Arduino Based RFID Line Switching Using SSR

Michael E., Isah Y, Bako Hussaini, Hassan O. F., Ezika V. C.

Abstract: The importance of line switching cannot be overemphasized as they are used to connect and disconnect substations to and from a distribution grid. At the cradle of technology, line switching was achieved via the use of manual switches or fuses which could endanger life as a result of electrocution when expose during maintenance. This ill prompted the development of automated line switching using relays and contactors. With time, this tends to fail as a result of wearing of the contact which is as a result of arcing and low voltage. To avert all these ills, this paper presents Arduino based Radio Frequency Identification (RFID) line switching using Solid State Relay (SSR). This is to ensure the safety of operators or technologist and to also avert the problem associated with relays and contactors using SSR. This was achieved using RFID RC-522 reader, ardriuno Uno, SSR and other discrete components. The system was tested and worked perfectly reducing the risk of electrocution and eliminating damage (wearing of the contacts) common with contactors and relays.

Index Terms: Distribution, electrocution, grid, line, RFID, switching, SSR.

1 Introduction

RFID can be considered to be a dedicated short range communication (DSRC) technology [1]. In previous years, RFID technology has moved from obscurity into conventional applications that help the speed of solving security and safety problems [2],[3]. The technology enables identification from a distance, which has advantages over traditional authentication, anti-counterfeiting mechanism such as holograms, color shifting inks, 2D barcodes just to mention a few[2],[3]. This ever growing technology from several researches made, shows that it has great potential applications in the near future. In electrical power system engineering where feeder pillar is used prior to the load in a substation, the use of fuse within the system cannot be over emphasized. These fuses which often times faults as a result of arcing, are used to check over loading and to ensure the safety of consumers. Traditionally, when faults are discovered, these fuses are removed sometimes using insulated pliers so as to create a safe ground for maintenance. Even with that, this method exposes the technologist to the risk of being electrocuted. However, to create a safe environment, this paper presents Arduino based RFID line switching using SSR. RFID over the years have been used for a lot of application. In 2003, Kärkkäinen [4] developed a monitoring system using RFID for the supply chain of manufacturing companies in order to track the goods being supplied to customers. Also, in 2006, Chamarti et al [5] developed a transmission delay line based ID generation circuit for RFID applications. In 2008 Devadas et al.[3] designed the use of PUF-based RFID IC's for Anti-counterfeiting and security applications. Also, to improve services, Chen [6] in 2012 used RFID together with real-time tracking system to enhance the facility operations of healthcare centers. Furthermore, Montaser el al [7], in 2014, developed indoor location identification system for construction projects using RFID. These versatile applications of the RFID technology have also being applied to new technologies like the Internet of Things which was developed by Yong-ShinKang et al. [8].

- *Michael E., Bako Husaini, Hassan O., Ezika V. C.,Scientific Equipment Development Institute Minna, Nigeria PH-+2347069289786. E-mail: electmike84@gmail.com*
- *Isah Y., is currently pursuing undergraduate degree program in Physics in Federal University of Technology Minna, Nigeria.*

However, none of these is developed for line switching. This therefore necessitates the presentation of this paper.

2 Methodology

The work was achieved via the use of the following components as shown in Figure 1.

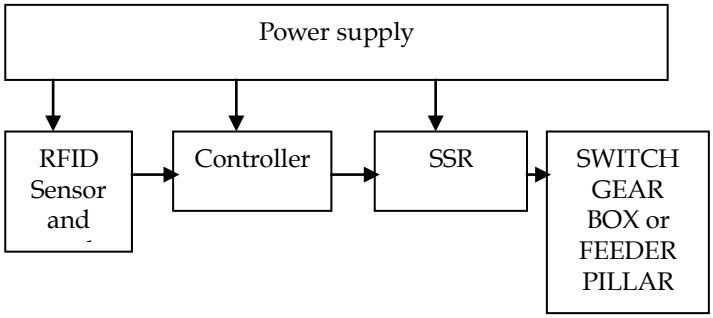

Figure 1. *Block diagram of the system*

2.1 Power

The power supply is achieved with three AC to DC converters sourcing power from the three phases on the grid, connected together with an OR gate. Each is made up of a transformer which steps down 230V AC to 24V AC. Afterwards, the 24V AC is converted to DC via the use of a bridge rectifier BR1. Furthermore, a capacitor C1 is used to remove the ripples as shown in Figure 2. 7812 voltage regulator (U1) is used to achieve a regulated 12V DC which is used to power the controller. Figure 3 shows how the three AC to DC converter are connected together with three diodes which acts as an OR gate. This is done to make sure that the main circuit is powered when ever any of the phases is available.

