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# Arduino MKR Analysis Using the RTC Alarm Method

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**ABSTRACT**

The researcher analyzed the Real-Time Clock (RTC) alarm readings on the Arduino MKR Zero, Arduino MKR Wan 1300, and Arduino MKR GSM 1400. The Arduino MKR board compared the data with the accuracy of reading the RTC values. To support this research, experimental quantitative research methods were used, and an independent sample t-test was used. The use of this method is very suitable because this method displays numbers as data and also conducts experiments directly on the Arduino MKR board. Comparative measurement of the three MKR using the RTC Alarm get the average time difference. This average indicates the IC capability and accuracy of MKR. From the experimental results, MKR GSM 1400 has the greatest. Arduino MKR GSM 1400 is the Arduino MKR that has the fastest data response among the other two Arduino MKRs. So, to create or develop a project related to real-time data transmission, it is recommended to use the Arduino MKR GSM 1400.



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## 1. INTRODUCTION

Arduino MKR is a 67.64×25mm board, which has many integrated connectivity modules and the potential for various levels of projects. The MKR board is equipped with on-board Wi-Fi to GSM connectivity modules, supporting Narrowband IoT, Lo-Ra connectivity, and the SigFox network [1][2][3][4][5]. Compared to Arduino Uno's general form factor, the MKR board, is much smaller. Within the Arduino MKR family, there is the Arduino MKR Zero which is the most basic Arduino MKR which aims to provide a platform for innovative projects in wearable technology, high-tech automation, robotics, etc. One of them is used in prostheses[6][7][8]. MKR Zero has an onboard SD connector with a dedicated SPI interface (SPI1) which makes it possible to use files without additional hardware [9][10][11]. The board is powered by Atmel's SAMD21 MCU, which features a 32-bit ARM Cortex® M0 + core. Unlike most Arduino & Genuino boards, MKR Zero runs at 3.3V. MKR WAN 1300 is a strong board that combines MKR Zero and LoRa connectivity functionality [12][13][14]. LoRa or Long Range Area and low power consumption are the two things that are most concerned about in IoT connectivity [15][16][17][18][19].

The Arduino MKR WAN 1300 has been designed to offer a practical and cost-effective solution for manufacturers looking to add Lo-Ra connectivity to their projects with minimal prior experience in networking. It is based on the Atmel SAMD21 and the Murata CMWX1ZZABZ Lo-Ra module [20][21][22][23]. The design includes the ability to power the board using two external 1.5V or 5V AA or AAA batteries [24][25][26]. Arduino MKR 1400 GSM is a combination of Arduino Zero and GSM Module. The microcontroller used on this Arduino is the Atmel SAMD21 and SARAU201 for the GSM module [27][28][29][30]. With a 5V power supply that can be connected via USB or VIN. Unlike other Arduino boards, the Arduino MKR 1400 GSM has a working voltage of 3.3v for the I/O ports [31][32]. A voltage greater than 3.3V will damage this board. Arduino MKR GSM 1400 utilizes the cellular network as a means of communicating. The GSM / 3G network is one that covers the highest percentage of the world's surface, making this connectivity option especially attractive when there are no other connectivity options available [33][34][35]. The RTC IC of each Arduino MKR board is suspected of having different capabilities [36][37][38]. By obtaining data from the experimental results, it is hoped that the accuracy level of the IC RTC on the Arduino MKR is the highest. This is where the three Arduinos have the same clock speed, namely 32.678 kHz (RTC) [39][40][41][42][43].

Based on the explanation of the problem, this study will discuss the capabilities of the IC RTC embedded in the Arduino MKR board. Then compare the data from the accuracy of reading the RTC value. The value obtained will show that the Arduino MKR board has the best RTC value reading capability. This study aims to maximize communication and data transmission.

## 2. METHOD

This section will discuss the flow of the research carried out. Start from determining problem identification to determining conclusions. The method used is an experimental quantitative research method. The use of this method is very suitable in studies that highlight numerical data. The research is also a direct experiment on the Arduino MKR device. With all the data collected, it is possible to determine the accuracy of the RTC IC for each Arduino MKR board Fig 1.

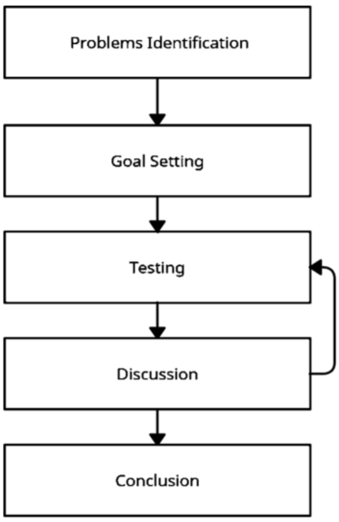


**Fig. 1.** Diagram Method

Problem identification is the first step in preparing this journal. This stage investigates that the RTC IC on each Arduino MKR has different capabilities.

