Design of Microcontroller-Based Vernier Fringe Counter for Interferometric Measurement of Laser Wavelength

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***Abstract*— This paper presents a new electronic Vernier fringe counter for the wavelength measurement of a diode laser in a scanning interferometer. The system is intended to be a low cost alternative to commercial systems used for gauge block calibration. The counter stage and phase coincidence detector are made with a microcontroller and high-speed CMOS logic to achieve the required resolution. The microcontroller also can synchronize with other elements to make a fully automated measurement system. This electronic design improves the resolution of the electronic counters in the previous designs**

I. INTRODUCTION

Scanning interferometer wavemeters carry out interferometer. Both laser beams suffer the same path variation but produce a different number of interference fringes because of their different wavelength An interferometer is a device that can be used to measure lengths or changes in length with great accuracy by means of interference fringes. In this experiment, it will be used to measure the wavelength of He-Ne laser. The beam splitter is a glass plate that is half silvered so that light from the source splits at the first surface. Half of the incoming beam is transmitted to the mirror (passing through the glass compensator plate on the way) and the other half is reflected toward the mirror. Mirrors and reflect the light back to the beam splitter. And half of each reaches viewing screen. The reminder being directed back to the source and lost. Mirror, mounted on a carriage which slides on a track, can be translated toward or away from the observer by means of a precision micrometer. So the displacement of mirror can be measured accurately by reading the micrometer.

II. EXISTING SYSTEM

In this letter, we present a design for such a wavemeter in which the reference laser is a frequency-stabilized diode laser locked to an atomic transition. This gives the reference laser the desired frequency stability of 1 MHz and the required wavelength calibration for absolute measurements. While expensive commercial wavemeters that use a stabilized He–Ne laser as the reference are available, our wavemeter is built in- house around a low-cost laser diode and the entire instrument has a maximum component cost. To characterize the accuracy of the instrument, we have measured the wavelength of a second stabilized diode laser system.

III. PROPOSED SYSTEM

This paper is focused on the new electronic system of a Michelson wavemeter designed to give traceability to the wavelength of external cavity diode lasers (ECDLs). This system is intended to be a low cost alternative to commercial systems with better characteristics. The configuration of our experimental setup. which is produced by the movement of the arms of a Michelson interferometer. Both laser beams suffer the same path variation but produce a different number of interference fringes because of their different wavelength

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Connected to the output dc voltage changes. This voltage regulation is usually obtained using one of the popular voltage regulator IC units.

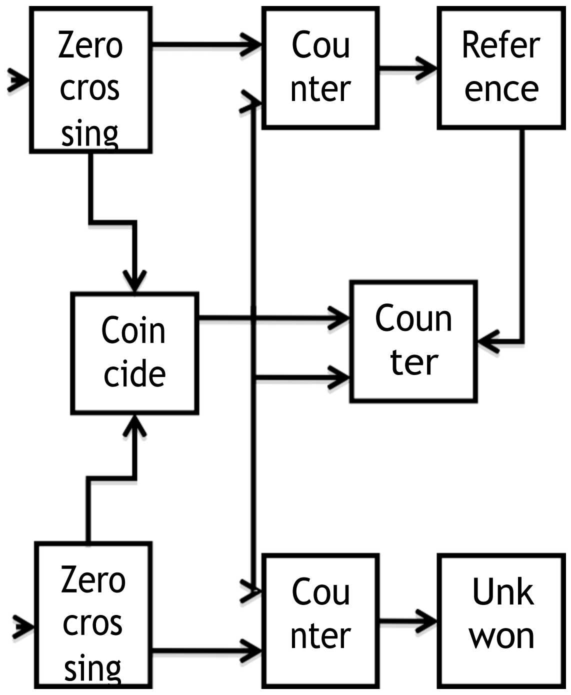


Fig. 1 Block diagram

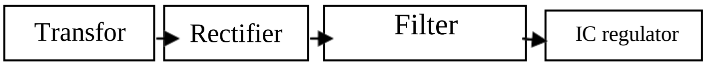
The interferometer employs a calibrated He–Ne laser as reference and an ECDL as unknown laser. The path variation is obtained by a Thorlabs DDS220/M motorized stage that moves at constant velocity. This stage has a maximum displacement of 220 mm, large enough to continuously acquire about 1 400 000 interference fringes for laser wavelengths about 633 nm in one direction travel. A Vernier coincidence detection is used to improve the accuracy of the system. The prototype mounted in the Laboratorio Oficial de Metroloxía de Galicia (LOMG), Spain Laboratory. The system presented in this paper improves the previous designs in modularity and flexibility by means of a microcontroller board that implements the counter stage and Vernier detector and can be easily modified to improve the characteristics of the wavemeter incorporating analog-to-digital converters to process the signal by digital algorithms. In addition, it can communicate with a computer to receive control commands, send results, and synchronize with the motorized stage of the interferometer.

