Design and Implementation of a 3-input 220VAC to Digital Input OR Gate using ATtiny13A with Optocoupler Interface, Welding Protection, Dual Power Supply, and Voltage-Drop Detection Method: A Limited Knowledge Perspective

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Author: Perovic Milo
miloperovic64@gmail.com

Introduction

This paper presents the design and implementation of a reliable and cost-effective 3-input OR gate system for converting 220VAC signals to digital inputs. The system is based on an ATtiny13A microcontroller and employs an optocoupler interface for voltage isolation and protection. A voltage-drop detection method is used to determine if the 220VAC signal is on, allowing the microcontroller to accurately control the relay.

It is important to note that the author's knowledge and understanding of electronics and electrical engineering is limited. This design and implementation of the system is a result of the author's current understanding and may contain mistakes that the author is not aware of.

The system also includes a welding protection mechanism to ensure safe and reliable operation of the relay. The relay is powered by a separate power supply module to prevent electrical noise from affecting the microcontroller and optocoupler circuitry. The system is powered by two WX-DC12003 power supply modules, with one module supplying the microcontroller and optocouplers and the other supplying the relay.

The ATtiny13A is an onboard programmable microcontroller, and the design employs the MicroCore hardware package for programming and debugging. This makes the system flexible and cost-effective, as users can easily make modifications or upgrade the firmware as needed.

In conclusion, the design and implementation of this 3-input 220VAC to digital input OR gate system offers a reliable and cost-effective solution for a wide range of industrial and commercial applications. The system's compact size, low power consumption, and onboard programmability make it an ideal choice for projects where space and cost are limited.

However, it is important to exercise caution and thoroughly validate the design before implementation in any critical applications.

**This paper is written with help of ChatGPT*

Block Digram

The block diagram of the 3-input 220VAC to digital input OR gate system is a visual representation of the various components and their connections. It provides a high-level overview of the system's architecture and allows for easy identification of the different functional blocks.

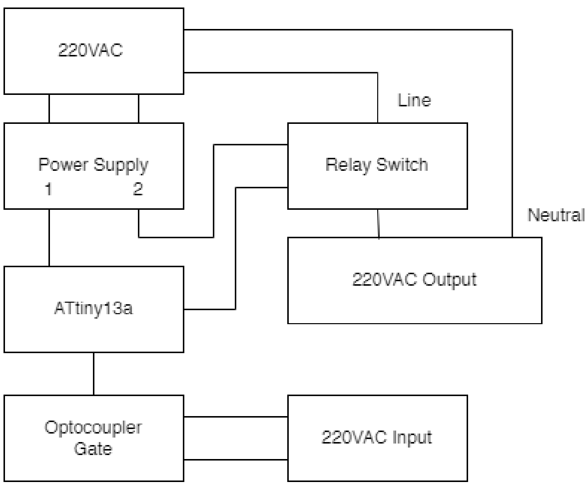

Figure 1. Block diagram

Power Supply

The power supply used in this design is the WX-DC12003, a Chinese-made power supply module. This power supply is a compact and efficient module that provides a regulated 5V output with a maximum current of 700mA. It features over-current, over-voltage, and short-circuit protection, which helps to ensure safe and reliable operation of the system. The WX-DC12003 also has a high conversion efficiency and low output ripple, making it suitable for powering microcontroller and optocoupler-based systems. It is low-cost and widely available. By adopting a dual power supply design, with two WX-DC12003 modules, the design separates the power supply for the microcontroller and optocoupler interface from the power supply for the relay, helping to prevent electrical noise and unwanted hazards from affecting the sensitive microcontroller and optocoupler circuitry.

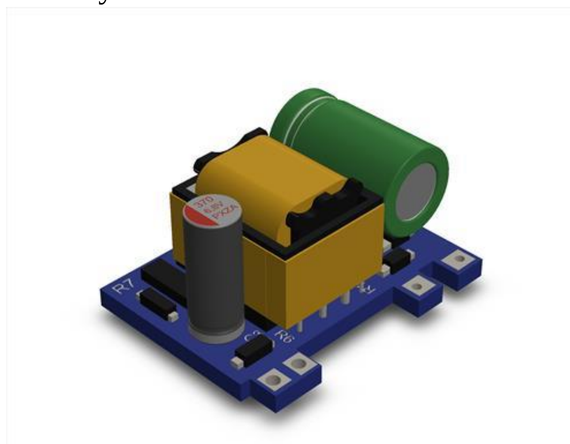

Figure 2. WX-DC12003

ATtiny13A MCU

The ATtiny13A microcontroller used in this design has a low power consumption, with a typical power consumption of only 0.2 mA at 1 MHz and 1.8V. It has 1KB of flash memory for program storage, and 64 bytes of SRAM for data storage\.Additionally, the ATtiny13A was chosen for this project because of its low cost and ease of implementation on the board. Unlike other microcontrollers, the ATtiny13A does not require external peripherals to properly function, making it a simple and cost-effective solution for this project. The use of the MicroCore library for ATtiny allows for easy programming and utilization of the microcontroller's features, making it a versatile and flexible component for a wide range of applications.