At Goal Setting stage, the researcher has determined the research objectives. This study determined the ability of the RTC IC on each Arduino MKR. Then compare the performance of each Arduino MKR.

In the setting section, the first step of testing is making the initial settings on each Arduino MKR board. These settings include setting the driver, adding libraries, and setting the board manager. After the initial setup process, the RTC Alarm test was carried out fifty times on each Arduino MKR board. This test aims to get more data and better comparison results.

This research conducted a statistical test with an independent sample t-test. The samples that have been obtained are then compared to see if there is a difference after the sample is given a different treatment. The average difference test is carried out to see whether there is a difference.

At the discussion stage, the researcher collected data from the test results. In the discussion, researchers also analyzed the capabilities of each IC RTC for each Arduino MKR board.

The conclusion part, concluding is the final stage of this research. The summary of the test data becomes the result of this research.

The Arduino MKR Zero schematic is shown in Fig. 2. Arduino MKR WAN 1300 schematic is shown in Fig. 3. Arduino MKR WAN 1400 schematic is shown in Fig. 4.

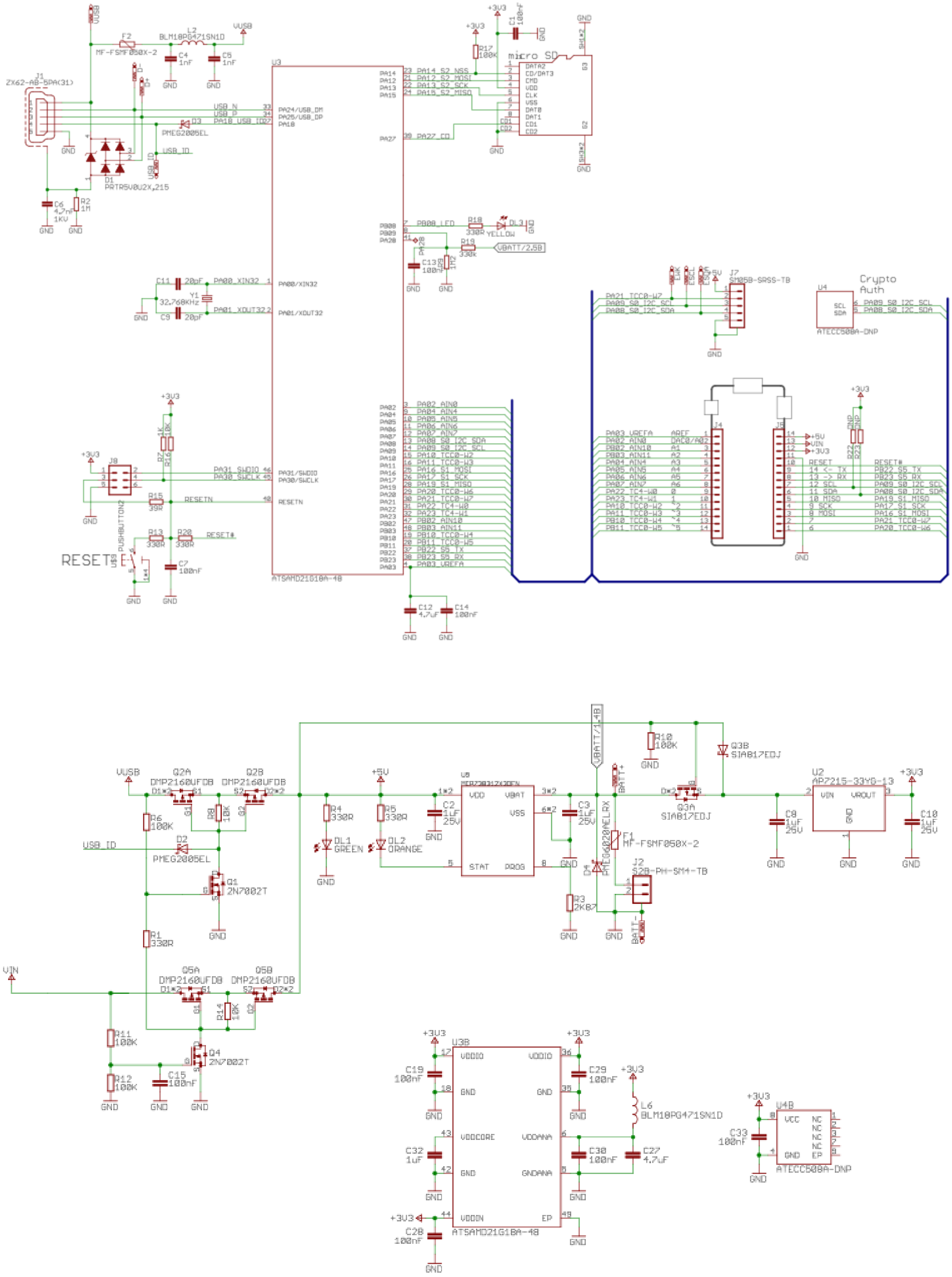


**Fig. 2.** Arduino MKR Zero schematic

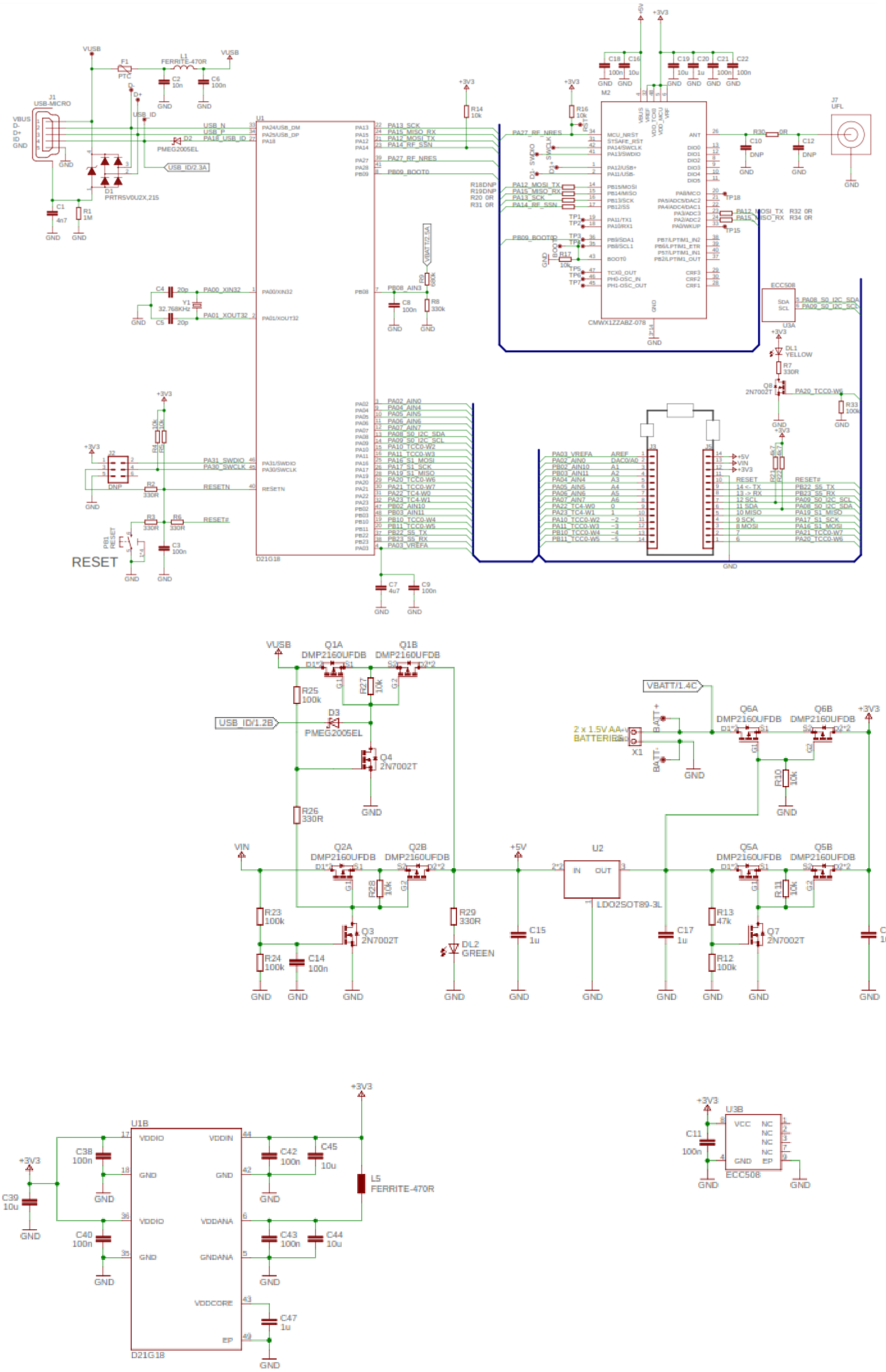


**Fig. 3.** Arduino MKR WAN 1300 schematic

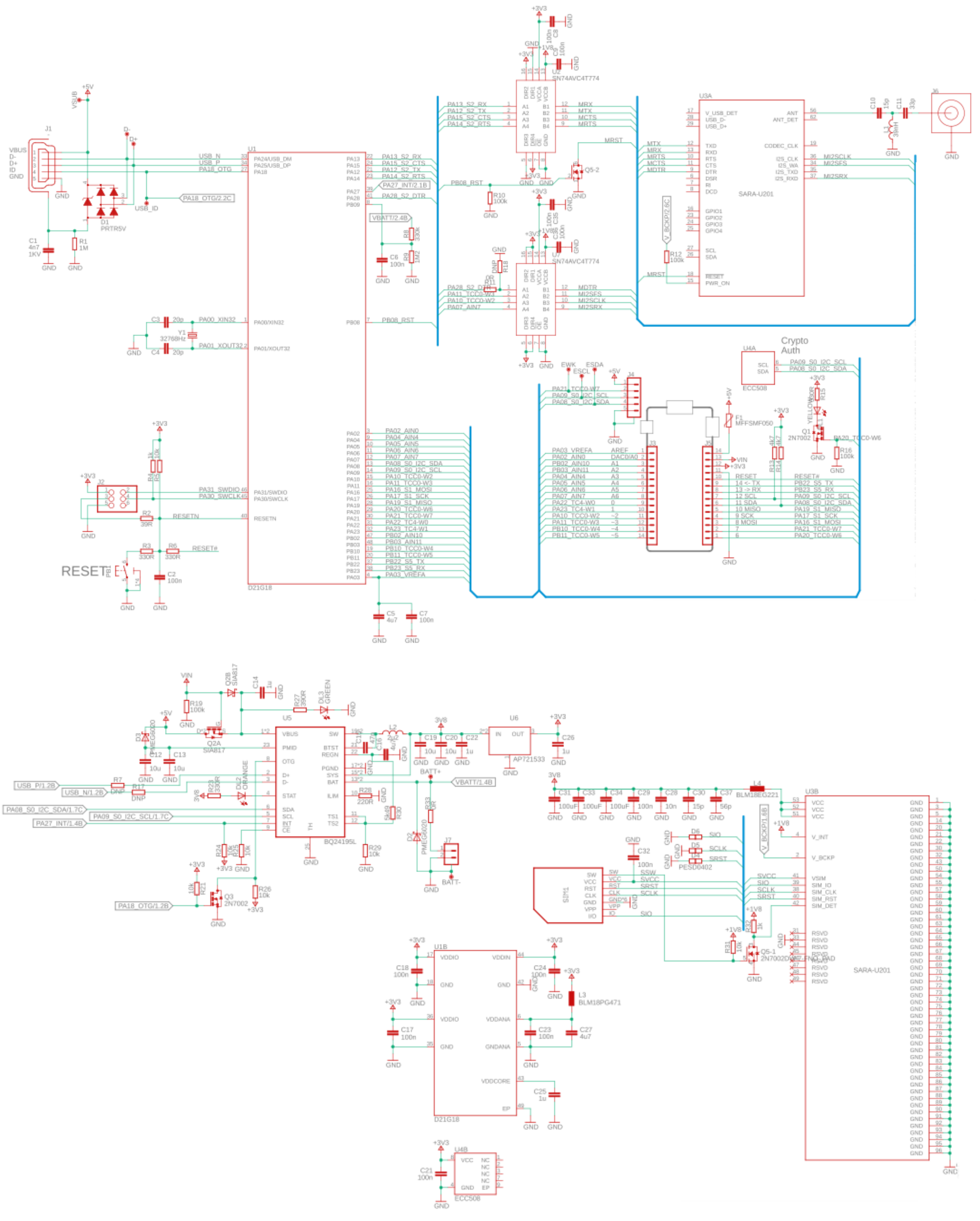


**Fig. 4.** Arduino MKR WAN 1400 schematic

## 3. RESULTS AND DISCUSSION

This study uses several types of microcontrollers from the Arduino family, namely the Arduino MKR. In detail, the Arduino MKR Zero (Fig. 5), Arduino MKR WAN 1300 (Fig. 6), and Arduino MKR GSM 1400 (Fig. 7). MKRZero provides Power Zero in a smaller format due to the MKR form. The board provides a platform for innovative projects in technologies subject to high-tech automation, robotics, and more. The MKR WAN 1300 is a strong board, combining MKR Zero and LoRa connectivity functionality. The Arduino MKR WAN 1300 offers a practical and cost-effective solution for makers looking to add Lo-Ra connectivity to their projects with minimal prior experience in networking. Arduino MKR 1400 GSM is a combination of Arduino Zero and GSM Module. This Arduino is intended for microcontroller project makers more practically without having to have in-depth knowledge of networks. Fig. 8 is a block diagram simple RTC alarm. This block diagram consists of input with 3 variables, devices with 3 variables, process with 2 variables, and output with 1 variable.