IV HARDWARE DESCRIPTION.

A. POWER SUPPLY

The ac voltage, typically 220V rms, is connected to a transformer, which steps that ac voltage down to the level of the desired dc output. A diode rectifier then provides a full- wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation.

A regulator circuit removes the ripples and also remains the same dc value even if the input dc voltage varies, or the load



(a)power suply

B. ATMEL89C51 MICROCONTROLLER

AT89C51 is an 8-bit microcontroller and belongs to Atmel's ATMEGA family. ATMEL 89C51 has 4KB of Flash programmable and erasable read only memory (PEROM) and 128 bytes of RAM. It can be erased and program to a maximum of 1000 times.In 40 pin AT89C51, there are four ports designated as P1, P2, P3 and P0. All these ports are 8- bit bi-directional ports, i.e., they can be used as both input and output ports. Except P0 which needs external pull-ups, rest of the ports have internal pull-ups. When 1s are written to these port pins, they are pulled high by the internal pull- ups and can be used as inputs. These ports are also bit addressable and so their bits can also be accessed individually.

Fig. 2 Atmel 89c51 Microcontroller

The Atmel AT89 series is an Intel-ATMEGA-compatible family of 8 bit microcontrollers (µCs) manufactured by the Atmel Corporation. Based on the Intel ATMEGA core, the AT89 series remains very popular as general purpose microcontrollers, due to their industry standard instruction set, and low unit cost This allows a great amount of legacy code to be reused without modification in new applications. While considerably less powerful than the newer AT90 series of AVR RISC microcontrollers, new product development has continued with the AT89 series for the aforementioned advantages of more recent times, the AT89 series has been augmented with ATMEGA-cored special function microcontrollers, specifically in the areas of USB, I²C (TWI), SPI and CAN bus controllers, MP3 decoders and hardware PWM AT89 Series Microcontrollers.

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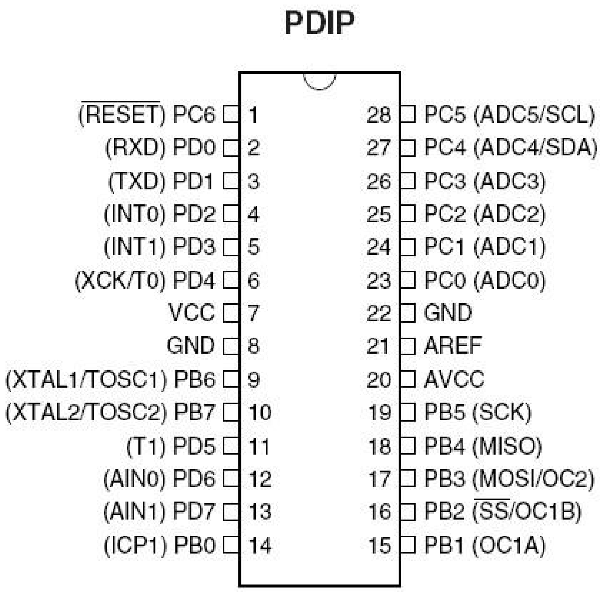
V. MICROCONTROLLER PIN DIAGRAM



A. PORT DESCRIPTION

Port 0:

- Port 0 is an 8-bit open drain bi-directional I/O port.
- As an output port, each pin can sink eight TTL inputs.
- When 1sare written to port 0 pins, the pins can be used as high impedance inputs.
- Port 0 may also be configured to be the multiplexed low order address/ bus during accesses to external program and data memory.
- In this mode P0 has internal pull-ups.
- Port 0 also receives the code bytes during Flash programming, and outputs the code bytes during program verification.
- External pull ups are required during program verification.

Port 1:

- Port 1 is an 8-bit bi-directional I/O port with internal pull-ups.
- The Port 1 output buffers can sink/source four TTL inputs.
- When 1s are written to Port 1 pins they are pulled high by the internal pull ups and can be used as inputs.
- As inputs, Port 1 pins that are externally being pulled low will source current (IIL) because of the internal pull-ups.
- Port 1 also receives the low-order address bytes during Flash programming and verification.

