Overload Protection and Electricity Volume Monitoring on Internet of Things (IOT)-Based Three-Phase Induction Motors

Ramly Rasyid, Miftah Muhammad, Mochammad Apriyadi Hadi Sirad
Department of Electrical Engineering, Faculty of Engineering, Universitas Khairun
Jl. Jusuf Abdurrahman. (Gambesi) South Ternate District, Ternate – Indonesia
*ramlyrasyid@unkhair.ac.id

Article history: Received Feb 25, 2025 | Revised April 10, 2025 | Accepted April 11, 2025

The protection and monitoring of the amount of electricity in three-phase induction motors that are widely used in the industry needs to be carried out continuously so that the performance of the motor continues to run well and if there is a disturbance, it can be known early. The purpose of the research to be carried out is to make a device to protect and monitor the amount of electricity of a three-phase induction motor based on the Internet of Things (IoT) and see the performance of the device. From the results of the overload protection test with the three-phase induction motor load current indicator, it can be seen that when the motor is loaded until the current rises at the R phase of 1.23 A, the S phase 1.31 A, and the T phase 1.24 A, which means that the maximum current of the induction motor is exceeded by 0.401 A as the relay works to protect the induction motor. As for the calculation of the measurement error presentation, it can be seen that for the error presentation, the voltage measurement ranges from 0.001% to 0.088%, current 0.001% to 3.509%, power factor 0.433% to 4.438%, apparent power 0.020% to 3.774%, active power 0.149% to 4.904%, and reactive power 0.008% to 4.455%. The tool that is made works well because the protection runs well and the error presentation is below 5%. Keywords: Induction Motor, Protection, Monitoring, IoT.

Keywords: Overload Protection, Electrical Volume Monitoring, Three-Phase Induction Motor, Internet Of Things, (IOT)

1. INTRODUCTION

Induction motors are widely used in industry, this is because induction motors are relatively cheap, simple in structure, sturdy, and easy maintenance. The development of today's technological era, making fast and accurate information and data monitoring is needed [1]. For example, 3-phase induction motor monitoring which contains information on current values, voltage, speed and motor power is very much considered at all times because electric motors are the driving force of the production process in the industrial world. The efficiency of the production process for the industry aims to increase competitiveness and profitability both in terms of finances [2].

Monitoring the amount of electricity in three-phase induction motors that are widely used in the industry needs to be done continuously (real time) so that the performance of the motor continues to run well and if there is a disturbance it can be known early [3].. The results of this real-time flow monitoring are then used as material for analysis whether the motorcycle is experiencing a disturbance, and if there is a disturbance, the handling can be done as soon as possible by installing protective equipment [4].

Monitoring the amount of electricity on induction motors in the industry is usually still done manually by workers who are assigned to record the current every certain period (usually once every one or two hours). The worker who is in charge of monitoring this will go to the current measuring device as well as record the amount of current that is being measured at that time and record it again in the next period. Work like this has a risk of error due to human error, so it becomes ineffective [5]. An alternative way is needed to facilitate the work of monitoring current on electric motors by minimizing the occurrence of errors, namely by using the IoT concept. IoT is a network that is used to realize interconnection between objects and web services. The use of IoT applications today has penetrated various realms such as WSN, RFID, GPS and others which overall aim to make work more efficient and easier [6].

The operation of a three-phase induction motor using a series of two motors works in sequence automatically by applying IoT-based technology in the industrial field to make it easier to use a three-phase induction motor by controlling it remotely [7]. Technological advances make things work efficiently and smarter, especially objects that are connected using the internet, this term is called IoT (Internet of Things) technology. This IoT system is also economical so that the system performance is maximized [8-10].

The development of communication technology has brought many changes to other technological developments, one of which is data acquisition technology. The application of communication technology in data acquisition systems has given birth to a very large telecommunication network technology and is used as a means to flow data generated by sensors/things [11-15]. Through IoT, data will be collected, exchanged and analyzed to obtain valuable information related to the relationship between things. Therefore, based on the background, it is necessary to conduct a research entitled "Overload Protection and Monitoring the Amount of Electricity in Three-Phase Induction Motors Based on the Internet of Things (IoT)".

2. METHOD

From the block of series diagrams, the overall working principle of the tool can be known, so that it will produce a system that can function according to the working principle of a series. Block diagram of Overload Protection and Electrical Volume Monitoring on Internet of Things (IoT)-Based Three-Phase Induction Motors can be seen in figure 1.

