v. 3, n. 8, 2023

Journal of
Engineering
Research

DEVELOPMENT OF AN AUTOMATIC GATE FOR THE PREVENTION OF ACCIDENTS ON INTRAMUNICIPAL RAILWAYS

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Abstract: Brazil currently has several important railroads such as Estrada de Ferro Vitória a Minas and Ferrovia do Pantanal. Even so, the country lacks this transport model and several investments have been made in railroads across the country. The increase and expansion of railways across the country improves logistics and reduces transport costs, in addition to considerably reducing accidents, since in Brazil alone in 2018 there were approximately 53,000 victims of accidents and 5,000 deaths in traffic. (CAROLINE BRAGA PATROCÍNIO DE SOUZA, 2020; GOVERNMENT OF BRASIL, 2020; LUIZA CALEGARI, 2018; MASS WEIGHTING AND INDUSTRIAL AUTOMATION, 2020; PAULA PACHECO, 2017; VALE, 2018). Several cities have railways crossing their interior, as is the case of the city of Lorena, in the interior of São Paulo. Unfortunately, accidents involving trains and people occasionally occur, such as the case of the 23-year-old man and the 35-year-old woman who were killed by a train in Lorena (FERNANDA NIQUIRILO, 2021; PORTAL DE NOTÍCIAS G1, 2020). The objective of this work is to use electronics to qualitatively develop an automatic door opening and closing system to be installed on railway lines that cross cities using a control board, an induction electric motor, aluminum doors and a sensor. These devices can prevent accidents and make the city safer. In the work, all the functions of an Automatic Gate Control Board were analyzed together with a sensor and an MIT. The junction of the entire circuit brings a system that automates the railway lines and prevents accidents. Its application is perfectly possible, having a low cost and an easy implementation, making it a product with a good cost benefit and that generates security for the residents of cities that have intramunicipal railway lines.
Keywords: Railroads. electronics. automatic doors. accidents prevention.

INTRODUCTION

Brazil currently has several important railroads such as Estrada de Ferro Vitória a Minas and Ferrovia do Pantanal. Even so, the country lacks this transport model and several investments have been made in railroads across the country. The increase and expansion of railways across the country improves logistics and reduces transport costs, in addition to considerably reducing accidents, since in Brazil alone in 2018 there were approximately 53,000 victims of accidents and 5,000 deaths in traffic. (CAROLINE BRAGA PATROCÍNIO DE SOUZA, 2020; GOVERNMENT OF BRAZIL, 2020; LUIZA CALEGARI, 2018; MASS WEIGHTING AND INDUSTRIAL AUTOMATION, 2020; PAULA PACHECO, 2017; VALE, 2018).

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DEVELOPMENT

REVISION BIBLIOGRAPHY

AUTOMATIC GATE CONTROLLER BOARD

Figure 1 shows the complete schematic

diagram of the controller board, the next topics will address each circuit in more detail and its functions.

POWER SUPPLY 90-265 V AC

The first part of the board that will be analyzed is where the mains voltage will be placed (J2), Figure 2 illustrates this part and the rest of the power supply circuit.

In the circuit, V1 is the Varistor (VDR) that protects the circuit from overvoltage, it offers protection for the entire board, as the fuse is not always enough (ELECTROLAB, 2016; SOLDA FRIA, 2020; WAGNER RAMBO, 2019) . Next, there is a switch that selects between the 110 V network (smaller winding) and 220 V (larger winding), depending on the voltage, it will pass through a specific transformer and at the end it will have an AC voltage of 12 V. This voltage will enter the circuit full-wave bridge rectifier with capacitive filter (the capacitor is electrolytic), diode D4 separates the rectified part from the filtered part (important for AC_OPT) and after that the current will pass through the LM7805 voltage regulator (LIMITED, 2002). The 5V output is connected to the microcontroller, the ceramic capacitors C5 (1 nF) and C6 (100 nF) are the stability and decoupling capacitors, and the electrolytic capacitor C3 (100μF) works as a low capacity source for higher current requests, only slower, while C6 are for fast and lower current requests.

