating voltage is +/_ 4v to +/_18v, available in 8 pin DIP package [7]. The digital inputs, A0 and A1, select the gain according to the logic table, table-2.

TABLE 2.
PGA103 gain selection

Gain	A1	A0
1	0	0
10	0	1
100	1	0
Not valid	1	1

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E. Interface Circuit

The Max-038 IC's I/O can easily be interfaced with a PC. IIN pin is connected to DAC output.. A0, A1 pins are connected to P0.0, P0.1 port lines of DAS. Frequency adjustment is accomplished with a capacitor C2 and variable resistor, R1. I in current is drive from DAS's DAC. Amplitude, offset, and duty-cycle adjustments are performed via variable resistors. Switches A0 and A1 select the waveform type, to be generated. The frequency range decides the capacitor C2 value (in present work C2 is fixed for particular range). The F*adj* pin of U1 is tied to ground through a 12k resistor, so the frequency of the waveform at U1-19 is f = 2(IIN/C2), where IIN = VREF/R, and VREF = 2.5 V. The output at U1-19 is 2 V p-p, centred around zero, for all waveforms. For amplitude adjustment, The portion of U1-19 fed to the programmable gain amplifier BB PGA103. The gain varies from 1, 10 and 100 times in fixed 3 - steps. This gain is digitally selected from PGA's

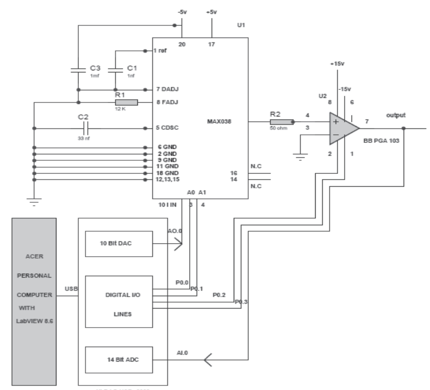

Figure 2. Schematic Diagram of PC Based Waveform Generator.

A0, A1 pins which are connected to P0.2, P0.3 port line of DAS. The duty cycle adjustment is fixed at 50% in present work for constant output. The schematic diagram is in figure-2.

F. Software requirement

Software plays very important role in any PC based instrumentation system, as it includes all tools which a developer needs to build and execute applications. In the present work National Instruments' LabVIEW 8.5 version is used for development of application software like C/C++, Java. It is Graphical programming language, so called 'G' language [8]. It has back panel where we write programming code in form of icons and front panel indicators, controls for display and control purpose. The programs written in LabVIEW are called "Virtual Instruments" or VI's due to their instrument related origin. The programs created are portable of the type of machine and operating system. It has a built-in mathematical function, graphical data display objects and data input objects. LabVIEW has many features some them are.. data flow controlled execution, real time debugging features, data base (SQL) interfacing for industrial PLC's, and add-on software packages for specific extension of the program features, etc.

The software control program is written in LabVIEW 8.5.

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Figure-3a shows the program of front and back panels of present developed setup system.

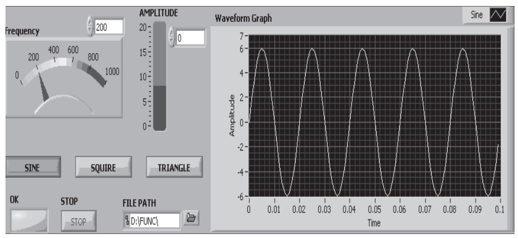

Figure 3a. Show a front and back panel of waveform generator in LabVIEW.

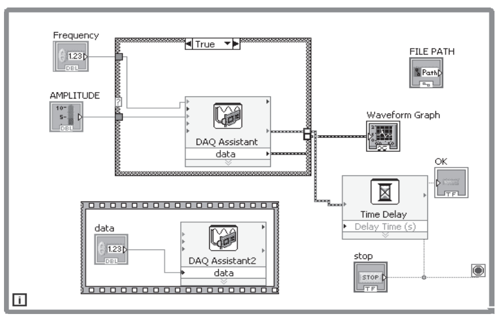

Figure 3b. LabVIEW Program for PC based waveform generator.