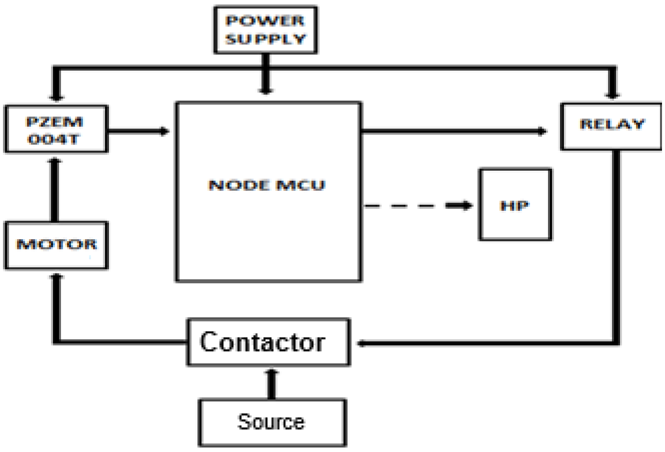

Figure 1**.** Block Diagram

The working principle of the block diagram above is that when the relay is in a connected state or *Normally Close* (NC) so that the electric current enters the contactor magnetic coil then the contactor will function and turn on the 3-phase induction motor. All quantities of current quantities will be received by the Pzem sensor and sent to the NodeMCU, after which all the data will be sent to the HP. But if the current generated by the induction motor and received by Pzem exceeds its nominal current, then the relay will work to disconnect the current automatically. The function of *the Power Supply* is to provide or supply electrical current to the Pzem, NodeMcu, and Relay sensors.

The achievement indicator plan that will be implemented in this study is the manufacture of overload protection devices and monitoring the amount of electricity using IoT-based microcontrollers applied to three-phase induction motors. This tool can be used for industrial, office, household, and laboratory purposes

3. RESULTS AND DISCUSSION

3.1 Hardware Design

This *hardware* design aims to design a concept and layout to assemble a 3-phase motor control and monitoring system based on *IOT (*Internet Of Things). The tools and materials used in this design are NodeMCU-ESP8266, PZEM-004T Sensor, Relay, Contactor, 3-phase MCB. The hardware design can be seen in figure 3.

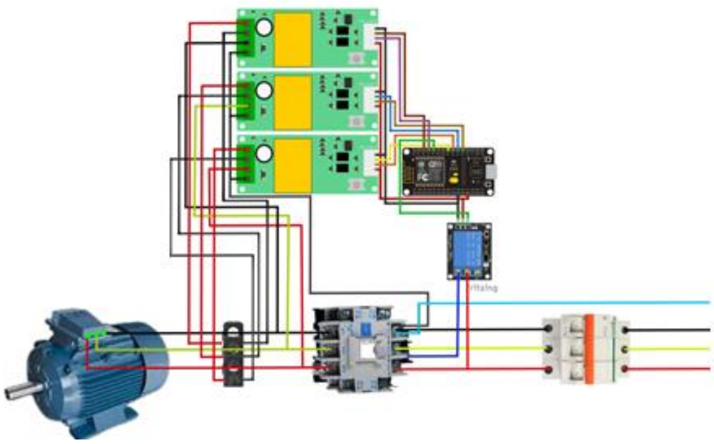

Figure 3. Design of Current Monitoring and Protection Series on 3-phase Induction Motors

3.2 **Tool Testing**

Three-phase induction motor overload protection test, namely the *over current reading* on the current sensor does not exceed the maximum current of the induction motor at the time of load, which is 1.04 A, if the current exceeds 1.04 A then the relay will work to break the contacttar coil which causes the motor to stop due to the overload motor.

The test results of this monitoring tool to find out the comparison of the value of the tool made with the MI 2892 metrel power quality analyzer, also describe how to conduct the test according to the expected results. In addition, the purpose of the testing tool is intended to test all the elements of the hardware and software that is made to ensure that they are as expected. In this test, there are several parameters on the induction motor that are tested, namely voltage, current, power factor, pseudopower, active power, and reactive power. The test image can be seen in figures 4, and 5.

