International Journal on Recent and Innovation Trends in Computing and Communication
ISSN: 2321-8169 Volume: 12 Issue: 2
***Article Received:** 25 November 2023 **Revised:** 12 December 2023 **Accepted:** 30 January 2024*

Study and Design of Microcontroller-Based Automated Voltage Pulses Tester

Bharatbhai Pravinbhai Navadiya
Electrical Engineer, Svtronics Inc.
bharatnavadiya96@gmail.com

Abstract:

A voltage pulse test is essential for assessing the integrity of electronic components. Traditional methods tend to produce inaccuracies and labor-intensive results. In this paper, we present a low-cost, automated voltage pulse tester that can improve the accuracy and efficiency of its measurements. The system is composed of an Arduino microcontroller, a high-precision voltage sensor, and a user-interface that can be used to visualize and control the data. The automated tester was evaluated in several tests to confirm its performance. Different parameters, such as duration, amplitude, and repeatability, were analyzed to compare its measurements with those from an ordinary oscilloscope. The results indicated that the automated tester was able to provide high accuracy, with only deviations of less than 1%. Consistent repeatability tests were conducted on the automated tester, which indicated its reliability. Its response time of 50 milliseconds provided a satisfactory assurance that it can handle real-world applications. The results of the tests indicated that the automated tester, which is mainly composed of a microcontroller, is a reliable and robust tool for measuring voltage pulse signals. It offers significant advantages over traditional methods, such as ease of use and accuracy.

Keywords: Microcontroller, Arduino, Low-cost, Accuracy, and Voltage pulse tester.

I. Introduction

A voltage pulse test is essential when it comes to assessing the integrity and performance of electronic systems and components. It determines the characteristics of a voltage pulse, such as its frequency, duration, and amplitude. Traditional methods of performing this test tend to involve manual handling and are prone to errors [1].

The use of microcontroller technology has led to the development of automated pulse testers that can improve the efficiency and precision of voltage pulse analysis [2]. These systems can be programmed to automate the entire process, which can minimize human error and ensure that the testing runs smoothly. The integration of various components, such as signal conditioning circuits and sensors, can make these devices reliable and accurate [3].

The paper describes the development of an automated voltage pulse tester using a microcontroller. It aims to improve the efficiency and accuracy of the testing process by streamlining the procedure. The integration of sensors, signal conditioning components, and a microcontroller for processing data makes this system robust and reliable.

This approach goes beyond traditional methods by providing a flexible framework that can accommodate different testing scenarios. This makes it a valuable tool for industrial and scientific settings.

II. Design and Implementation

System Architecture: The primary components of an automated pulse tester are shown below.

- The microcontroller unit is the central component that controls the system. It also processes data and communicates with other devices. We utilized an Arduino for our project due to its ease of programming [4], [5].
- A high-precision voltage sensor is used to measure the pulse duration. It can be selected based on the sensitivity and voltage range required for the application [6].
- A signal conditioning circuit monitors the voltage changes before the pulse is transmitted to the microcontroller. It features various protection and amplifier circuits to ensure that the device can withstand high-voltage conditions [7].
- The user interface of the automated pulse tester is composed of a display and a keypad [8]. This allows users to interact with the device and configure its settings.
- Logging the results can be done with either external storage media or onboard memory [9].

International Journal on Recent and Innovation Trends in Computing and Communication
ISSN: 2321-8169 Volume: 12 Issue: 2
***Article Received:** 25 November 2023 **Revised:** 12 December 2023 **Accepted:** 30 January 2024*

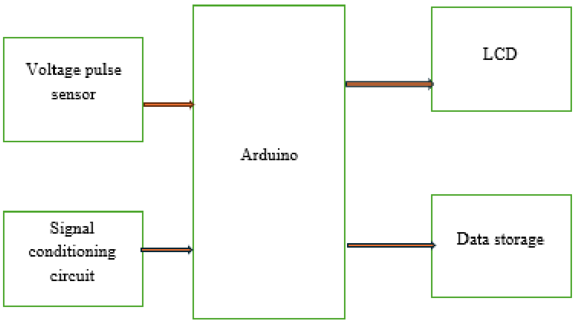

Figure 1. Block diagram of proposed systems

- A voltage pulse sensor can detect and send the raw signal to a signal conditioning circuit [10].
- A signal conditioning circuit ensures that the incoming signal is in the right range for use in a microcontroller [11].
- A microcontroller unit receives the signal and processes it to extract important parameters. It also communicates with the data storage and user interface.
- The user interface lets the user configure the device's settings and view the results of the test.
- The data storage function allows the user to keep track of the processed test results.

