Design of Ground Fault Detector Using NodeMCU ESP8266 microcontroller Based Telegram

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Abstract
One of the important things in the electricity distribution system is how to distribute electricity from generation to consumer so that it can take place continuously. When distributing electricity, technical disturbances may occur, such as over voltage, over load, reverse power and short circuit disturbances from generation to transmission to distribution. To facilitate the investigation of disturbances in the Medium Voltage Cable Line, namely by installing a disturbance detector. Fault detection tool for Medium Voltage Cable Lines, namely Ground Fault Detector (GFD). The Medium Voltage Cable Line network with GFD installed is more profitable than the Medium Voltage Cable Line network which is still lacking or not installed with GFD. GFD will detect a short circuit fault. Then the NodeMCU ESP8266 microcontroller will process the interference signal and then send a notification message via the telegram application. The tools that have been designed are then tested under conditions similar to field conditions. The test results show that the troubleshooting time is better with the fastest time being 00:36.10 seconds or thirty-six seconds, while the longest time is 01:24.06 minutes or one minute twenty-four seconds compared to the old GFD of 134.08 minutes and GFD 3G is 34.25 minutes.

Keyword: Ground Fault Detector, Telegram Application and Nodemcu ESP8266 Microcontroller

1. PRELIMINERY

The electric power system is an electrical system consisting of a generating system, distribution system and installation system for electric power users. The generating system is used to generate electricity. The distribution system or distribution system functions to distribute electric power generated from the generating system to the installation system of electric power users [1]. One of the important things in the electricity distribution system is how to distribute electricity from generation to consumers so that it can take place continuously. A good electricity distribution system is one form of efforts to improve the service quality of the Perusahaan Listrik Negara (PLN).

When distributing electricity, technical disturbances may occur, such as over voltage, over load, reverse power and short circuit disturbances from generation to transmission to distribution. The distribution of electric power can use the type of overhead line, land or underwater. One type of channel that is prone to interference is the underground cable channel which is usually used for medium voltage which can cause short circuit disturbances. This can change the circuit structure, cause changes in power distribution, damage the stability of the power system and affect the normal operation of electrical equipment [3]. To facilitate the investigation of disturbances in the SKTM, namely by installing a disturbance detector. The fault detection tool for SKTM is the Ground Fault Detector (GFD).

The SKTM network with GFD installed is more profitable than the SKTM network which is still lacking or has not been installed with GFD [4]. This is because the SKTM network that has many GFD installed is faster at isolating interference. So that blackouts that occur can be handled quickly and electricity can be turned on quickly. At the Puma Feeder GFD has been installed at each distribution substation. Before installing GFD at each substation, when a disturbance occurs it takes a long time to investigate. The longer the investigation, the longer it will take the officer to isolate the disturbance.

Obstacles in troubleshooting are not only determined by the GFD installed in the area around the disturbance, but also by the timing of the probe and the information conveyed. The GFD used at this time requires the officer conducting the investigation of the disturbance to check the GFD indicator light at each substation, so it takes a longer time, which is around 143.08 minutes. There is a GFD update, namely the creation of a 3G GFD that is able to investigate disturbances for 34.25 minutes, but it is hoped that there will be a GFD that is able to investigate disturbances faster than 3G GFD [5]. Therefore, we need a GFD to notify the location of the disturbance in a fast, more effective and efficient manner. In this study, a GFD design was carried out that could provide information on disturbances directly through notifications via the telegram application to officers by adding a circuit to the old GFD.

2. RESEARCH METHODS

2.1 Research Flow

In simple terms, the research process that aims to create a GFD that can send information through this telegram application uses a NodeMCU ESP8266 microcontroller and a Current Sensor. The following is a display of the research flow chart.