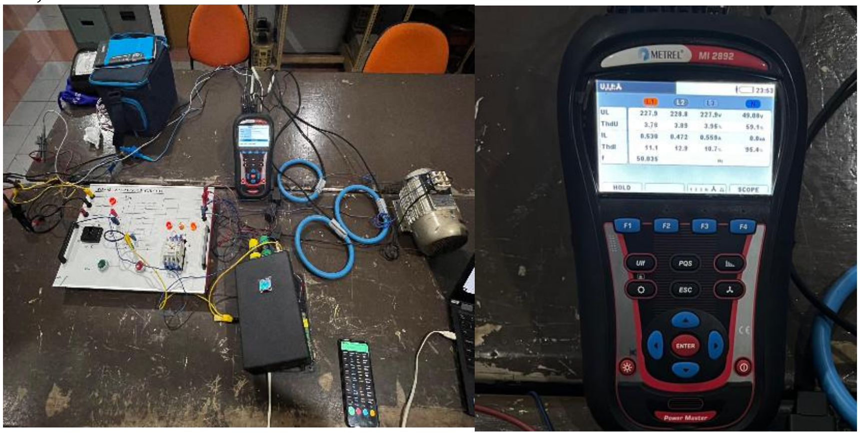

Figure 4. Measurement Testing 1 With MI 2892 Metrel Power Quality Analyzer

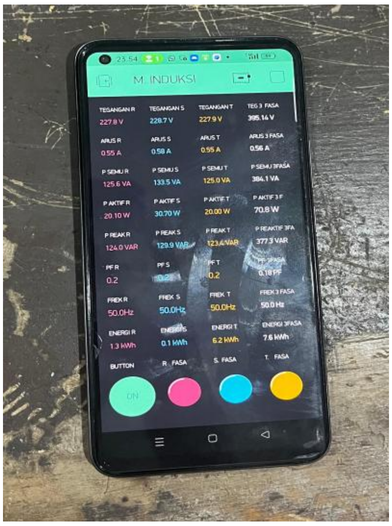

Figure 5. Measurement Testing with Blynk App

3.2.1 **Results of Overload Protection Test on 3-Phase Motors**

In this test the maximum limit of current that can be read by the sensor is 1.04 Ampere. If the current reading exceeds 1.04 Amperes, it means that the induction motor is overloaded, the relay will work and drive the contactor coil which causes the contactor to be in the off position , then the current that was previously flowed to the 3-phase motor will be cut off. The following is the test result data displayed on the monitor serial.

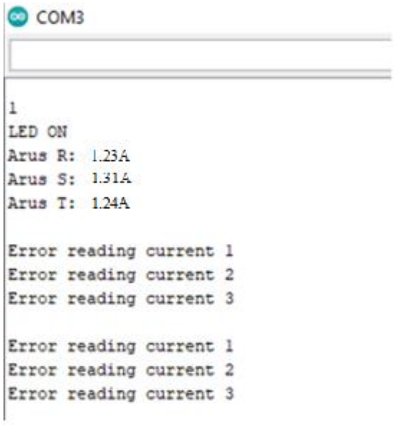

Figure 6. Excess Load Protection Test Results

In the test results, it can be seen that the current value in phase R is 1.23 A Ampere, phase S is 1.31 Ampere and phase T is 1.24 Ampere. A look at the serial monitor monitors does not read the sensor (error reading current) means that the relay has worked and disconnected the contactor magnet which indicates that the induction motor is overloaded.

3.3 Three-Phase Induction Motor Parameter Monitoring Testing

3.3.1 Test Results With *Power Quality Analyzer Metrel MI 2892*

The results of this test used the MI 2892 metrel power quality analyzer with the test data as shown in tables 1 and 2.

Table 1. Test Results With Metrel For Current Voltage Parameters, and Power Factor

No.	Time	voltage (Volt)				Current (ampere)				Power Factor			
		phase R	phase S	phase T	3 phase	phase R	phase S	phase T	3 phase	phase R	phase S	phase T	3 phase
1	23:54:01	227,900	228,800	227,900	395,330	0,570	0,570	0,560	0,567	0,162	0,220	0,145	0,183
2	23:54:06	227,720	228,621	227,821	394,972	0,552	0,571	0,555	0,559	0,163	0,232	0,153	0,182
3	23:54:01	227,731	228,625	227,824	395,145	0,554	0,573	0,553	0,560	0,162	0,234	0,154	0,186
4	23:54:16	228,019	228,619	227,832	395,148	0,557	0,575	0,555	0,562	0,164	0,231	0,163	0,185
5	23:54:21	228,118	228,632	227,944	395,255	0,556	0,576	0,556	0,563	0,166	0,232	0,166	0,183
6	23:54:26	228,113	228,631	227,962	395,258	0,553	0,578	0,552	0,561	0,164	0,233	0,165	0,184
7	23:54:31	228,115	228,637	227,937	395,257	0,555	0,579	0,557	0,564	0,165	0,234	0,168	0,186
8	23:54:36	227,723	228,642	227,969	395,029	0,558	0,583	0,558	0,566	0,162	0,237	0,164	0,184
9	23:54:41	227,645	228,649	227,948	394,975	0,559	0,585	0,552	0,565	0,167	0,235	0,168	0,187
10	23:54:46	228,134	228,745	227,951	395,319	0,558	0,586	0,554	0,566	0,164	0,238	0,167	0,182
11	23:54:51	228,143	228,686	228,101	395,318	0,551	0,578	0,555	0,561	0,168	0,234	0,165	0,181
12	23:54:56	228,129	228,732	228,099	395,314	0,553	0,571	0,551	0,558	0,167	0,232	0,163	0,186
13	23:55:01	228,132	228,742	228,125	395,374	0,559	0,582	0,553	0,565	0,174	0,236	0,164	0,194
14	23:55:06	228,137	228,747	228,132	395,377	0,554	0,574	0,559	0,562	0,168	0,239	0,168	0,184
15	23:55:11	228,143	228,775	228,142	395,376	0,556	0,584	0,557	0,566	0,165	0,233	0,164	0,182

