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Sri Hartanto <srihartanto@unkris.ac.id>

[MEV] Editor Decision

1 message

Dr Alexander Christantho Budiman <mev@mail.lipi.go.id> Thu, Dec 9, 2021 at 2:15 PM
To: Sri Hartanto <srihartanto@unkris.ac.id>

Dear Sri Hartanto:

We have reached a decision regarding your submission to Journal of Mechatronics, Electrical Power, and Vehicular Technology, "Plumbing Leakage Detection System With Water Level Detector Controlled by PLC CPM2A".

Our decision is : Revisions Required.

Kindly find the attached files and comments from reviewers below, as well as in your MEV submission page. Please make necessary amendments or provide rebuttals to each of the comments. We look forward to receiving your revised manuscript as soon as possible but preferably before 31 December 2021. Please do not hesitate to contact us if you need more time. Thank you.

Alexander Christantho Budiman, Ph.D.
Indonesian Institute of Sciences
alex002@lipi.go.id
MEV Section Editor

Reviewer A:

Suggestion/revision for author/s regarding ABSTRACT and KEYWORDS:
Rewrite abstract. Abstract should state briefly the purpose of the research, the principal results and major conclusions.

Suggestion/revision for author/s regarding INTRODUCTION:
No references are cited in the contents of the paper. Add the latest references related to the leakage detection system with water level detector and cite any references used in the contents of the paper. Explain the difference between this paper and the previous paper.

Suggestion/revision for author/s regarding CONTENT:
Make a complete circuit diagram of the electrode stick --> WLD --> selector/dip switch --> 8 channel relay

Suggestion/revision for authors regarding RESULT AND DISCUSSION:
- in the paper, the author uses 10 WLD, please explain the placement of the 10 WLD and if it is placed not far apart, please state the distance between the sensors

- To test the reliability of the system, it is necessary to do a test by testing each WLD sensor of the 10 WLD sensors used. For example, activate sensor no.9 whether it is read in the system as well as sensor no.9, and so on for other sensors. I don't see the author explaining this in the paper, if it hasn't been done, it would be better to do it to test the reliability of the designed system

Suggestion/revision for authors regarding CONCLUSION:
The conclusion can be filled with the results of the 10 WLD test that are

read and function properly according to the installation position on the plumbing system

Suggestion/revision for author/s regarding REFERENCES:
Add the latest references related to the leakage detection system with water level detector

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Reviewer B:

See the attached document.

Suggestion/revision for author/s regarding ABSTRACT and KEYWORDS:
The abstract should be improved. It only consists of five sentences. What kind of method is used and its pros or advantages. What kind of results are obtained. You can put a number that shows your best result.

Suggestion/revision for author/s regarding REFERENCES:
> I can not find citations of the references in this part. Please clarify and check again how to cite references in your manuscript.

OTHER Additional suggestion/revision for author/s:
Need to check the grammar/English proof.

Reviewer C:

See the attachment.
See the attachment.

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2 attachments

Reviewer B - 560.docx
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Reviewer C - 560.pdf
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Plumbing Leakage Detection System With Water Level Detector Controlled by PLC CPM2A

Abstract

There is a potential of leakage in the water distribution network, whether caused by water pressure in problematic pipes, improper installation of pipe connections or external influences such as earthquakes. To detect leakage, a system is made that places the detector on the shaft of water lines in the building or at the point where a potential of leakage occurs. Leakage point can be detected by a Water Level Detector (WLD) controlled by the PLC CPM2A. This research is focused on measuring and analyzing the stability of the power supply and measuring the performance of ~~the Water Level Detector (WLD)~~. From this research, it is desired that the plumbing leakage detection system work well when a plumbing leakage occurs.

Keywords: PLC; WLD; Leakage; HMI.

I. Introduction

With the development of high-rise buildings, many challenges arise. One of them is how to detect technical disturbances that can cause damage to building equipment, such as electrical disturbances that can damage other components, disturbances in plumbing installations that can cause leakage and cause serious damage to a system, and so on. Due to the many floors and equipment that must be considered, it is necessary to have a system that efficiently monitors and operates all equipment based on information from sensors.

To efficiently monitor and operate a clean water distribution system in a building, generally water from the water supply is transferred to the Raw Water Tank (RWT), then to the Clean Water Tank (CWT) and finally to the top floor (Roof Tank) with the lift pump system. The collected water is then distributed to the floors by a gravity system whose input pressure is 20 Bar and the output pressure is controlled by a Pressure Reducing Valve (PRV) system between 3 to 5 Bar on each floor of the building.

In this clean water distribution, the water line installation uses pipes of various sizes according to the water pressure used, such as

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cast iron pipes for the main installation (Main Line) and Poly Propylene Random (PPR) pipes for distribution installations. The emergence of potential leakage is generally caused by water pressure in problematic pipes, improper installation of pipe connections or external influences, such as earthquakes. Water leakage that are detected too late can cause damage to other systems through which water leakage pass, such as electrical panels, elevators, and so on.