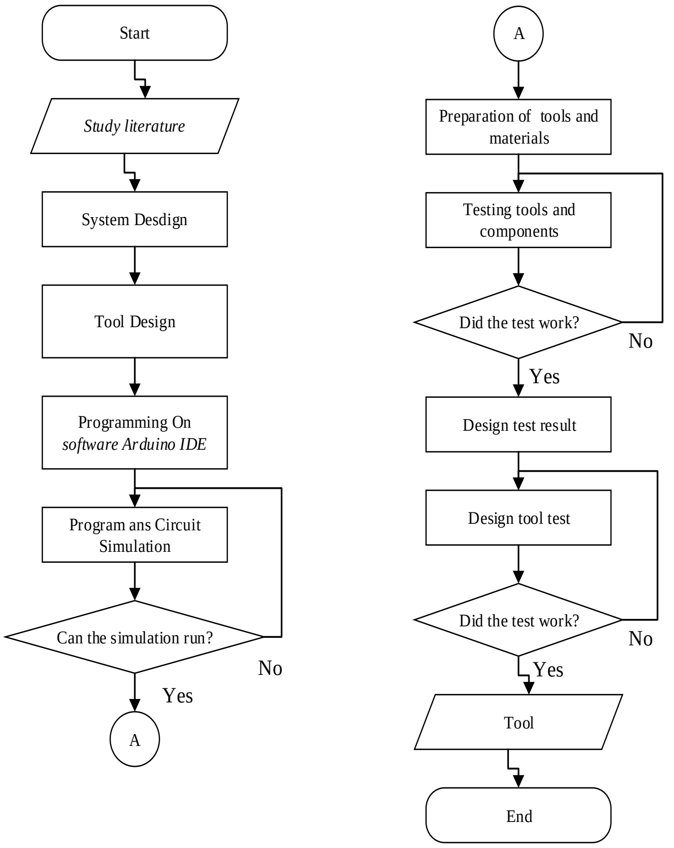

Figure 1 Research Flow

2.2 System Planning

The system design is based on the block diagram of the GFD and the research plan carried out. The system created starts at the area marked in the following GFD block diagram.

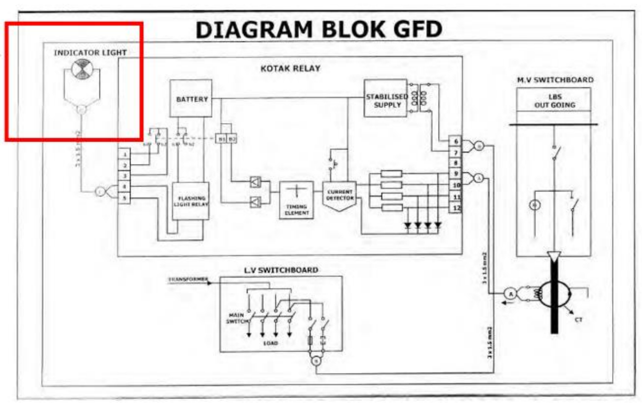

Figure 2 System Design Based on GFD Block Diagram

The additional circuit for the new GFD is made in a different box, so there is no need to disassemble the circuit in the old GFD relay box. The system design is made to determine the relationship between one component and another. This can be seen in the following system design block diagram.

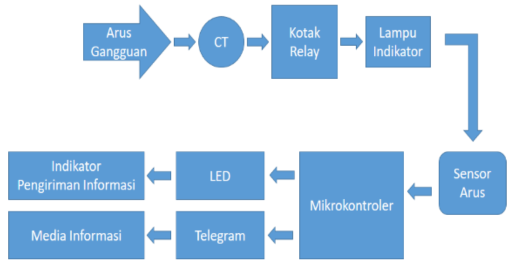

Figure 3 System Design Block Diagram

2.3 Software Planning

1. Create a telegram bot

Figure 4 Telegram Bot

Telegram bot in this study serves as a medium to convey information in the form of short circuit disturbances. Making a telegram bot requires several steps, namely as follows.

a. Installing the telegram application on mobile devices.
b. Create a username for the telegram bot.
c. Get telegram bot token and telegram id to connect GFD tool with telegram app.

2. Connecting the Microcontroller to a Wife Network or Hotspot

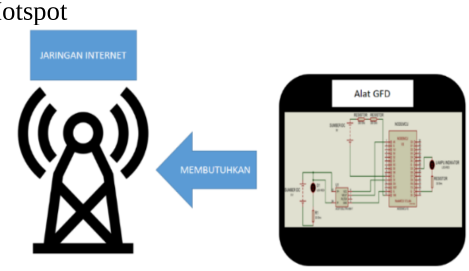

Figure 5 Connecting the Microcontroller to a Wifi Network or Hotspot

To connect the GFD tool with the telegram application, of course it requires an internet network. The internet source that can be used is a wifi modem, but at the time of testing an internet source is used in the form of a hotspot from a mobile device.