Port 2:

- Port 2 is an 8-bit bi-directional I/O port with internal pull-ups.
- The Port 2 output buffers can sink/source four TTL inputs.
- When 1s are written to Port 2 pins they are pulled high by the internal pull ups and can be used as inputs.
- As inputs, Port 2 pins that are externally being pulled low will source current (IIL) because of the internal pull ups.
- Port 2 emits the high order address byte during fetches from external program memory and during accesses to external data memory that uses 16-bit addresses (MOVX @DPTR).
- In this application, it uses strong internal pull ups when emitting 1s.
- During accesses to external data memory that uses 8- bit addresses (MOVX @ RI), Port 2 emits the 7 contents of the P2 Special Function Register.
- Port 2 also receives the high order address bits and some control signals during Flash programming and verification.

Port 3:

- Port 3 is an 8-bit bi-directional I/O port with internal pull-ups.
- The Port 3 output buffers can sink/source four TTL inputs.
- When 1s are written to Port 3 pins they are pulled high by the internal pull ups and can be used as inputs.
- As inputs, Port 3 pins that are externally being pulled low will source current (IIL) because of the pull-ups.

B. PIN DESCRIPTION

- Pins 1–8:- recognized as Port 1. Different from other ports, this port doesn't provide any other purpose. Port 1 is a domestically pulled up, quasi bi directional Input/output port.
- Pin 9:- As made clear previously RESET pin is utilized to set the micro-controller ATMEGA to its primary values, whereas the micro-controller is functioning or at the early beginning of application. The RESET pin has to be set elevated for two machine rotations.
- Pins 10–17:- recognized as Port 3. This port also supplies a number of other functions such as timer input, interrupts, serial communication indicators TxD & RxD, control indicators for outside memory interfacing WR & RD, etc. This is a domestic pull up port with quasi bi directional port within.

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- Pins 18 and 19:- These are employed for interfacing an outer crystal to give system clock.
- Pin 20:- Titled as Vss – it symbolizes ground (0 V) association.
- Pins- 21-28:- recognized as Port 2 (P 2.0 – P 2.7) other than serving as Input/output port, senior order address bus indicators are multiplexed with this quasi bi directional port.

C. IR SHARP SENSOR

Infrared sensors work by emitting bands or rays of light to determine whether or not there is a certain type of light wavelength in the nearby infrared spectrum. Infrared sensors essentially operate by using LED lights, which emit light of the same wavelength as light rays produced by the ideal IR spectrum. With the emission of IR lights, infrared sensors are able to obtain information about the intensity, frequency and length of other light waves in the surrounding space. As objects become closer, light emitted from IR sensors bounces in greater intensity and frequency off of the surrounding objects.

Fig. 3 IR SHARP SENSOR

This action allows those objects to be detected by the light sensor, appearing as magnified images in the beam of light emitted from the IR sensor. In the absence of surrounding objects, the light sensors within infrared sensors do not detect any surrounding infrared light and, therefore, do not emit a characteristic red glow. In addition to determining the presence of infrared light, sensors may pick up reflected light and determine how bright a nearby object is. Typically, objects that are lighter in color reflect more infrared light, while those that are darker absorb infrared light beneath their surfaces.

D. LCD

LCD (liquid crystal display) is the technology used for displays in notebook and other smaller computers. Like light- emitting diode (LED) and gas-plasma technologies, LCDs allow displays to be much thinner than cathode ray tube (CRT) technology. LCDs consume much less power than LED and gas-display displays because they work on the principle of blocking light rather than emitting it.

Fig. 4 lcd

An LCD is made with either a passive matrix or an active matrix display display grid. The active matrix LCD is also known as a thin film transistor (TFT) display. The passive matrix LCD has a grid of conductors with pixels located at each intersection in the grid. A current is sent across two conductors on the grid to control the light for any pixel. An active matrix has a transistor located at each pixel intersection, requiring less current to control the luminance of a pixel. For this reason, the current in an active matrix display can be switched on and off more frequently, improving the screen refresh time (your mouse will appear to move more smoothly across the screen, for example). Some passive matrix LCD's have dual scanning, meaning that they scan the grid twice with current in the same time that it took for one scan in the original technology. However, active matrix is still a superior technology.

VI. CONCLUSION

In conclusion, the results obtained with this new electronic design are good and open the possibility of employing the ECDL for gauge block calibration, but some improvements would be needed in the electronics for this specific application like better resolution in the coincidence detector, more amplification in the analog stages and higher speed in the counters. As this paper is focused on the development of the electronic system of the wavemeter, the measurement results should be considered as the first tests and not the final results of the complete system. The reference laser used for these tests is not good enough for gauge block calibration and should be replaced by a best one in the final stage of the development. The developed electronic design improves the resolution of the electronic counters in the previous designs and allows the synchronization with other elements to make a fully automated measurement system

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