In this research, a plumbing leakage detection system controlled by the PLC CPM2A and placed the detector on the building's water line shaft or at the point of potential leakage so that it could find out more specifically the point of leakage. This research is focused on measuring and analyzing the stability of the power supply and measuring the performance of the Water Level Detector (WLD) in the plumbing leakage detection system controlled by the PLC CPM2A.

II. Methodology

To design a plumbing leakage detection system through the following steps as shown in Figure 1.

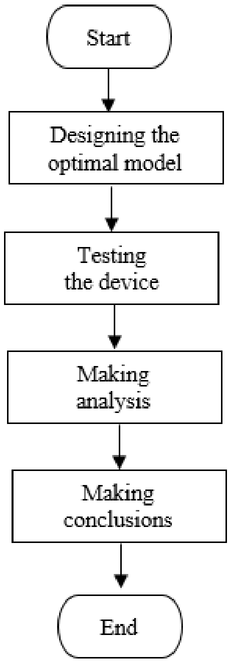

Figure 1. Flowchart of Research Methodology

1. Designing the optimal model form of the system to be made, which is distinguished by designing hardware, which includes making the design of the device to be made, determining the components and dimensions of the device to be made; and designing software, which includes making ladder diagrams on the CX Programmer which is then programmed to the PLC.
2. Testing the device, which is testing the hardware and software that has been made. Hardware testing includes testing the WLD function, supporting modules

and relays. Software testing includes the accuracy of data processing by PLC and an appearance on the HMI.

3. Making analysis, namely analyzing the tests carried out on the system with measurements of electronic circuits on The ~~Water Level Detector~~ and the power supply output.
4. Making conclusions, namely making conclusions from research data that has been analyzed.

A. Designing The Overall Model System

The design of the plumbing leakage detection system controlled by the PLC CPM2A can be seen in Figure 2 below.

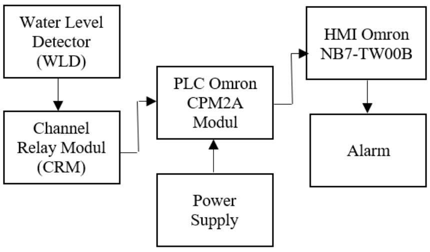

Figure 2. Block Diagram of System Design

In Figure 2, the designed system is divided into six parts, namely the input process using a ~~Water Level Detector (~~WLD) as a water level detector, which then activates the Channel Relay Module (CRM) as a direct bit information provider to the Omron CPM2A PLC. Further, the data processing is carried out by PLC Omron CPM2A. The results of data processing are displayed by graphical visualization by the Omron NB7-TW00B HMI, which includes the address of the detector bar and the detection status of the state whether normal or non-normal. The HMI communicates with the PLC as input for the alarm activate/deactivate commands. In addition, the power supply serves to supply power to the system via the Omron CPM2A PLC.

B. Designing The Water Level Detector

The ~~Water Level Detector (~~WLD) as shown in Figure 3 is made with electronic components including a single pole solid relay 12 VDC as a relay that will activate dry contact NO/NC, diode 1N4001/4002 as polarity reverse current protection in the relay coil, transistor BD441/D400 NPN as a function switching, resistors and capacitors. ~~The Water Level Detector~~ (WLD) will work when there is induction in positive and negative polarities. The voltage source used is 12 VDC.

Two copper rods will act as electrodes when immersed in water. The existence of a resistance value of the two copper rods causes the transistor to work to open the channel from the collector to the emitter and activate the 12V DC relay coil. The dry contact of the relay is used to provide logic 1 as a trigger for the 3B3D Module.

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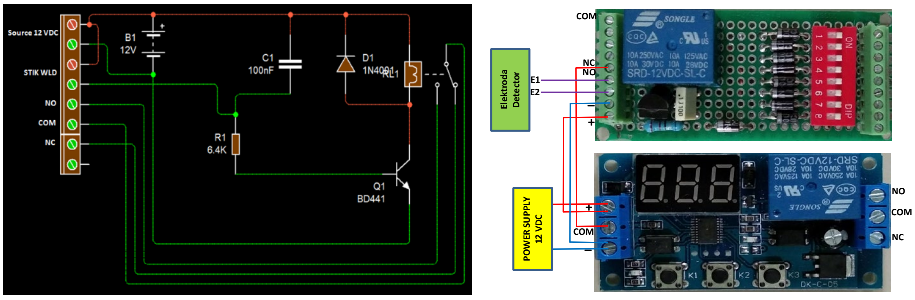

Figure 3. Water Level Detector

~~The Water Level Detector~~ (WLD) requires a standby voltage of 12 VDC which is connected to the (+) and (-) terminals, the voltage polarity must match. At terminals E1 and E2, a cable connection is installed to the electrode stick/copper rod as a water level detector. At the NO terminal when the system is working or the WLD detects water, the terminal will issue 12 VDC which will be used as a trigger and during normal standby the NO standby terminal is at 0 VDC. In this research the NC terminal was not used, but as an option if later development or other needs were carried out, the working principle of the NC terminal when standby this terminal issued a voltage of 12 VDC and when WLD worked this terminal was 0 VDC.