This research method is a quantitative method, where this method uses real-time clock accuracy readings on the Arduino MKRZero, MKR WAN 1300, and MKR GSM 1400. Testing on each Arduino MKR uses the RTC Alarm code (Fig. 9). This is done 50 times according to the test flow. Representation of test results using the tabular form.

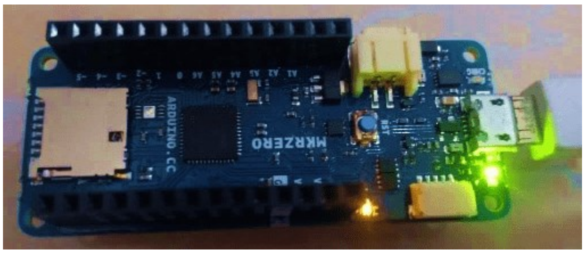

**Fig. 5.** Board Arduino MKRZero

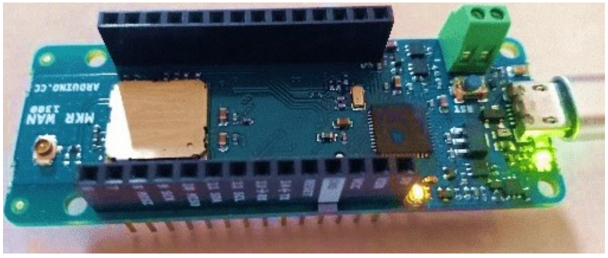

**Fig. 6.** Board Arduino MKR WAN 1300

**Fig. 7.** Board Arduino MKR GSM 1400

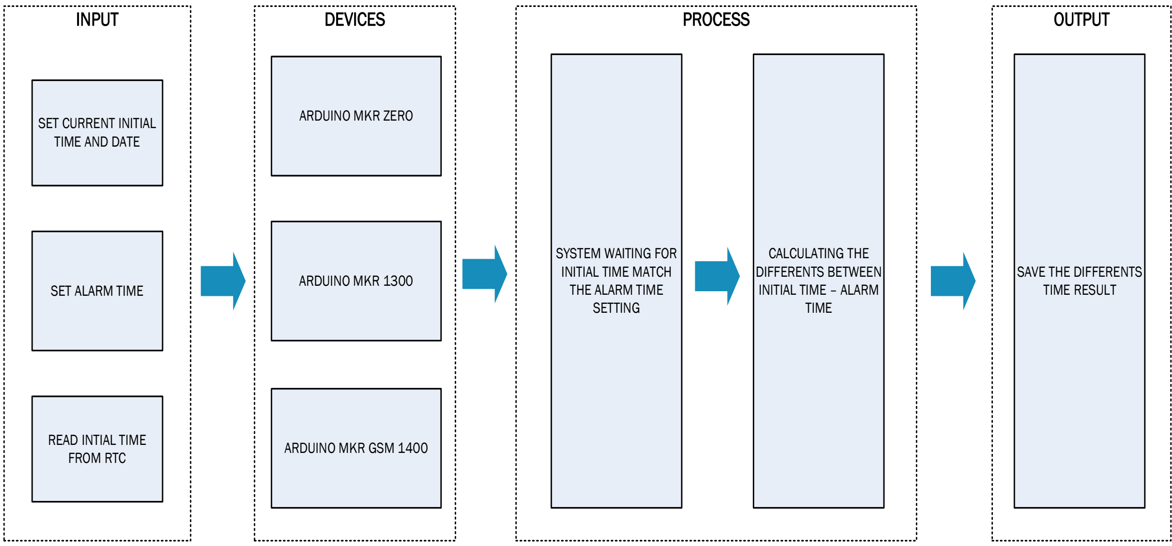


**Fig. 8.** Block Diagram Simple RTC Alarm

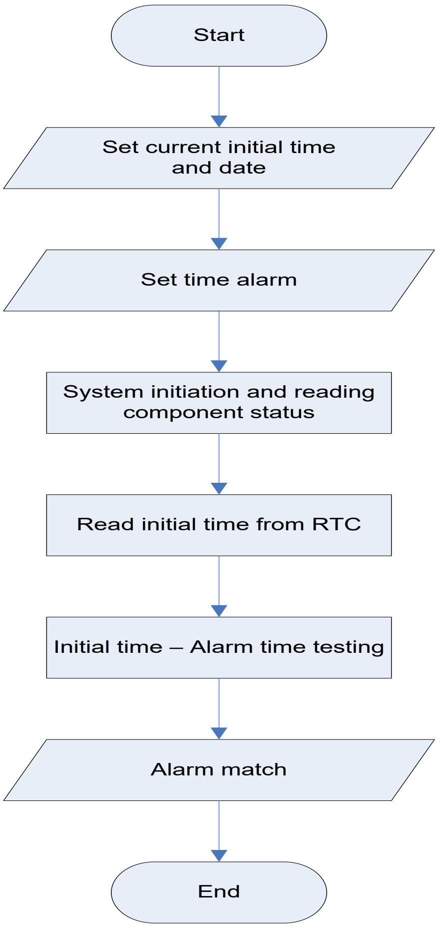


**Fig. 9.** Flowchart Simple RTC Alarm

**Table 1.** Questionnaire of the RTC Alarm Trial

| Trial | Time | Alarm Set | Alarm Match | Difference Time (second) | Description |
|---|---|---|---|---|---|
| 1 | 11:07:00 | 11:07:45 | 07:43.6 | -1.592 | Match less than the specified time |
| 2 | 11:08:00 | 11:08:55 | 08:56.1 | 1.122 | Match more than the specified time |
| 3 | 11:10:00 | 11:11:00 | 10:52.5 | -7.546 | Match less than the specified time |
| … | … | … | … | … | … |
| … | … | … | … | … | … |
| 50 | 19:26:00 | 19:28:00 | 28:05.2 | 5.171 | Match more than the specified time |
| | | | Average | 1.346 second | |

The first instruction is to input the time printed on our quartz watch or watch. These instructions aim to equalize the time on the program. After setting the current time, the user must set the alarm time. After both input processes by the user, the next step is to initialize the component status, whether it is ready for use