3. Connecting Microcontroller to Telegram Bot

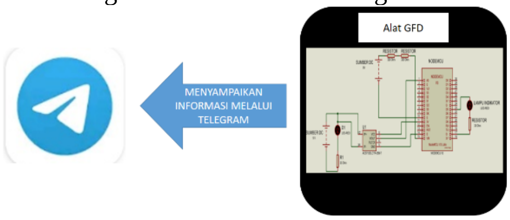

Figure 6 Connecting Microcontroller to Telegram Bot

The application that is used as a medium to convey information in the form of interference is the telegram application, so we need a program that can be used to connect the device with the telegram application.

2.4 Electrical Circuit Planning

The following are the electronic components that are arranged in such a way as to suit the system design and programs created.

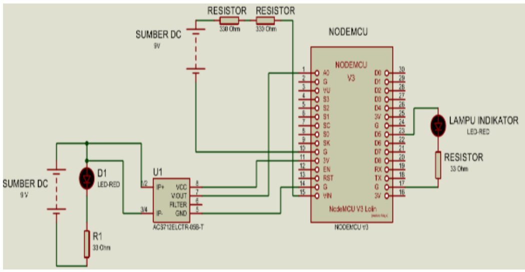

Figure 7 Electrical Circuit Planning

2.5 Modeling How The Tool Works During Disturbance

The following is a flow chart and a picture of how the GFD works in detecting short circuit faults.

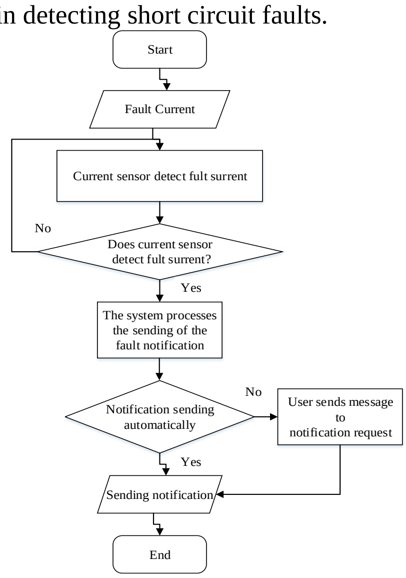

Figure 8 Flowchart of How GFD Works

3. RESULTS AND DISCUSSION

3.1 Software Testing

1. Telegram Bot Account Creation

Telegram bot account creation will get API (Application Programming Interfacing) Token, user's telegram application id. After that, the Telegram bot account can already be used for information media when there is a disturbance as shown in the following picture.

Figure 9 Telegram Bot Account

2. Testing Microcontroller with Internet Network

The connection status with the network source is displayed on the serial monitor as shown below.

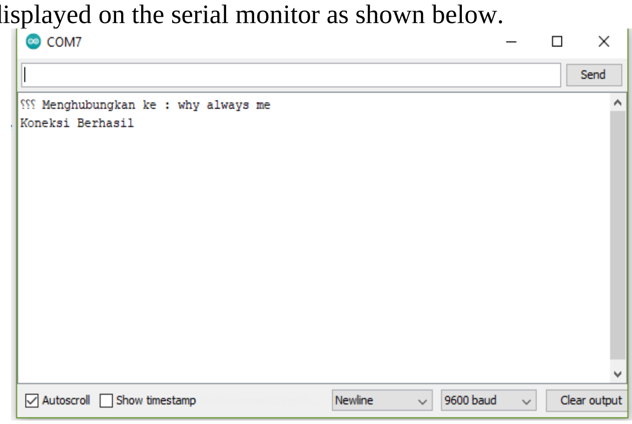

Figure 10 Serial Monitor Display After Testing Microcontroller With Internet Network

The test also displays the results of the microcontroller speed in accessing network resources, which are as follows.