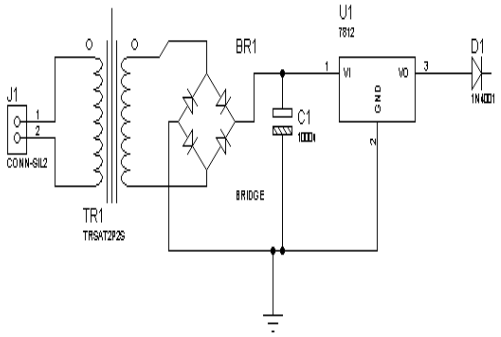

Figure 2. *Circuit diagram of single AC to DC converter*

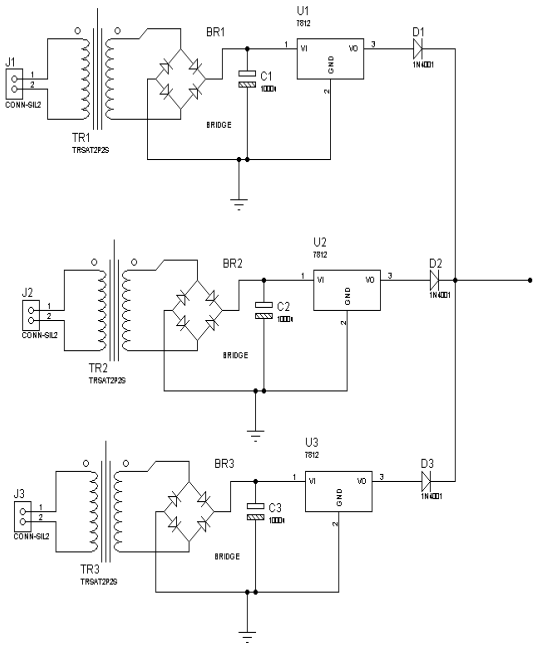

Figure 3. *Circuit diagram of three phase AC to DC converter connected together with OR Gate.*

2.2 RFID sensor

The sensor as shown in Figure 4, used in this work is a Mafare product MFRC522. The 3V driven sensor comes with a card (RFID tag). This card is embedded with some information which is picked up by the sensor at proximity and then interpreted by the controller.

Figure 4*. Pictorial view of the RFID sensor.*

2.3 Controller

The controller used as shown in Figure 5 is an Arduino Uno R3. It is made up of microcontroller ATMEGA328, a USB port, 14 inputs and output ports, 6 analog inputs, 5 V output, 3 V output and many more. This part of the circuit is the central processor of the work. It is the component that receives and process data for further control actions.

Figure 5. *Pictorial veiw of the controller used.*

2.4 Solid State Relay

This is an opto-coupler made up of a light emitting diode and a photo triac. For the triac to allow AC power to flow through, the LED has to be ON. This is achieved when the controller sends Logic 1 (5V) to a resistor R1 connected in series with the LED as shown in Figure 6. However in this project, three SSR were used for switching the three phases.