or not. When ready, the steps to take are to read the RTC value that has been inputted and perform a time calculation in the program. The program will print “Alarm Match” if the program time matches the alarm time setting. After testing the RTC Alarm, the next step is to record these results. The test results in tabular form aim to facilitate data analysis (Table 1).

There are six columns in the research result table (Table 1). We can explain that the first column is for the number of trials. The "time column" states the initial time. The "alarm set" column identifies the start time of the alarm. The "alarm match" column shows the alarm time will sound. The "difference time" column shows how many minutes or seconds the difference between the alarm sounds and the initial time. The following is the equation for calculating the time difference between the alarm sound and the initial time.

$$D = AM - AS \quad (1)$$

Where $D$ is Difference Time, $AM$ is Alarm Match, and $AS$ is Alarm Set.

The following is an equation for finding the average time difference

$$A = \frac{\sum_{i=1}^{n} D_i}{n} \tag{2}$$

Where $A$ is Average, $D_i$ is Difference Time, $n$ is the Number of trials.

The test gave different results on the Arduino MKRZero (Fig. 10), MKR WAN 1300 (Fig. 11), and MKR GSM 1400 (Fig. 12). Fig. 13 shows the results of the three Arduino MKR tests. Experiments on Arduino MKRZero with an RTC of 32.768 kHz obtained an average time difference of 2.065 seconds. Experiments on Arduino MKR GSM 1400 with an RTC of 32.768 kHz obtained an average time difference of 1.346 seconds (Table 2).