Table 2. Test results with a trellis for power parameters

No.	Time	Pseudo-Power S(VA)				Active Power P (Watt)				Reactive Power (VAR)			
		Phase R	Phase S	Phase T	3 Phase	Phase R	Phase S	Phase T	3 Phase	Phase R	Phase S	Phase T	3 Phase
1	23:54:01	129,903	130,500	127,624	388,027	21,044	28,710	18,505	68,260	124,187	127,303	126,275	381,765
2	23:54:06	125,701	130,543	126,441	382,685	20,489	30,286	19,345	70,121	124,020	126,981	124,952	375,953
3	23:54:01	126,163	131,002	125,987	383,152	20,438	30,654	19,402	70,495	124,496	127,365	124,484	376,345
4	23:54:16	127,007	131,456	126,447	384,909	20,829	30,366	20,611	71,806	125,287	127,901	124,756	377,943
5	23:54:21	126,834	131,692	126,737	385,263	21,054	30,553	21,038	72,645	125,074	128,099	124,978	378,151
6	23:54:26	126,146	132,149	125,835	384,130	20,688	30,791	20,763	72,241	124,439	128,512	124,110	377,060
7	23:54:31	126,604	132,381	126,961	385,946	20,890	30,977	21,329	73,196	124,869	128,705	125,156	378,730
8	23:54:36	127,069	133,298	127,207	387,574	20,585	31,592	20,862	73,039	125,391	129,501	125,484	380,376
9	23:54:41	127,254	133,760	125,827	386,841	21,251	31,434	21,139	73,824	125,467	130,014	124,039	379,519
10	23:54:46	127,299	134,045	126,285	387,628	20,877	31,903	21,090	73,869	125,575	130,193	124,511	380,279
11	23:54:51	125,707	132,181	126,596	384,483	21,119	30,930	20,888	72,937	123,920	128,511	124,861	377,292
12	23:54:56	126,155	130,606	125,683	382,444	21,068	30,301	20,486	71,855	124,384	127,042	124,002	375,428
13	23:55:01	127,526	133,128	126,153	386,807	22,164	31,418	20,689	74,271	125,585	129,367	124,445	379,397
14	23:55:06	126,388	131,301	127,526	385,214	21,233	31,381	21,424	74,038	124,592	127,496	125,713	377,800
15	23:55:11	126,848	133,605	127,075	387,527	20,930	31,130	20,840	72,900	125,109	129,927	125,355	380,391

3.3.2 Test Results Using MCU 8266 and *Blynk Nodes*

Test results using MCU Node 8266 and by looking at tables 3 and 4

Table 3. Test Results With MCU 8266 Nodes and *Blynk* For Current Voltage Parameters, and Power Factors

No.	Time	voltage (Volt)				Current (ampere)				Power Factor			
		phase R	phase S	phase T	3 Phase	phase R	phase S	phase T	3 Phase	phase R	phase S	phase T	3 Phase
1	23:54:01	228,100	228,600	227,800	395,200	0,550	0,580	0,560	0,560	0,170	0,230	0,150	0,180
2	23:54:06	227,700	228,600	227,800	394,970	0,550	0,570	0,550	0,560	0,160	0,230	0,150	0,180
3	23:54:01	227,700	228,600	227,800	395,140	0,550	0,570	0,550	0,560	0,160	0,230	0,150	0,180
4	23:54:16	228,000	228,600	227,800	395,140	0,550	0,570	0,550	0,560	0,160	0,230	0,160	0,180
5	23:54:21	228,100	228,600	227,900	395,250	0,550	0,570	0,550	0,560	0,160	0,230	0,160	0,180
6	23:54:26	228,100	228,600	227,900	395,250	0,550	0,570	0,550	0,560	0,160	0,230	0,160	0,180
7	23:54:31	228,100	228,600	227,900	395,250	0,550	0,570	0,550	0,560	0,160	0,230	0,160	0,180
8	23:54:36	227,700	228,600	227,900	395,020	0,550	0,580	0,550	0,560	0,160	0,230	0,160	0,180
9	23:54:41	227,600	228,600	227,900	394,970	0,550	0,580	0,550	0,560	0,160	0,230	0,160	0,180
10	23:54:46	228,100	228,700	227,900	395,310	0,550	0,580	0,550	0,560	0,160	0,230	0,160	0,180
11	23:54:51	228,100	228,600	228,000	395,310	0,550	0,570	0,550	0,560	0,160	0,230	0,160	0,180
12	23:54:56	228,100	228,600	228,000	395,310	0,550	0,580	0,550	0,560	0,160	0,230	0,160	0,180
13	23:55:01	228,100	228,700	228,000	395,370	0,550	0,580	0,550	0,560	0,170	0,230	0,160	0,190
14	23:55:06	228,100	228,700	228,000	395,370	0,550	0,570	0,550	0,560	0,160	0,230	0,160	0,180
15	23:55:11	228,100	228,700	228,000	395,370	0,550	0,580	0,550	0,560	0,160	0,230	0,160	0,180