MOTOR PWM AND POWER RELAY AND ADJUSTMENTS

In Figure 3, it is possible to see the TRIAC (Q2), this device with its triggers in the "gate" slices the alternating wave and controls the power, being controlled by the optocoupler MOC302X (DATA, 2003), which in turn is triggered by the microcontroller (connected by pin 11), as the microcontroller generates pulses that trigger the optocoupler (PROFESSOR RODOLFO, 2020).

In the power relay diagram, DIR W and DIR V (connected to pins 15 and 12 of the microcontroller respectively) control the direction of the motor. To open the gate, transistor Q4 is energized, which in turn triggers the relay, opens the phase and puts terminal 1 on the motor at J5. It is also possible to close the gate, energizing transistor Q5, which triggers the relay, opens the phase and puts it on *terminal* 2 on the engine at J5). The engine must have a **starting capacitor** suitable for alternating voltage, which is illustrated in J4, as the capacitor advances the current and compensates for the lag generated by the coil (the coil delays the current) between voltage and current, making both arrive in phase and start the motor (STORE BURGOSELETRONICA, 2017).

The motor power is controlled by the potentiometer, which can work with more or less force, so it is possible to define the adequate force to just move the gate and in cases of accident not to hurt a person, because the excessive force would not be allowed and already would be preset. It is important to remember that the lighter the door, the less force the motor will have to use to move it and the less chance this minor force will injure a person or child. The brake, when detecting the opening or closing, turns off the relay and will turn on the other in the opposite direction just to stop/start the system when leaving inertia, this must only be used in heavy gates and as a last resort, as it causes damage to the mechanical part. The schematic of this diagram is illustrated in figure 4 below:

OPEN AND CLOSED GATE SENSOR LEDS

The FF LED is on pin 4 and the FA on pin 5, when the FF is on it means the gate is closed and when the FA is on it means the gate is open. The RED LED (ST) indicates that the gate is