Table 1 Microcontroller Speed Test Results Data Accessing Network Resources

Num	**Start Condition**	**Final Condition**	Speed Data Accessing Network **(Second)**
1	Not Connected	Connected	00:03.66
2	Not Connected	Connected	00:05.69
3	Not Connected	Connected	00:02.38
4	Not Connected	Connected	00:04.29
5	Not Connected	Connected	00:03.85
6	Not Connected	Connected	00:03.26
7	Not Connected	Connected	00:04.82
8	Not Connected	Connected	00:04.08
Average			00.04.00

The table above is the result of testing the speed of the microcontroller accessing internet network resources. The test data shows that the fastest time for microcontroller in accessing internet network resources is 00:02.38 seconds, while the longest time for microcontroller in accessing internet network resources is 00:05.69 seconds. The average time of microcontroller in accessing internet network resources is 00:04.00 seconds. To make it easier to read the test data, it is displayed in the form of the following graphic image.

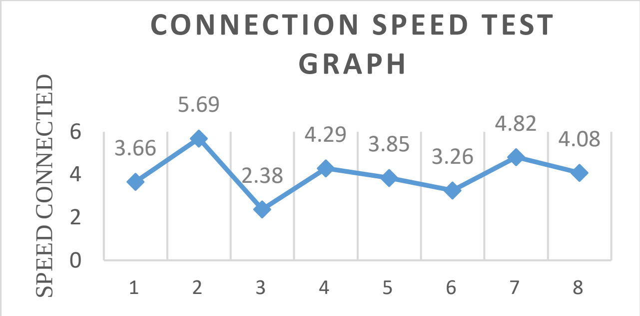

Figure 11 Connection Speed Test Graph

The picture is a graph of the connection speed test between the microcontroller microcontroller and the internet network source. The graph shows a fairly stable result because the intervals in several experiments carried out are not too far away. This shows good results because it is still far from sending via 3G data communication.

3. Testing Microcontroller with Telegram Bot

The following are the test results on the serial monitor display.

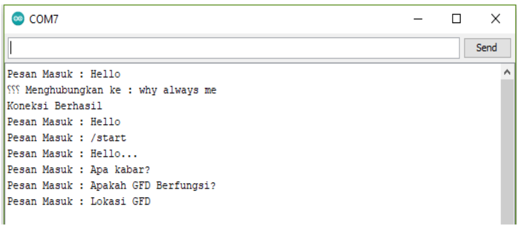

Figure 12 Serial Monitor Display After Testing Microcontroller With Telegram Application Appearance

The following is an image that states that the telegram bot application has successfully sent messages from users and received messages sent by the system.

Figure 13 Display Testing on the Telegram App

3.2 Electrical Circuit Testing

1. Testing Microcontroller with Current Sensor

The following is a circuit used in current sensor testing that requires a current sensor, microcontroller and indicator lights.

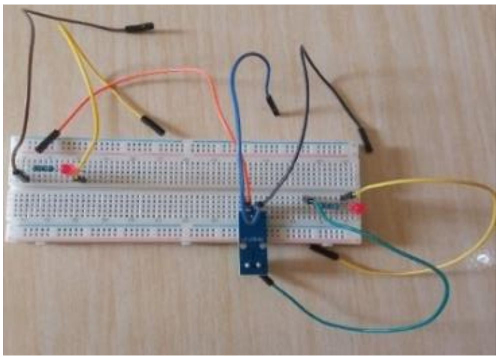

Figure 14 Current Sensor Test

The results of the tests carried out can be seen in the following figure.

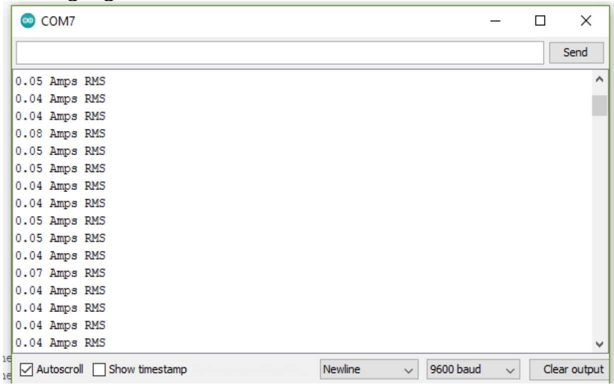

Figure 15 Serial Monitor Display Testing Microcontroller With Current Sensor

The test results in Figure 15 show that there is an increase in current when the fault simulation is carried out, which is 0.07-0.08 Amps RMS which was previously 0.04-0.05 Amps RMS. This is influenced by the load which results in a sudden increase in current.