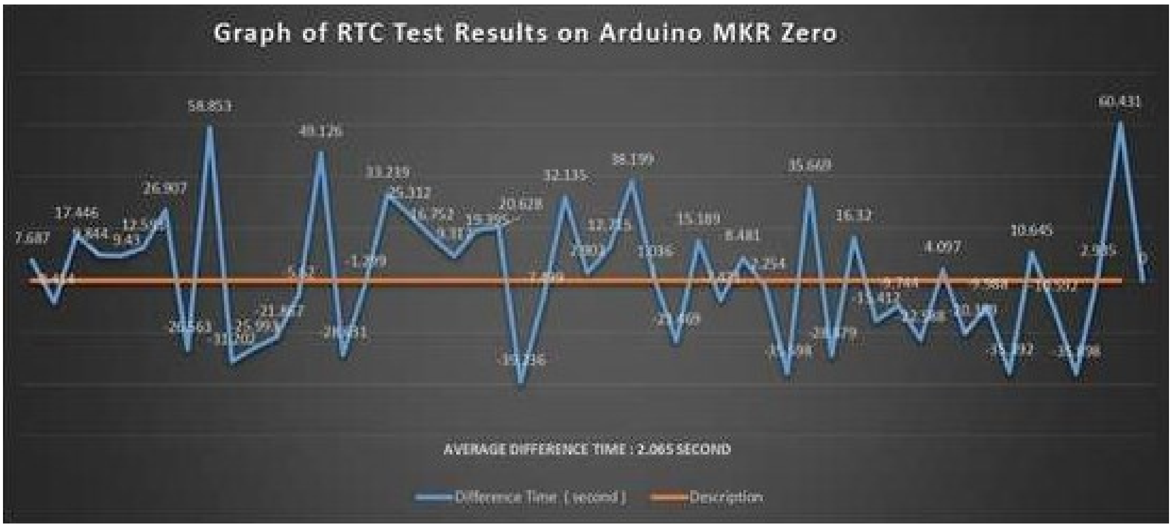


**Fig. 10.** Graph of RTC Results on Arduino MKR Zero

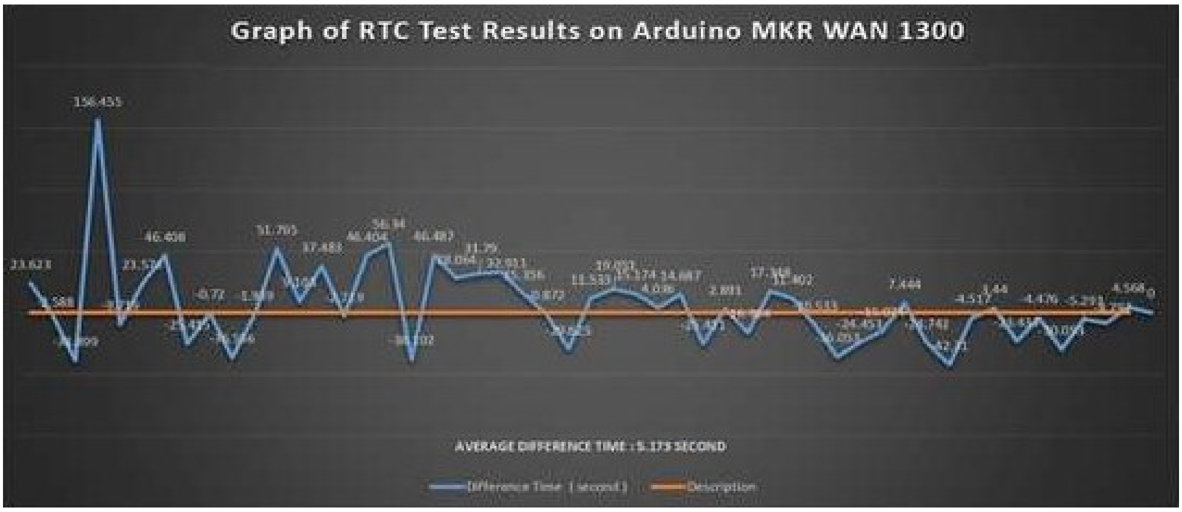


**Fig. 11.** Graph of RTC Results on Arduino MKR WAN 130

**Table 2.** RTC Alarm Trial

| Arduino | Mean | Std. Deviation | Std. Error | Median (Minimum-Maximum) |
|---|---|---|---|---|
| Arduino MKR Zero | 2.07 | 24.90 | 3.52 | 2.92 (-39.24 – 60.43) |
| Arduino MKR WAN 1300 | 5.17 | 33.73 | 4.77 | 1.09 (-42.31 – 156.45) |
| Arduino MKR GSM 1400 | 1.35 | 16.32 | 2.31 | 5.00 (-37.33 – 40.68) |