Table 4. Test Results With MCU 8266 Nodes and *Blynk* For Power Parameters

No.	Time	Pseudo-Power S(VA)				Active Power P (Watt)				Reactive Power (VAR)			
		Phase R	Phase S	Phase T	3 Phase	Phase R	Phase S	Phase T	3 Phase	Phase R	Phase S	Phase T	3 Phase
1	23:54:01	125,000	132,600	125,600	382,840	20,700	30,300	19,400	70,400	119,990	128,210	127,870	376,070
2	23:54:06	122,500	132,170	130,000	384,670	19,600	30,400	19,500	69,500	120,920	128,630	128,530	378,080
3	23:54:01	122,500	132,170	130,000	383,230	19,600	30,400	19,500	70,600	120,920	128,630	130,000	376,450
4	23:54:16	128,120	132,610	122,500	383,230	20,500	30,500	19,600	70,600	126,470	129,050	120,920	376,450
5	23:54:21	128,120	132,170	123,130	383,420	20,500	30,400	19,700	70,600	126,470	128,630	121,540	376,640
6	23:54:26	128,750	132,170	123,130	384,050	20,600	30,400	19,700	70,700	127,090	128,630	121,540	377,260
7	23:54:31	128,750	132,170	122,500	383,420	20,600	30,400	19,600	70,600	127,090	128,630	120,920	376,640
8	23:54:36	123,130	133,480	126,250	382,850	19,700	30,700	20,200	70,600	121,540	129,900	124,620	376,060
9	23:54:41	121,880	133,040	127,500	382,420	19,500	30,600	20,400	70,500	120,300	129,480	125,860	375,640
10	23:54:46	128,750	132,610	125,630	386,980	20,600	30,500	20,100	71,200	127,090	129,050	124,010	380,150
11	23:54:51	128,120	132,170	123,750	384,050	20,500	30,400	19,800	70,700	126,470	128,630	122,160	377,260
12	23:54:56	128,750	132,170	123,750	384,670	20,600	30,400	19,800	70,800	127,090	128,630	122,160	377,880
13	23:55:01	121,760	132,610	123,750	378,120	20,700	30,500	19,800	71,000	119,990	129,050	122,160	371,200
14	23:55:06	128,750	132,610	123,750	385,110	20,600	30,500	19,800	70,900	127,090	129,050	122,160	378,300
15	23:55:11	128,120	132,610	124,380	385,110	20,500	30,500	19,900	70,900	126,470	129,050	122,770	378,300

3.4 Tool Error Presentation Compared to *Power Quality Analyzer Metrel MI 2892*

Presentation Tool error compared to the *MI 2892 metrel power quality analyzer* calculated using the equation:

$$\% = |\frac{Value\ of\ the\ tool\ created - Value\ of\ the\ metrel\ tool}{Value\ of\ the\ metrel\ tool} x100\%|$$