2. Microcontroller Distance Testing To Network Source

The following is an electrical circuit from the results of the microcontroller distance test to the network source.

Figure 16 Microcontroller Range Testing To Network Source

The following is the test result data for the microcontroller distance to the network source.

Table 2 Test Results Microcontroller Range Range To Network Source

Trial To	Range To Network Source (m)	Connected Successfully
1	0	Yes
2	5	Yes
3	10	Yes
4	15	Yes
5	20	Yes
6	25	Yes
7	30	No

The table shows that the test is carried out at a distance of 0 meters to a certain distance which is the limit of the range of the microcontroller in accessing the internet network. The test results show that at a distance of 30 meters the microcontroller cannot access the internet network. The results of the test are displayed on the following serial monitor.

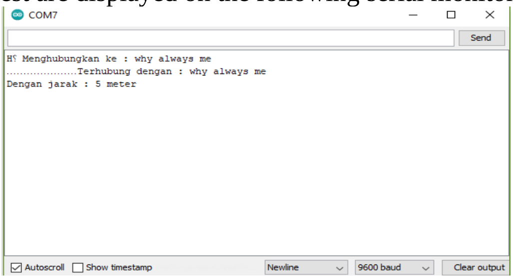

Figure 17 Display Serial Monitor Connected Successfully

Figure 17 is a serial monitor display of the results of testing the range of the microcontroller to an internet network source that is successfully connected at a distance of 5 meters. The picture shows that the microcontroller has succeeded in reaching the internet network source with a distance between the microcontroller and the network source of 5 meters. Meanwhile, the serial monitor display that is not connected to the internet network source at a distance of 30 meters is as follows.

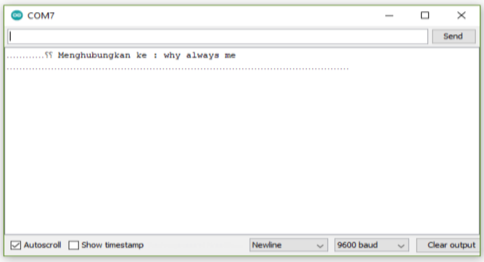

Figure 18 Serial Monitor Display Not Connected Successfully

Figure 18 is a serial monitor display of the results of testing the range of the microcontroller to the internet network source. The figure shows that the microcontroller has not succeeded in reaching the internet network source with the distance between the microcontroller and the network source being 30 meters. This is shown on the serial monitor display which does not display the connection status and there is no description of the distance range which indicates that the microcontroller has not been successfully connected to the internet network source. Distance information is not displayed when the microcontroller is not connected successfully.

3. Implementation of Electrical Circuit Design

The results of the implementation are shown in Figure 4.20.

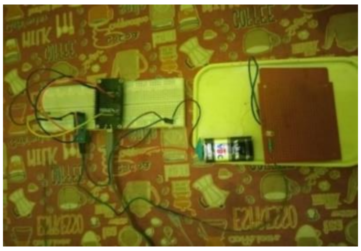

Figure 19 Electrical Circuit Design Implementation

The electrical circuit in question is a form of implementation of system design. In this case it is explained that the components used such as microcontrollers, current sensors, LEDs and batteries are assembled to form a unified system. The battery is used as a DC source for the indicator light and the microcontroller.

When running a system that can send fault information, it is necessary to change conditions which in this case is a condition when the indicator light and the microcontroller get a current supply from the battery. Changes in conditions are regulated by a pushbutton which is used as a simulator of short circuit faults that occur. When the pushbutton is pressed, current flows and indicates a short-circuit fault. Then instruct the system to send a disturbance notification via the telegram application installed on the user's device.

3.3 System Testing

System testing is carried out if all the components needed in the short circuit to ground fault detection device or GFD have been assembled and programmed. The system under test starts when the current is read by the current sensor which then the system sends a notification via telegram bot. The system testing carried out is divided into several conditions, namely normal conditions and testing the number of GFD tools when a disturbance.

1. Normal System Testing

The following is a picture of a series of tests and the results of normal system testing.