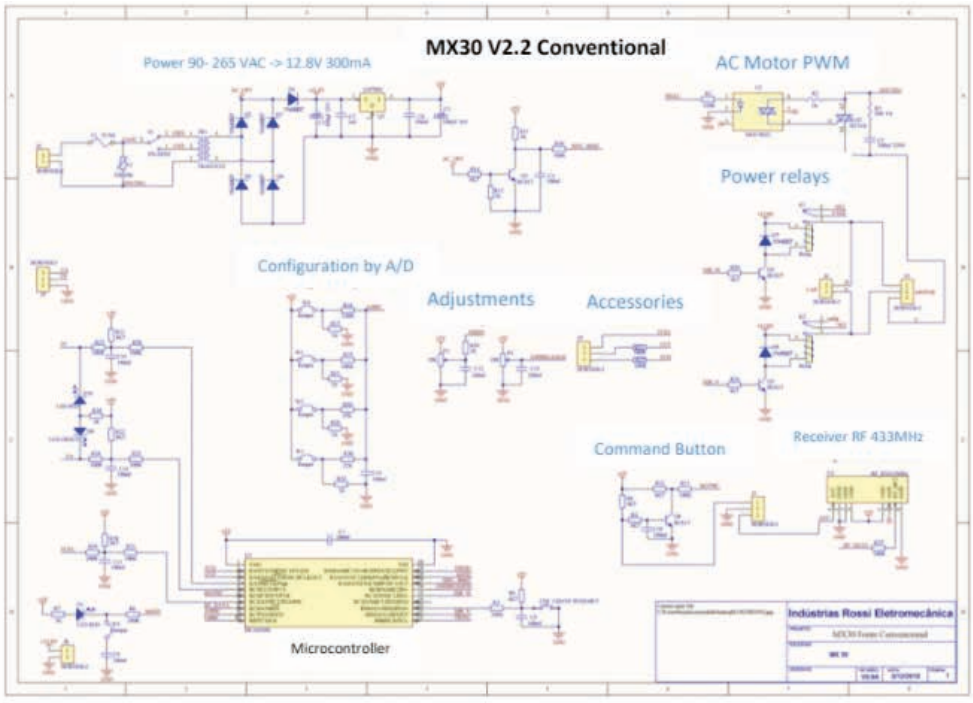

Figure 1 - Schematic diagram

Source: INTELLIGENTS (2010)

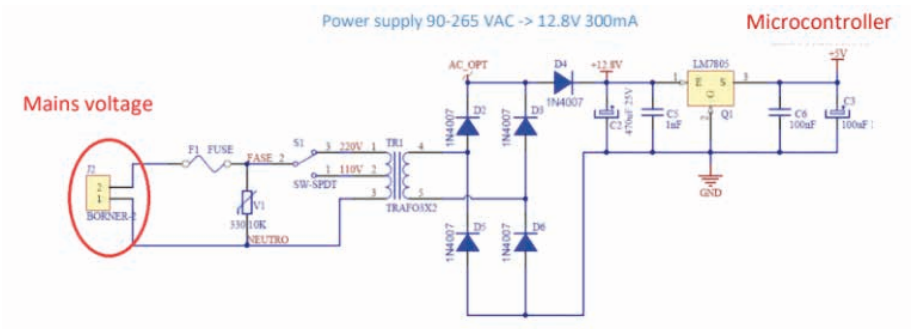

Figure 2 - Power supply of the automatic gate controller board circuit with mains voltage highlighted

Source: (ANDRÉ PENHA, 2015)

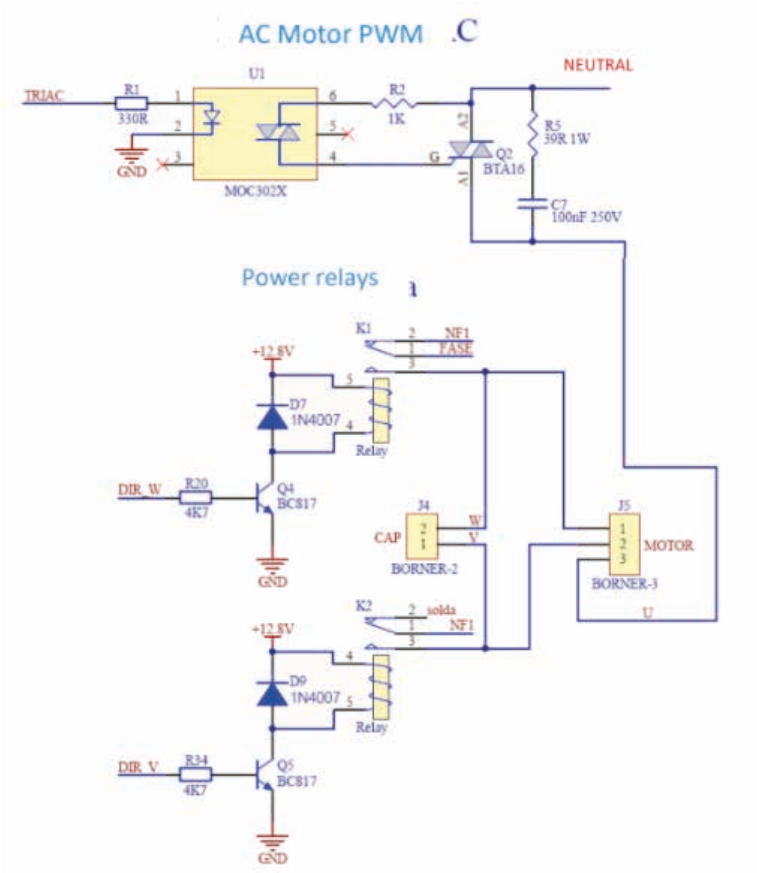

Figure 3 - AC Motor PWM Schematic Diagram and Power Relays

Source: ANDRE PENHA (2015)