Optocoupler Gate

The AC optocoupler block on the PCB is a crucial component for reading the 220VAC input signals and converting them to digital signals that can be processed by the ATtiny13A microcontroller. The emitter of the optocoupler is connected to ground, while the collector is connected to the 3.3V supply before the voltage divider. The voltage divided by voltage divider can be read by the microcontroller to determine the state of the input signal. When the optocoupler is ON, the voltage across the voltage divider will be approximately 1.9V, while it will be approximately 3.3V when the optocoupler is OFF. The voltage-drop method is used to detect if the 220VAC signal is ON, and this method provides a safe and reliable way to monitor the input signal. The two 100k resistors on the diode side of the optocoupler are important for protecting the optocoupler from damage. In the event of a surge or other voltage spike, the resistors limit the amount of current that flows through the optocoupler and prevent it from being damaged. The resistors also provide a stable input impedance, which helps to ensure that the input signal is accurately read by the optocoupler. On the transistor side, two resistors are connected to the collector to form a voltage divider, and an LED indicator is included after the voltage divider to provide a visual indication of the status of the input signal. Overall, the AC optocoupler block plays a critical role in ensuring safe and accurate processing of the input signals.

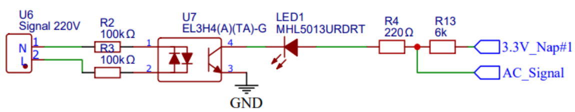

Figure 3. Optocoupler Element

Relay Switch

The relay switch block is a crucial part of the circuit, as it allows the microcontroller to control high voltage AC loads. The block consists of a relay with anti-welding protection, which is necessary to prevent the contacts from sticking together due to high current arcing when switching off the AC load. The anti-welding protection is implemented using a 4.7nf capacitor followed by a 10ohm resistor connected across the internal switch pins of the relay. Additionally, a fuse is added before the AC line comes into the relay to protect the relay from any potential damage due to overcurrent. The block also includes a flyback diode to discharge the inductive energy stored in the relay coil when the relay is turned off. To control the relay, a MOSFET is used, which is controlled by the microcontroller. This enables the microcontroller to switch the MOSFET on and off, which in turn controls the state of the relay. The use of the MOSFET also provides a high degree of isolation between the microcontroller and the high voltage AC load, ensuring safety and reliability of the circuit.

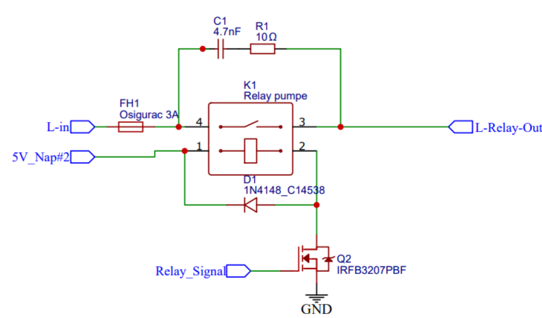

Figure 4. Relay element

Conclusion

In conclusion, this project aimed to create a three-input OR gate that could operate using 220VAC input signals. To accomplish this, an optocoupler was utilized to read the input signals and a voltage-drop method was employed to detect the presence of an AC signal. An ATTiny13A microcontroller was used for processing the signals, which was programmed using the Arduino Mega and MicroCore library. Additionally, a dual power supply system was implemented, with two WX-DC12003 power supply modules being used to power the microcontroller and relay separately. The relay switch block consisted of a relay with anti-welding protection, a flyback diode, and a MOSFET controlled by the microcontroller. The anti-welding protection was added to the relay circuit to prevent the contacts from sticking together, and a fuse was included to protect the relay from power surges. The AC optocoupler block and relay switch block were connected through the ATTiny13A, and the output of the circuit was connected to an LED indicator. While the circuit may contain errors, it was created with the aim of providing a functional three-input OR gate for 220VAC signals using readily available components**.**