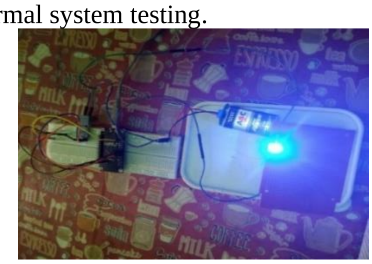

Figure 20 GFD Tool Testing

This test is said to be successful because the system has sent information via telegram as shown in Figure 21. When the indicator light is turned on there is a change in conditions which causes the system to work. The value changes to the current sensor input for the microcontroller to work and commands the LED to light up. The illuminated LED is an indicator that the intrusion detection tool has sent a notification via the telegram application. When there is current flowing, the tool can already be run even though it is only connected to the internet network source.

Figure 21 Submission of Interference Information From the GFD Tool Through the Telegram Application

In this test, it is also found that the GFD that does not provide a disturbance notification message automatically can be said to be successful. This is because users can still send messages to GFD to find out the latest conditions regarding disturbances. The GFD that answers the telegram application message from the user indicates that there is a disturbance in the GFD area because only the GFD is powered by current from the indicator light or battery in the old GFD relay box that can send or receive messages from the user's telegram application.

2. System Testing Based on the Number of Installed Tools

This test is carried out as a simulation of tools that have been installed on several GFDs to prepare for disturbances. GFD that has been installed sends interference to the telegram application which in this test will be known whether the telegram application can receive messages from several GFD tools or not. In this test, two GFD tools were tested with the parameters of sending a disturbance notification message between the GFD 1 and GFD 2 tools on the telegram bot. The following is an image of the system test results based on the number of GFD installed for a telegram application device.

Figure 22 Testing Two GFD Tools on Telegram Bot Accounts

This test is said to be successful because the system has sent information via the telegram application as shown in Figure 22. The test results show that with one telegram account the bot can receive messages from several GFD tools. The program used is the same between GFD with one another. The difference between the programs used lies in the content of the messages displayed. The source of the internet network used also affects the program content that is entered into the microcontroller which is adjusted to the location of the GFD and the available internet network sources.

3. Testing the Response Speed of Sending and Receiving Telegram Messages

a. Message Sending Test

The following is the data from the results of the tests carried out.

Table 3 Message Sending Test Results Data

Trial To	**Message**	**Sending Time (Second)**
1	Test send	00:08.93
2	Test send	00:50.40
3	Test send	00:22.42
Rata-rata		00:27.25

Table 3 is the test result of sending messages from the Telegram application to the microcontroller. The test is carried out using the time parameter in seconds as a reference for the success rate. The test result data shows the time value that varies. Timing intervals generated in the test are quite far even if only in seconds. The fastest time in the testing of sending messages from the telegram application is 00:08.93 seconds, while the longest time is 00:50.40 seconds. The average message sending time is 00:27.25 seconds. This shows that the process of sending messages from the telegram application is less stable. This is influenced by the quality of the internet network and the response from the microcontroller which was not good at the time of testing.

b. Message Receiving Test

The following is the data from the results of the tests carried out.

Table 4 Message Receiving Test Results Data

Trial To	**Message**	**Receiving Time (Second)**
1	GFD Location	00:24.79
2	GFD Location	00:27.62
3	GFD Location	00:27.97
Average		00:26.79

Table 4 is the data from the test results for receiving messages from the microcontroller to the Telegram application. The test is carried out using the time parameter in seconds as a reference for the success rate. The test result data shows the time value that varies. The time interval for receiving messages is not much different from several times of testing. The fastest time in the message acceptance test was 00:24.79 seconds, while the longest time was 00:27.97 seconds. The average time of receiving messages is 00:26.79 seconds. This indicates that the reception of messages by the telegram application is stable. This is influenced by the quality of the internet network and the response of the microcontroller which was quite good at the time of testing.

c. Receiving and Sending Message Testing

The following is the data from the results of the tests carried out.