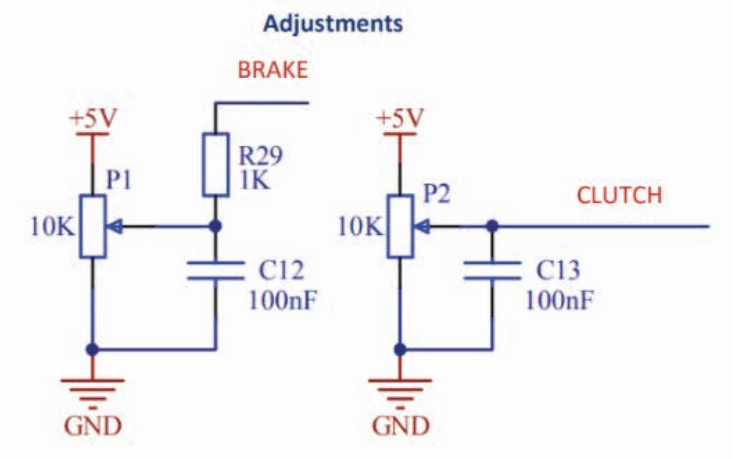

Figure 4 - Diagram of engine power settings

Source: ANDRE PENHA (2015)

moving (closing or opening). J6 provides 12 V that we can use in other circuits (such as an optical barrier). Figure 5 below shows the complete diagram of this system.

CONFIGURATION JUMPERS

The board has several configuration jumpers (soft stop, pause, building, no pause, no soft stop) that command the microcontroller. It is important to note that all resistors in relation to ground have the same resistance (1 kΩ) and the other resistor changes which changes (220 k, 100 k, 47 k and 22 k), this changes the voltage that arrives at the ADPIC and then the microcontroller will know which function it must perform, as it will know which *jumper* has been selected. Figure 6 illustrates the schematic diagram of the configuration *jumpers*:

INFRARED SENSOR (IR)

The Command Button and the RF 433 MHz Receiver were removed from the project and were replaced by IR sensors that contain an infrared light emitter and receiver, this sensor will be installed 1 km away from the passage and will energize the RF DATA and the gate will start to close, after the train has passed, the IR will change the sign after a few minutes (previously set time) and will open the passage again by turning the motor through the command in the RF DATA.

METHODOLOGY

The nature of the research carried out was exploratory with secondary sources and the results will be presented qualitatively.

A study was carried out on the application of an automatic gate controller board circuit in order to prevent accidents on railways that cross cities.

RESULTS ANALYSIS

The junction of the entire circuit brings a system that automates the passages within the city of the railway lines and prevents accidents. The application of sensors must be placed in places close to where there are watchtowers with guards and all empirical tests must be carried out before implementation to ensure safety in the project. Each circuit has been explored and has its function, it is also worth noting that there is no need to use indirect starting (such as star-delta or inverter device), however it may be necessary to use them if the door is very heavy or large, the initial design counts with the direct start and that the material of the gate will be aluminum. If the material used is light, the motor will have a low power to move it, consequently the system will avoid accidents, because in case of gate lock the relay will activate instantly.

FINAL CONSIDERATIONS

Electronics has several applications, in this work we saw that it is possible to use it to save lives. In this work, a circuit for electronic control of gates was developed together with a sensor that prevents accidents on railway lines that cross cities. Its application is perfectly possible, with a low cost and easy implementation, making it a product with a good cost-benefit ratio and that generates security for residents of cities that have intramunicipal railway lines.