3.4.1. Presentation of Voltage Measurement Errors

The presentation of the error of the R phase voltage measurement at 23:54 01 is as follows :

$$\% = |\frac{228{,}100\ \text{Volt} - 227{,}900\ \text{Volt}}{227{,}900\ \text{Volt}} x100\%|$$

$$\% = 0{,}088\%$$

Table 5. Presentation of Voltage Measurement Errors

No.	Time	Presentation of Voltage Faults (%)			
		Phase R	Phase S	Phase T	3 Phase
1	23:54:01	0,088	0,087	0,044	0,033
2	23:54:06	0,009	0,009	0,009	0,001
3	23:54:01	0,014	0,011	0,011	0,001
4	23:54:16	0,008	0,008	0,014	0,002
5	23:54:21	0,008	0,014	0,019	0,001
6	23:54:26	0,006	0,014	0,027	0,002
7	23:54:31	0,007	0,016	0,016	0,002
8	23:54:36	0,010	0,018	0,030	0,002
9	23:54:41	0,020	0,021	0,021	0,001
10	23:54:46	0,015	0,020	0,022	0,002
11	23:54:51	0,019	0,038	0,044	0,002
12	23:54:56	0,013	0,058	0,043	0,001
13	23:55:01	0,014	0,018	0,055	0,001
14	23:55:06	0,016	0,021	0,058	0,002
15	23:55:11	0,019	0,033	0,062	0,002

3.4.2 Presentation of current measurement errors

The presentation of the error of the R phase current measurement at 23:54:01 is as follows :

$$\% = |\frac{0{,}550\ \text{Amp} - 0{,}570\ \text{Amp}}{0{,}570\ Amp} x100\%|$$

$$\% = 3{,}509\%$$

Table 6. Current Measurement Error Presentation

No.	Time	Current Measurement Error Presentation (%)			
		Phase R	Phase S	Phase T	3 Phase
1	23:54:01	3,509	1,754	0,000	1,176
2	23:54:06	0,362	0,175	0,901	0,119
3	23:54:01	0,722	0,524	0,542	0,001
4	23:54:16	1,257	0,870	0,901	0,415
5	23:54:21	1,079	1,042	1,079	0,474
6	23:54:26	0,542	1,384	0,362	0,178
7	23:54:31	0,901	1,554	1,257	0,651
8	23:54:36	1,434	0,515	1,434	1,118
9	23:54:41	1,610	0,855	0,362	0,943
10	23:54:46	1,434	1,024	0,722	1,060
11	23:54:51	0,181	1,384	0,901	0,238

12	23:54:56	0,542	1,576	0,181	0,299
13	23:55:01	1,610	0,344	0,542	0,826
14	23:55:06	0,722	0,697	1,610	0,415
15	23:55:11	1,079	0,685	1,257	1,002

3.4.3. Power Factor Measurement Error Presentation

The presentation of the error of the measurement of phase R factor at 23:54:01 is as follows :

$$\% = |\frac{0{,}170\ -0{,}162}{0{,}162} x100\%|$$

$$\% = 4{,}938\%$$

Table 7. Power Factor Measurement Error Presentation

No.	Time	Power Factor Measurement Error Presentation (%)			
		Phase R	Phase S	Phase T	3 Phase
1	23:54:01	4,938	4,545	3,448	1,639
2	23:54:06	1,840	0,862	1,961	1,099
3	23:54:01	1,235	1,709	2,597	3,226
4	23:54:16	2,439	0,433	1,840	2,703
5	23:54:21	3,614	0,862	3,614	1,639
6	23:54:26	2,439	1,288	3,030	2,174
7	23:54:31	3,030	1,709	4,762	3,226
8	23:54:36	1,235	2,954	2,439	2,174
9	23:54:41	4,192	2,128	4,762	3,743
10	23:54:46	2,439	3,361	4,192	1,099
11	23:54:51	4,762	1,709	3,030	0,552
12	23:54:56	4,192	0,862	1,840	3,226
13	23:55:01	2,186	2,542	2,439	2,062
14	23:55:06	4,762	3,766	4,762	2,174
15	23:55:11	3,030	1,288	2,439	1,099

3.4.4. Presentation of Pseudo-power measurement errors

The presentation of the R phase apparent power measurement error at 23:54:01 is as follows :

$$\% = |\frac{125{,}000\ \text{VA} - 129{,}903\ \text{VA}}{129{,}903\ \text{VA}} x100\%|$$

$$\% = 3{,}774\%$$

Table 8. Presentation of Pseudo-power measurement errors

No.	Time	Presentation of Pseudo-power measurement errors S (%)			
		Phase R	Phase S	Phase T	3 Phase
1	23:54:01	3,774	1,609	1,586	1,337
2	23:54:06	2,547	1,247	2,815	0,519
3	23:54:01	2,903	0,891	3,186	0,020
4	23:54:16	0,877	0,878	3,121	0,436
5	23:54:21	1,014	0,363	2,846	0,478
6	23:54:26	2,064	0,016	2,150	0,021
7	23:54:31	1,695	0,159	3,514	0,654
8	23:54:36	3,100	0,136	0,752	1,219
9	23:54:41	4,223	0,538	1,329	1,143