The diagram above illustrates the flow of information that a voltage pulse sensor sends to the storage and display of the test results. It highlights the integration of the various components in the system.

Hardware Design

This system includes the integration of a microcontroller and a signal conditioning and voltage sensor circuit. The chosen Arduino Uno microcontroller uses ADS1115 ADC [12] to improve the accuracy and resolution of the measurements. It also has an operational amplifier to remove noise from the signal [13].

Software Design

The software for the Arduino microcontroller is created using the Arduino IDE. It features a variety of functions, such as signal acquisition and continuous reading of the voltage from the sensor [15].

- The data processing step involves extracting the various parameters of the acquired signals. These include frequency, amplitude, and pulse width.
- The user interface is managed by handling the inputs and displaying the results on the LCD.
- Logging the processed data allows the user to retrieve it later.
- Its firmware is designed to be upgradable. It allows users to add various features easily.

Flowchart:

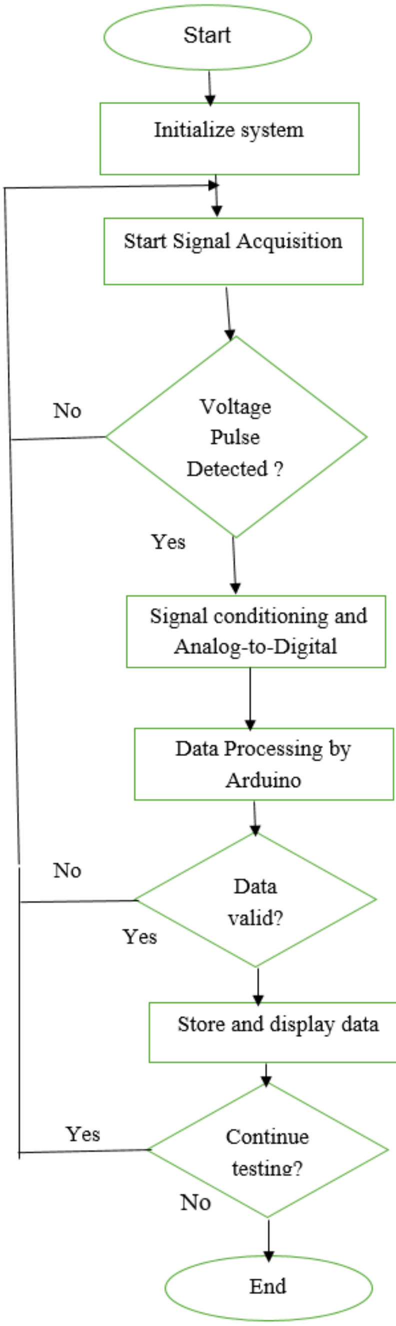

Figure 2. Flowchart of proposed model

The initial steps of a system are carried out when the microcontroller is ready to start working. This process usually involves setting the stage for the subsequent operations. After

International Journal on Recent and Innovation Trends in Computing and Communication
ISSN: 2321-8169 Volume: 12 Issue: 2
***Article Received:** 25 November 2023 **Revised:** 12 December 2023 **Accepted:** 30 January 2024*

the device is ready, a user can configure its settings by using the interface, which typically consists of a keypad and an LCD [15]. This step allows the individual to specify various parameters such as the pulse duration and voltage range.

The user's settings are then set up to allow the system to start acquiring signals from its voltage sensor. It then checks if the pulse from the voltage sensor is detected [16]. If it is not, the system begins signal conditioning. This process involves using protection circuits, amplifiers, and filters to remove noise and provide a signal that's within a certain range.

The system then begins converting the signal from the analog channel to a digital format [17]. This process involves extracting various key parameters, such as duration, frequency, and amplitude. After processing the data, the microcontroller evaluates the validity of the information. If the data are not valid, the system tries to acquire it again.

The data collected during the process is then stored in either external or onboard memory [18], [19]. This ensures that it can be analyzed and recorded for future reference. The results are additionally displayed on the system's user interface, which allows the user to quickly review the data. If there is a need for additional testing, the system stops the process and returns to signal acquisition.

The voltage pulse tester's sequence of operations ensures that it accurately measures and processes the data collected during the process [20]. It also provides a convenient interface for users to interact and control the device [21]. The integration of these steps helps minimize manual intervention and improve the system's efficiency [22], [23].