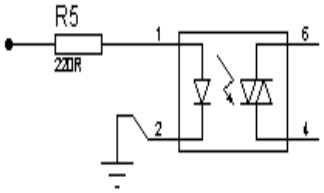

Figure 6. *Circuit diagram of the SSR.*

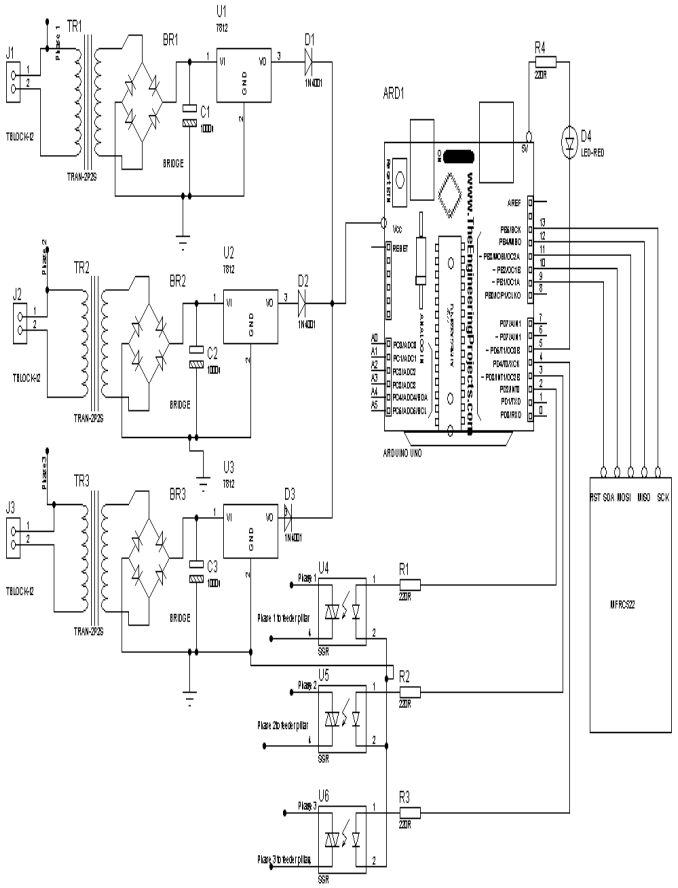

Figure 7*. Complete circuit diagram of RFID based line switch.*

2.5 Mode of Operation

The circuit diagram in Figure 7 illustrates the design of the RFID based line switch powered with three AC to DC converters where J1, J2 and J3 are connected to the three phases of the distribution station. The 230V AC line to neutral voltage is then stepped down via the use of three 24V transformers. To aid AC to DC conversion for each phase, the bridge rectifiers BR1, BR2 and BR3 is employed. Afterwards, the ripples within the DC produced by the bridge rectifier is filtered off via the use of capacitors C1, C2 and C3.The diodes D1, D2 and D3 are connected as OR gate so as to power the controller (ARD1) which is wired to the RFID sensor MFR522 as long as at least one phase is available. Initially, the controller ARD1 outputs a logic 1 (5V) to each SSR. This allows AC power to be supplied to the feeder pillar. However, whenever maintenance is required in the network, instead of the technologist to be exposed to the danger of electrocution via the traditional method of removing fuses, the technologist only needs to swipe the RFID tagged cards across the sensor. This will make the controller output a logic 0 (0V) which turns off the SSR disallowing power to be supplied to the feeder pillar. To re energize the network, the same card is swiped over the sensor.

3 RESULT

The designed was prototyped and the following result was obtained

***Table 1**: Experimental result of the power circuit.*

S/N	P1	P2	P3	OUTPUT
1.	0	0	0	0
2.	0	0	1	1
3.	0	1	0	1
4.	0	1	1	1
5.	1	0	0	1
6.	1	0	1	1
7.	1	1	0	1
8.	1	1	1	1

***Table 2.** Experimental result of the RFID control of the three phases.*

S/N	RFID	P1	P 2	P3
1.	0	1	1	1
2.	1	0	0	0
3.	1	1	1	1

Key:

- P1= PHASE 1, P2= PHASE 2, P3= PHASE 3
- OUTPUT=1 when 12V is measured and OUTPUT= 0 when 0V is measured.
- PHASE x = When phase x is available and PHASE x=0 when phase z is not available
- x= 1or 2 or 3
- RFID = 1 if RFID tag is usedon the sensor. RFID=1 if RFID tag is not used.

4. DISCURSION

- Table 1 show that the output of the power supply measures 12V so as to power the controller if any of the phases are available.
- In Table 2 the first row shows the availability of the three phases initially even though the RFID card is not used. This means that each SSR is energized by the controller such that power from the phases flows through it to the feeder pillar. The second row shows the effect on the phases when the RFID Card was swiped across the sensor. As a result, the SSR is de-energized and the three phases impeded from supplying the feeder pillar. When the card is swiped across the sensor again as shown in the third row, the SSRs are then re energized to enhance the powering of the feeder pillar.

5 CONCLUSION

The design worked well and creates a safe environment for the technologist when ever maintenance is to be done on.

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