10	23:54:46	1,140	1,070	0,519	0,167
11	23:54:51	1,920	0,008	2,248	0,113
12	23:54:56	2,057	1,198	1,538	0,582
13	23:55:01	4,521	0,389	1,905	2,246
14	23:55:06	1,869	0,997	2,961	0,027
15	23:55:11	1,003	0,744	2,121	0,624

3.4.5. Active Power Measurement Error Presentation

The presentation of the error of the active power measurement of phase R at 23:54:01 is as follows :

$$\% = \left|\frac{20{,}700\ \text{Watt} - 21{,}044\ \text{Watt}}{21{,}044\ \text{Watt}} x100\%\right|$$

$$\% = 1{,}636\%$$

Table 9. Active Power Measurement Error Presentation

No.	Time	Active Power Measurement Error Presentation P (%)			
		Phase R	Phase S	Phase T	3 Phase
1	23:54:01	1,636	4,538	4,834	3,135
2	23:54:06	4,340	0,377	0,799	0,885
3	23:54:01	4,102	0,830	0,505	0,149
4	23:54:16	1,580	0,440	4,904	1,680
5	23:54:21	2,633	0,499	4,361	2,815
6	23:54:26	0,425	1,269	4,119	2,134
7	23:54:31	1,386	1,863	4,108	3,547
8	23:54:36	4,300	2,823	3,173	3,339
9	23:54:41	4,241	2,652	3,496	4,502
10	23:54:46	1,327	4,397	4,692	3,613
11	23:54:51	2,930	1,714	4,210	3,067
12	23:54:56	2,221	0,328	3,350	1,468
13	23:55:01	4,605	2,922	4,297	4,404
14	23:55:06	2,982	2,807	4,582	4,239
15	23:55:11	2,054	2,023	4,512	2,744

3.4.6. Reactive Power Measurement Error Presentation

The presentation of the error of the reactive power measurement of phase R at 23:54:01 is as follows :

$$\% = \left|\frac{119{,}990\ \text{VAR} - 124{,}187\ \text{VAR}}{124{,}187\ \text{VAR}} x100\%\right|$$

$$\% = 3{,}380\%$$

Table 10. Reactive Power Measurement Error Presentation

No.	Time	Reactive Power Measurement Error Presentation (%)			
		Phase R	Phase S	Phase T	3 Phase
1	23:54:01	3,380	0,713	1,263	1,492
2	23:54:06	2,500	1,299	2,864	0,566
3	23:54:01	2,873	0,993	4,431	0,028
4	23:54:16	0,944	0,899	3,075	0,395
5	23:54:21	1,116	0,415	2,751	0,400
6	23:54:26	2,131	0,092	2,071	0,053

7	23:54:31	1,779	0,059	3,385	0,552
8	23:54:36	3,071	0,308	0,689	1,135
9	23:54:41	4,118	0,411	1,468	1,022
10	23:54:46	1,206	0,878	0,403	0,034
11	23:54:51	2,058	0,093	2,163	0,008
12	23:54:56	2,176	1,250	1,485	0,653
13	23:55:01	4,455	0,245	1,836	2,161
14	23:55:06	2,005	1,219	2,826	0,132
15	23:55:11	1,088	0,675	2,062	0,550

From the results of the overload protection test with the three-phase induction motor load current indicator, it can be seen that when the motor is loaded until the current rises in phase ...., S phase, and T phase, it means that it exceeds the maximum current of the induction motor 0.401 Ammpere as the relay works to protect the induction motor.As for the calculation of the measurement error presentation, it can be seen that for the error presentation, the voltage measurement ranges from 0.001% to 0.088%, current 0.001% to 3.509%, power factor 0.433% to 4.438%, apparent power 0.020% to 3.774%, active power 0.149% to 4.904%, and reactive power 0.008% to 4.455%. From the testing of the tool that is made, the error presentation is below 5%, which means that the tool made by ani is working properly, the test will be continued for other large-scale.

4. CONCLUSION

From the results of the overload protection test with the three-phase induction motor load current indicator, it can be seen that when the motor is loaded until the current rises at the R phase of 1.23 A, the S phase 1.31 A, and the T phase 1.24 A, which means that the maximum current of the induction motor is exceeded by 0.401 A as the relay works to protect the induction motor. As for the calculation of the measurement error presentation, it can be seen that for the error presentation, the voltage measurement ranges from 0.001% to 0.088%, current 0.001% to 3.509%, power factor 0.433% to 4.438%, apparent power 0.020% to 3.774%, active power 0.149% to 4.904%, and reactive power 0.008% to 4.455%. The tool that is made works well because the protection runs well and the error presentation is below 5%.