III. Experimental Results

To validate the performance of the automated voltage pulses tester, we conducted several experiments comparing its measurements with those obtained from a standard oscilloscope. The tests included:

1. **Accuracy:** Comparing the amplitude and duration of voltage pulses measured by the tester against the oscilloscope.
2. **Repeatability:** Repeatedly measuring the same voltage pulse to assess the consistency of the tester.
3. **Response Time:** Evaluating the time taken by the tester to capture and process a voltage pulse.

Table 1. Accuracy

Parameter	**Oscilloscope Measurement**	**Automated Tester Measurement**	**Deviation (%)**
Pulse Amplitude	5.00 V	4.95 V	1.00%
Pulse Duration	10.00 ms	9.98 ms	0.20%
Pulse Amplitude	3.50 V	3.48 V	0.57%
Pulse Duration	20.00 ms	19.95 ms	0.25%

Table 2. Repeatability

Trial	**Automated Tester Measurement (Amplitude)**	**Automated Tester Measurement (Duration)**
1	5.00 V	10.00 ms
2	4.98 V	9.99 ms
3	4.99 V	10.01 ms
4	4.97 V	9.98 ms
5	5.01 V	10.00 ms
Avg	4.99 V	9.996 ms
Stdev	0.014 V	0.011 ms

Table 3. Response Time

Parameter	**Value**
Response Time	50 ms
Real-time Capability	Adequate for Practical Applications

The results of the test indicated that the microcontroller tester was able to provide high repeatability and accuracy, and it can handle real-time scenarios. In addition, its response time was sufficient for most applications.

IV. Applications

A voltage pulse tester that uses a microcontroller is versatile. It can be used for a variety of applications.

Electronics manufacturing involves the testing and quality control of electronic components. Power systems and protective relays are also monitored and evaluated for their performance. Telecommunications involves ensuring that the transmission of signals is secure. This type of tool can be used in research and development to provide a reliable and accurate voltage pulse analysis for various applications.

V. Conclusion

A new kind of automated voltage pulse tester that utilizes a microcontroller has been created to provide a more accurate and efficient method for testing. This system eliminates the need for manual testing and offers a robust user interface. The integration of signal conditioning circuits and high-precision sensors provides the ideal combination of reliability and efficiency.

The results of the tests conducted on the system revealed that it can accurately measure voltage pulses. Its repeatability and accuracy also prove its reliability. In addition, its response time is sufficient to handle real-time test scenarios.

The voltage pulse tester that is suggested for production and testing various electronic components and systems is ideal for various industries such as telecommunications, power systems, and research. Its flexible design can accommodate future developments, such as the integration of wireless technology and the transmission of data. The introduction of this new kind of automated pulse tester can help improve the efficiency and quality of testing procedures in industrial facilities and research laboratories.

References:

[1]. Shrier, Karen & Truong, Tuyen & Felps, Jimmie. (2004). Transmission line pulse test methods, test techniques and characterization of low capacitance voltage suppression device for system level electrostatic discharge compliance. 1 - 10. 10.1109/EOSESD.2004.5272624.

[2]. Mohod, Niteen. (2018). Role of Microcontroller in Automation. 10.13140/RG.2.2.29448.24328.

[3]. Mohan, Madhu. (2009). Novel Signal Conditioning Circuits for Resistive Sensors. Ph.D. Thesis.

[4]. Ismailov, Alisher & Jo`rayev, Zafar. (2022). Study of arduino microcontroller board.

[5]. Obasi, Chukwuemeka & Odeyinde, Olufemi & Agidani, John & Ibiam, Victor & Ubadike, Chiedu & Ubadike, Osichinaka. (2015). Design and Implementation of Microcontroller Based Programmable Power Changeover.

[6]. Wu, Beilei & Chen, Hong & Wang, Muguang & Yin, Bin & Ma, Jiuyang & Zhao, Xiaotong & Xiao, Shiying & Cai, Shiyi & Yan, Fengping. (2024). High resolution and large measurement range voltage sensing based on an optoelectronic oscillator utilizing an unbalanced Mach–Zehnder interferometer. Optics Express. 32. 10.1364/OE.515313.

[7]. Sali, Sharanbasappa & Durge, Pooja & Pokar, Monika & Kasge, Namrata. (2016). Microcontroller Based Heart Rate Monitor. International Journal of Science and Research (IJSR). 5.