III. EXPERIMENTAL

The prototype of the PC based waveform generator is successfully designed and tested in the laboratory. The photograph in figure-3 b, shows the prototype used in the present experiment. The performance of the present design system is evaluated by comparing with standard reported instrument [9]. The response time (τ) of Ferroelectric Liquid Crystal (FLC) compounds 2CI.BAAP.120-BBP and 2CI.BAAP.180-BBP, with temperature variation is calculated in present work. To determine the response times (in SC* phase) also by the measurement of shift (frequency dependent) of the peaks due to polarization reversal in the current signal (converted in to voltage) as reported [10] by Bawa et.al. . Plotting the current peaks measured at double the frequencies (viz., 100Hz and 200Hz) reduces the pulse gaps to half in the time axis 10. The scanning time of the oscilloscope is to be halved, while plotting the higher frequency signal (to obtain the same abscissa length) and the slope of the applied triangular pulse. By doing so (i.e., doubling the frequency), one actually shifts the event (occurrence of peak of the polarization reversal current) by the same time corresponds to the response time of the device. The response time is directly measured by the difference of the occurrence of peaks in lower frequency (i.e., 100Hz) time scale. The reported values are tabulated in table-3. Then the experiment (for two compounds) is performed by substituting the function generator with developed waveform generator and the calculated values are tabulated in the same table.

IV. RESULTS AND DISCUSSION

The temperature variation of response time is measured by following the reported double frequency technique [10]. The observed variation of switching times with temperature in Smectic-C* phase is given in Tables-3,4,5,6 for the compounds 2Cl.BAAP.12O-BBP and 2Cl.BAAP.18O-BBP respectively. It is also observed that the range of switching times exhibited by the present compounds with developed setup are found to agree with the reported [9] values of same FLC compounds.

TABLE 3.
Response time of FLC compound 2CI.BAAP.120-BBP

S.No.	Temperature^{o}/C	Reported values (T/μs)	Instrument measured values(T/μs)
1	35	77	77
2	36	74	75
3	37	71	71
4	38	69	70
5	39	67	67
6	40	65	64
7	41	*63*	62
8	42	60	60
9	43	58	58
10	44	55	54
11	45	53	53
12	46	48	48
13	47	45	45
14	48	40	42

Table 4
Response time of FLC compound 2CI.BAAP.120-BBP

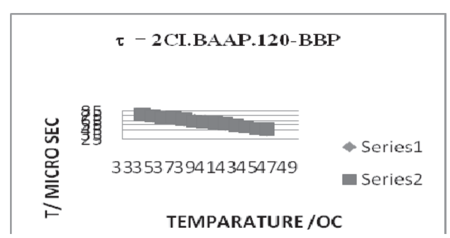

TABLE 5
Response time of FLC compound 2CI.BAAP.180- BBP

S.No.	**Temperature ^{o}C**	**Reported values (T/μs)**	**Instrument measured values (T/μs)**
1	32	90	90
2	33	90	89
3	34	88	87
4	35	78	78
5	36	75	75
6	37	71	70
7	38	66	66
8	39	60	61
9	40	57	57
10	41	49	48
11	42	38	36
12	43	33	30
13	44	22	21

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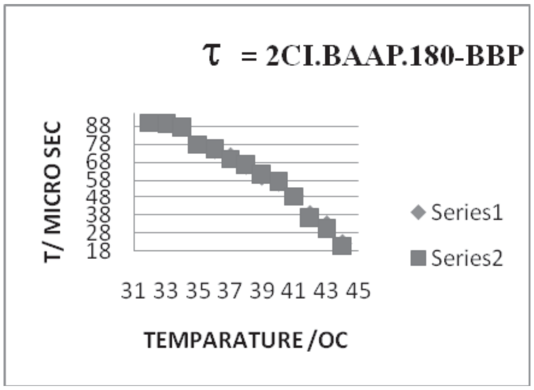
TABLE 6
Response time of FLC compound 2CI.BAAP.180-BBP



CONCLUSION

PC based wave form generator which was built and tested for its functionality with standard instruments capable to generate sine, square and triangular waves with accurate frequency and amplitude had been built and tested for its functionality with standard instruments.

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