REFERENCES

[1] Alipudin, M. A., & et. al. (2019). Rancang bangun alat monitoring biaya listrik terpakai berbasis internet of things (IOT). 1–11.

[2] Attubel, M., Siswanto, D., & Mukhsim, M. (2019). Sistem Monitoring Perawatan Kendaraan Berbasis Internet of Things (IOT). Ciastech 2019, Ciastech, 331–338.

[3] Ardiansyah et al., (2020). Sistem Monitoring Suhu Dan Kelembaban Lingkungan Berbasis Iot Dan Listrik Tenaga Surya. Widya Teknik, 18(2), 71–76.

[4] Rijanto and Leksono, (2020). Internet Of Things (Iot) Sistem Pengendalian Lampu Menggunakan Raspberry Pi Berbasis Mobile. Jurnal Ilmiah Ilmu Komputer, 4(2), 21–27.

[5] 5Ramly Rasyid, Mifta Muhammad, Rahmat R. Rasyid, (2022), Pengaturan Kecepatan Motor Induksi Tiga Fasa Menggunakan Spwm Inverter dan Kontrol Pid dengan Metode Hibrid Volt/Herzt Konstan-Sensor Arus, PROtek : Jurnal Ilmiah Teknik Elektro

[6] Ramly Rasyid, Mifta Muhammad, Rahmat R. Rasyid, (2023), Monitoring Sudut Fasa Menggunakan Mikrokontroler Berbasis Internet Of Things (Iot), Journal Of Science and Engineering

[7] Shinar, Joseph (Eds.), Organic Light-Emitting Devices: A Survey, NY: Springer-Verlag, 2004.

[8] Abid, G., Shaikh, S. A., Shaikh, M. F., Rajput, S. H., Majeed, U. A., & Shaikh, A. M. (2020, January). IOT based Smart Industrial panel for controlling Three-phase Induction motor. In *2020 3rd International Conference on Computing, Mathematics and Engineering Technologies (iCoMET)* (pp. 1-8). IEEE.

[9] Santhosh, R., Siddharthan, M. V., & Yadav, S. (2022, April). Protection and Control of 3 Phase Induction Motors in Industrial Plants with Smart Remote Monitoring and Control on a Centralized System. In *2022 6th International Conference on Trends in Electronics and Informatics (ICOEI)* (pp. 317-326). IEEE.

[10] Gowthaman, A., Hussaini, M. M., & Govindasamy, P. Controlling Three-Phase Induction Motor with an Internet of Things (IoT) Smart Industrial Panel.

[11] Takawale, A. J., & Nalawade, H. S. (2024). IoT Enhanced 3 Phase Induction Motor Control and Protection with PLC. *Indian Journal of Technical Education*, *47*(1), 317-323.

[12] See, A. K. B., & Ong, J. J. Y. (2023). Revolutionizing Motor Health: IoT-Driven Detection of Electrical Abnormalities

in Three-Phase AC Induction Motors. *Malaysian Journal of Science and Advanced Technology*, 280-293.

[13] Adhimanata, Y., Sulistiyowati, I., Wisaksono, A., Ayuni, S. D., & Nasar, M. (2025). Overload Monitoring and Warning System for 3-Phase Electric Motorcycle based on IoT. *Buletin Ilmiah Sarjana Teknik Elektro*, *7*(1), 30-41.

[14] Noyjeen, E., Tanita, C., Panthasarn, N., Chansri, P., & Pukkham, J. (2021, March). Monitoring parameters of three-phase induction motor using iot. In *2021 9th International Electrical Engineering Congress (iEECON)* (pp. 483-486). IEEE.

[15] Ioannides, M. G., Koukoutsis, E. B., Stamelos, A. P., Papazis, S. A., Stamataki, E. E., Papoutsidakis, A., ... & Stamatakis, M. E. (2023). Design and operation of Internet of Things-based monitoring control system for induction machines. *Energies*, *16*(7), 3049.

BIOGRAPHIES OF AUTHORS

Ramly Rasyid, is Lecture, Faculty of Engineering, Khairun University, Ternate - Indonesia. She can be contacted at email:
ramlyrasyid@unkhair.ac.id

Miftah Muhammad, is Lecture, Faculty of Engineering, Khairun University, Ternate - Indonesia. She can be contacted at email:
miftahmuhammadzZ@unkhair.ac.id

Mochammad Apriyadi Hadi Sirad, is Lecture, Faculty of Engineering, Khairun University, Ternate - Indonesia. Researching about being in Power System Analysis, Optimization, Distributed Energy Resources, and Renewable Energy. She can be contacted at email:
apriyadisirat@unkhair.ac.id