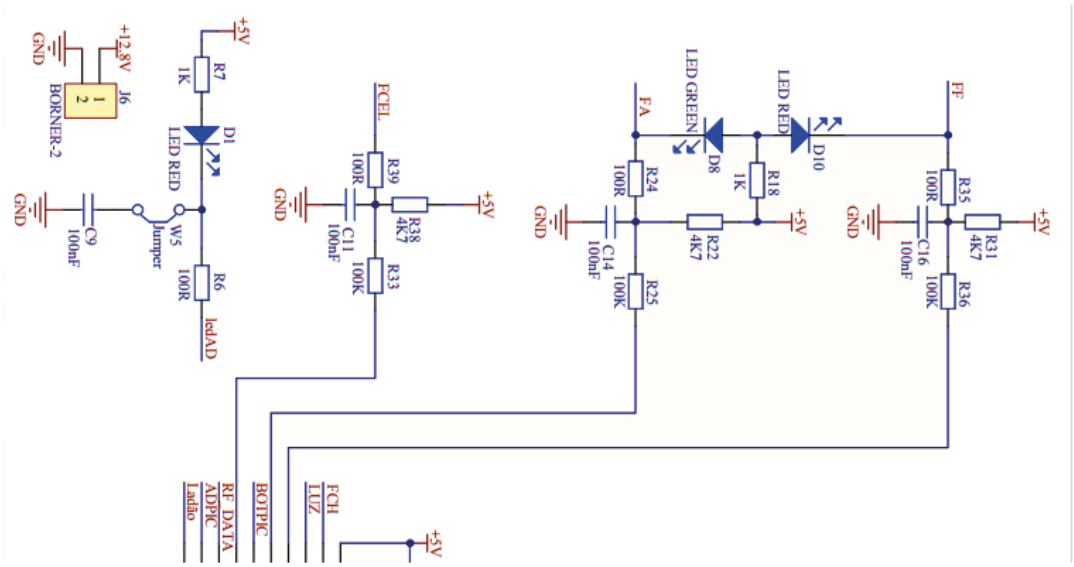

Figure 5 - Gate indicator LEDs

Source: INTELIGENTES (2010)

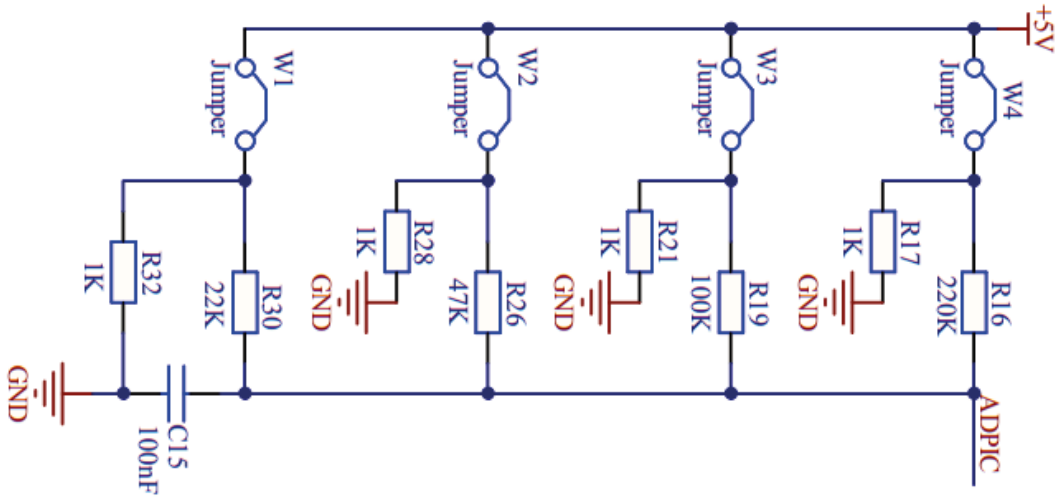

Figure 6 - Configuration jumpers schematic diagram

Source: INTELLIGENTS (2010)

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