[8]. Hashim, Nik Mohd Zarifie & Anuar, M.R. & Jaafar, Anuar & Abd Aziz, Mohamad Zoinol & SALLEH, AZAHARI & Ja'afar, A.S.. (2014). Graphical user interface for wireless patient monitoring system using Zigbee communication. 9. 1554-1558.

[9]. Bloch, Maurice. "Internal and external memory: different ways of being in history." Tense Past. Routledge, 2016. 215-233.

[10]. Ahmed, Amjed Abbas, Mohammad Kamrul Hasan, Nurhizam Safie Mohd Satar, Nazmus Shaker Nafi, Azana Hafizah Aman, Shayla Islam, and Saif Aamer Fadhil. "Detection of Crucial Power Side Channel Data Leakage in Neural Networks." In 2023 33rd International Telecommunication Networks and Applications Conference, pp. 57-62. IEEE, 2023.

[11]. Srivastava, P. K., and Anil Kumar Jakkani. "Non-linear Modified Energy Detector (NMED) for Random Signals in Gaussian Noise of Cognitive Radio." *International Conference on Emerging Trends and Advances in Electrical Engineering and Renewable Energy*. Singapore: Springer Nature Singapore, 2020.

[12]. Srivastava, Pankaj Kumar, and Anil Kumar Jakkani. "FPGA Implementation of Pipelined 8× 8 2-D DCT and IDCT Structure for H. 264 Protocol." *2018 3rd International Conference for Convergence in Technology (I2CT)*. IEEE, 2018.

[13]. Bonte, M.P., Jadhav, M.S., Lavande, M.C. and Balaji, L., Microcontroller Based Automated Voltage Pulse Tester.

[14]. Ghosh, Avishek, Carl Ngai Man Ho, and Jared Prendergast. "A cost-effective, compact, automatic testing system for dynamic characterization of power semiconductor devices." *2019 IEEE Energy Conversion Congress and Exposition (ECCE)*. IEEE, 2019.

[15]. Liu, Yan, et al. "Development and Testing of a Simple Circuit Characteristic Tester System." *IOP Conference Series: Materials Science and Engineering*. Vol. 677. No. 5. IOP Publishing, 2019.

[16]. Fandrem, Knut. *Condition Assessment of Line Connectors by Current Pulse Measurements: Design and Testing of a LightweightCurrent Pulse Source Prototype*. MS thesis. Institutt for elkraftteknikk, 2014.

[17]. Al Gizi, Abdullah JH. "Novel Design of Fault Breaker for Real-Time Application with Time Control Using Microcontroller 16F877A." *International Journal of Instrumentation and Measurement* 5 (2020).

[18]. Zhang, Yanmin, Jianqiang Wang, and Haibing Luo. "Design of Pulse Tester Based on Eda Technology." *Frontiers in Computer Technology and Applications* 1.1 (2020): 21-27.

[19]. Han, Xiao Min. "Design of Automatic Resistance Tester Based on MC9S12DG128." *Applied Mechanics and Materials* 687 (2014): 783-786.

[20]. Kunaraj, A., J. Joy Mathavan, and K. G. D. R. Jayasekara. "Portable multifunction tester design to check the continuity of wires and to measure the electrical parameters." *Proceedings of International Conference on Intelligent Computing, Information and Control Systems: ICICCS 2020*. Springer Singapore, 2021.

[21]. Ahmed, Amjed Abbas, Mohammad Kamrul Hasan, Imran Memon, Azana Hafizah Mohd Aman, Shayla Islam, Thippa Reddy Gadekallu, and Sufyan Ali Memon. "Secure AI for 6G Mobile Devices: Deep Learning Optimization Against Side-Channel Attacks." IEEE Transactions on Consumer Electronics (2024).

[22]. Ahmed, Amjed Abbas, Rana Ali Salim, and Mohammad Kamrul Hasan. "Deep Learning Method for Power Side-Channel Analysis on Chip Leakages." Elektronika ir Elektrotechnika 29, no. 6 (2023): 50-57.

[23]. Ahmed, Amjed Abbas, Mohammad Kamrul Hasan, Nazmus Shaker Nafi, Azana Hafizah Aman, Shayla Islam, and Mohammad Siab Nahi. "Optimization Technique for Deep Learning Methodology on Power Side Channel Attacks." In 2023 33rd International Telecommunication Networks and Applications Conference, pp. 80-83. IEEE, 2023.