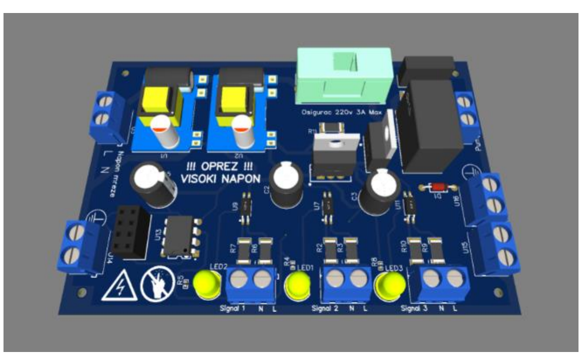

Figure 5. PCB Model

Working design and tested Code example

The code shown is written in C/C++ and is intended to be uploaded to a microcontroller.The code is designed to continuously read the analog input of pin A1, which is connected to a voltage divider circuit. Depending on the voltage level, the code will either turn on or turn off the analog output on pin A3, which is connected to a relay. The delay function is included to prevent the relay from turning off instantaneously, as this can lead to damage caused by the inductive kickback produced by the relay coil. This code is a simple example of how a microcontroller can be used to read and respond to analog inputs and control outputs, making it a useful tool in various automation and control applications.

```
int main(){
  while(1){
  //600 ~ 3.0V
  // A1-PB2 , A3-PB3
  if(analogRead(A1) < 600) {
      analogWrite(A3, 255);
  } else {
      /* Delay prevents realy
       *  from turning OFF instant
       */
      delay(200);
      analogWrite(A3, 0);
    }
  }
}
```

Figure 6. Code

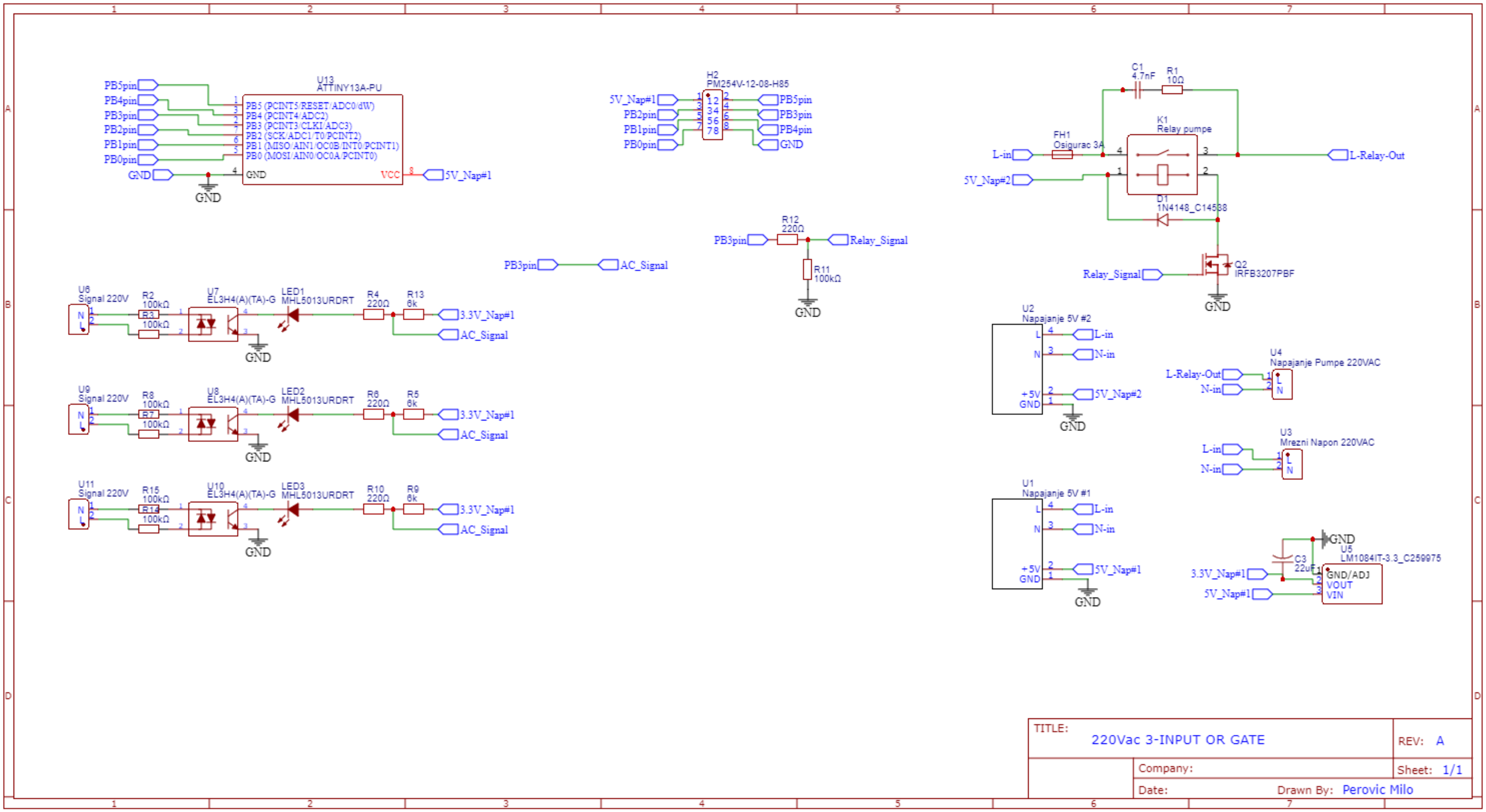

Figure 7. Schematics