Table 5 Test Result Data Sending And Receiving Messages

Trial To	Message	Receiving And Sending Message Time (Second-Minute)
1	Does GFD Work?	00:56.87
2	GFD Location	01:05.73
3	Does GFD Work?	00:34.23
4	GFD Location	00:43.65
5	Does GFD Work?	00:43.37
6	GFD Location	01:12.32
Average		00:52.69

Table 5 is the test data for sending and receiving messages from the microcontroller to the Telegram application and vice versa. The test is carried out using the time parameter in minutes-seconds as a reference for the success rate. The test result data shows the time value that varies. The time interval for receiving messages is quite different from several times of testing. The fastest time in testing sending and receiving messages is 00:34.23 seconds, while the longest time is 01:12.32 minutes. The average time of sending and receiving messages is 00:52.69 seconds. This shows that the reception of messages by the telegram application is less stable. This is influenced by the quality of the internet network and the response from the microcontroller which was not good at the time of testing. The test results data on the three conditions are combined to make it easier to read the test results data. In addition, to find out the comparison of each condition, it is displayed in the form of the following graphic image.

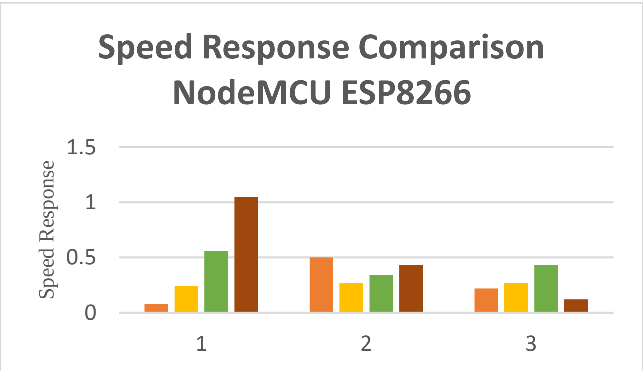

Figure 23 Response Speed Comparison Graph Microcontroller

Figure 23 shows that the comparison interval is quite far because the conditions used in the test are different. Testing the response speed of the GFD tool to electrical power disturbances affects the overall success of the test. The parameter of success is exceeding the troubleshooting time on the old GFD and 3G GFD which have trouble tracing time of 143.08 minutes and 34.25 minutes, respectively. The following is a calculation of the amount of time used to investigate disturbances in the New GFD.

Table 6 Calculation of the Number of Troubleshooting Time

Num	Condition	Status	Times	Description
1	Sending and Receiving Separate Messages	Fastest	00:36.1 Second	< 34,25 Minute
2	Sending and Receiving Separate Messages	Longest	01:24.06 Minute	< 34,25 Minute
3	Sending and Receiving Separate Messages	Average	00:58.04 Second	< 34,25 Minute
4	Sending and Receiving Messages Combined	Fastest	00:36.61 Second	< 34,25 Minute
5	Sending and Receiving Messages Combined	Longest	01:18.01 Minute	< 34,25 Minute
6	Sending and Receiving Messages Combined	Average	00:56.69 Second	< 34,25 Minute

Table 4.6 is a data table resulting from the calculation of the time required for the new GFD to investigate short-circuit disturbances in medium-voltage cable lines with the conductor in the ground. Overall time records show that the new GFD recorded a faster time in troubleshooting compared to the old GFD and 3G GFD.

Then when viewed from all conditions and time status, it shows that the fastest time in investigating disturbances is 00:36.1 seconds or thirty-six seconds, while the longest time is 01:24.06 minutes or one minute twenty-four seconds. The longest record shows better results than the 3G GFD, which is 34.25 minutes.

4. CLOSING

4.1 CONCLUSION

1. Message delivery is less stable with an average of 27.25 seconds, message reception is quite stable with an average of 26.79 seconds and sending or receiving messages combined is less stable with an average of 52.69 seconds.
2. The troubleshooting time is better with the fastest record time of 36.10 seconds, while the longest record time is 1.24 seconds compared to the old GFD of 134.08 minutes and 3G GFD of 34.25 minutes.

4.2 SUGGESTION

In this study, the authors realize that there are still many things that need to be improved or become input for further research regarding the Design of a Ground Fault Detector (GFD) Using the NodeMCU ESP8266 Microcontroller and a

Telegram-Based Current Sensor. Due to the maximum range of NodeMCU access to internet network sources as far as less than 30 meters, it is recommended to install an internet network source or use a microcontroller other than micocontroller NodeMCU ESP8266.

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