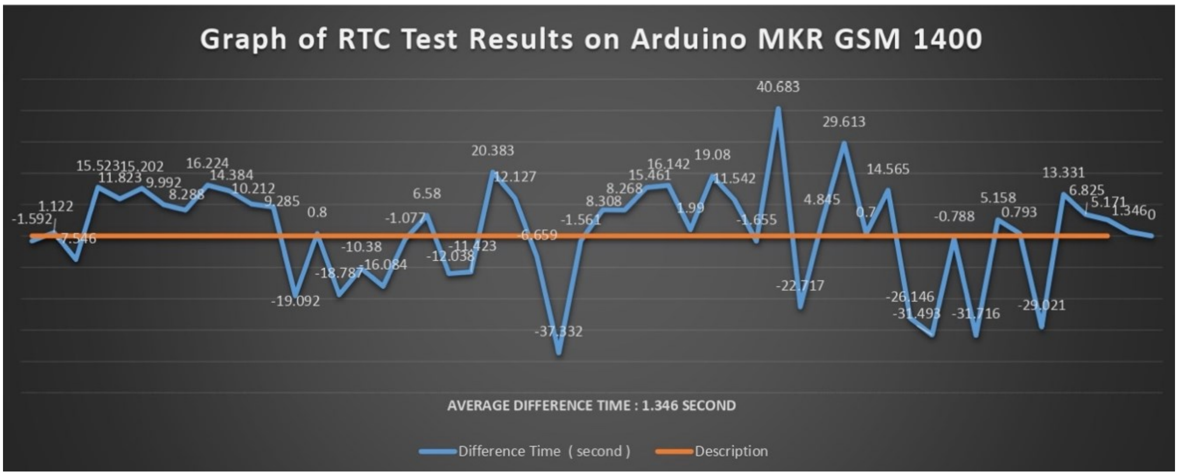


**Fig. 12.** Graph of RTC Results on Arduino MKR GSM 1400

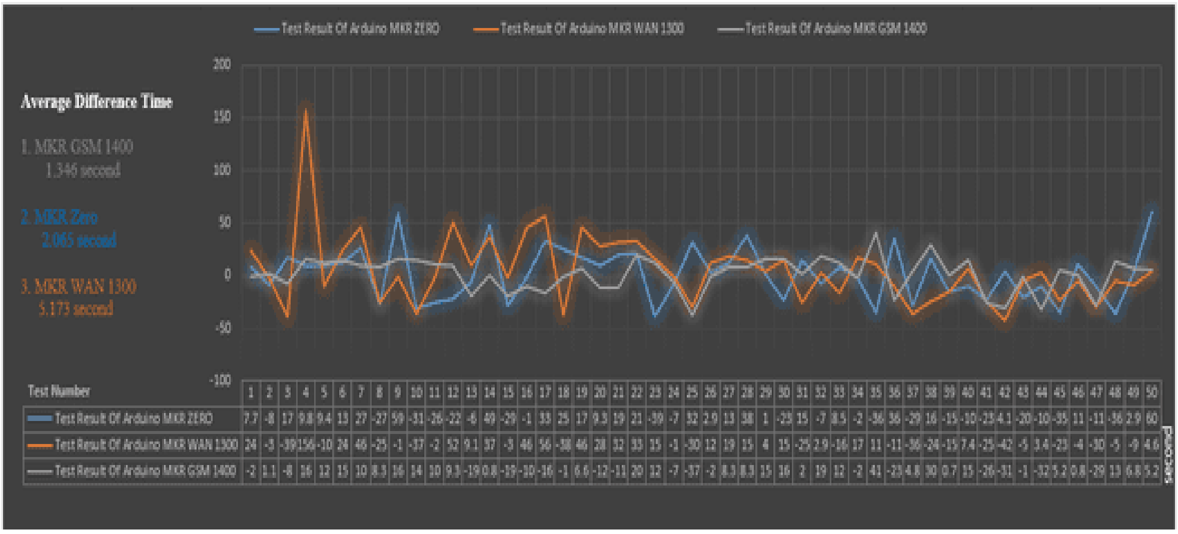


**Fig. 13.** Average Difference Time

Based on the results of the frequency test, the difference between the mean and standard deviation of the entire sample was obtained. Arduino MKR Zero obtained an average of 2.07 with a standard deviation of 24.900. Arduino MKR WAN 1300 obtained an average of 5.17 with a standard deviation of 33.73. Arduino MKR WAN 1400 obtained an average of 1.35 with a standard deviation of 16.32. So, it can be concluded from the three Arduinos there are significant differences. Based on Table 2 also shows that Arduino MKR GSM 1400 has the highest speed compared to Arduino MKR Zero and Arduino MKR WAN 1300.

## 4. CONCLUSION

Comparative measurement of the three MKR using the RTC (Real Time Clock) Alarm gets the average time difference. This average indicates the IC capability and accuracy of MKR. From the experimental results, MKR GSM 1400 has the greatest. The time difference is 1.346 seconds. MKR Zero has an average time difference of 2.07 seconds, while MKR WAN is 1300 5.17 seconds. With the same clock speed of 32.768 kHz, the Arduino MKR GSM 1400 has the best response time. Arduino MKR GSM 1400 is the Arduino MKR that has the fastest data response among the other two Arduino MKRs. So, to create or develop a project related to real-time data transmission, it is recommended to use the Arduino MKR GSM 1400.

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