C. Designing The Channel Relay Modul (CRM)

~~The Channel Relay Modul (CRM) modul can be seen in Figure 4 below.~~

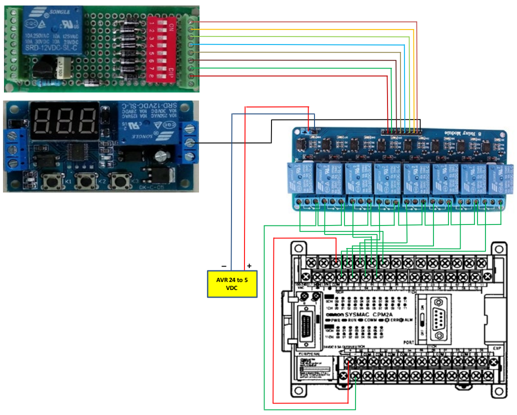

Figure 4. CRM Modul

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In the CRM module there is a 3B3D Module as a digital timer that can be set from 0–999 minutes and there are 4 timer options, namely delay off, delay on, delay on and off, and consistent delays on and off. In designing the plumbing leakage detection system, the 3B3D Module is used to adjust the pulse signal. The COM terminal is the trigger input to activate this module, which is positive (+) 12 VDC which is controlled by WLD. When the 3B3D Module functions, the ground data output through the NO terminal of the DIP Switch Module is connected to COM terminal on the DIP Switch Module.

~~The Channel Relay Modul (~~CRM) serves to provide a bit signal to the PLC. The active/deactivated relay is determined from the input received from the WLD. This module uses a voltage of 5V DC and is active when the ground is connected to the input connectors 1 to 8. The addressing table is shown in Table. 1 following:

Table 1. CRM Addressing

No	8 Channel Relay Modul		PLC CPM2A Address
	Relay	Logic	
1	1	1	0.00
		0	
2	2	1	0.01
		0	
3	3	1	0.02
		0	
4	4	1	0.03
		0	
5	5	1	0.04
		0	
6	6	1	0.05
		0	
7	7	1	0.06
		0	
8	8	1	0.07
		0	

D. Designing PLC CPM2A As Controller

PLC used in this system is PLC CPM2A 40 CDR-A. PLC OMRON CPM2A-40CDR-A has the following specifications:

1. Number of I/O 40
2. Number of inputs 24 (DC)
3. Number of outputs 16 (Relay)
4. Power: 100-240 VAC

The PLC requires a voltage source of 220 VAC, for the COM terminal and input it uses 24 VDC which comes from the PLC's internal voltage source. However, the output in this design uses an external voltage source of 24 VDC, this is done as a protective measure so that if there is a problem with the installed equipment, it does not damage the PLC.

The software used to create the Ladder Diagram is CX Programmer version 9.5 and the type of PLC selected when programming the CX Programmer is PLC Omron CPM2A. In the ladder diagram of the input detector section as shown in Figure 5, the bit information that enters both logics 0 and 1 at addresses 0.00 to 0.07 is a binary value that will be converted to hexadecimal with the BCD (24) instruction on Data Memory 0 (DM0). Then the incoming bits for addresses 0.00–0.07 can be ascertained apart from binary with a value of 0, a value above 1 then logic 1 will activate LR9.04 which is used as a relay bit to activate the T0003 timer, where this timer functions as a time lag whether the WLD is in the area is a true alarm or only a false alarm and is set at 20

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ms. If the T0003 time is reached then the binary data is considered valid and will be forwarded to the data comparison, T0003 will activate T0004 with a delay of 10 ms, T0004 serves to provide input for data reset by moving #0 to DM0 using the MOV instruction (21).

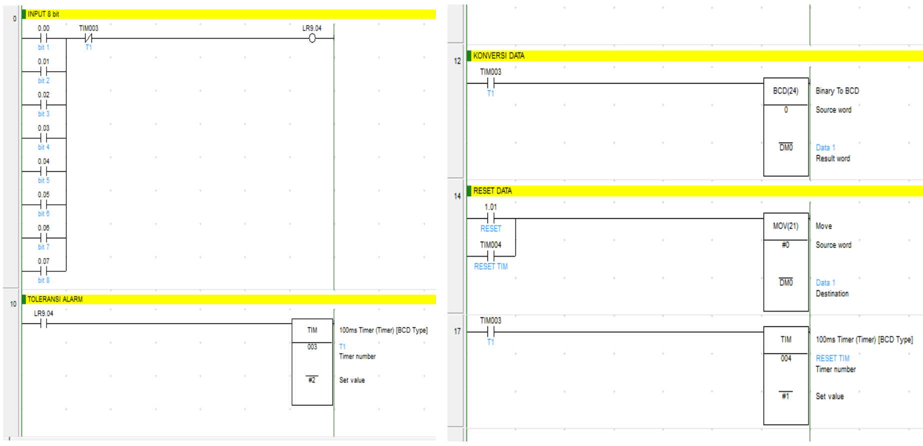

Figure 5. Ladder Diagram of Detector Input

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Ladder diagram created as initials of data representing decimal constant values into initials in the Data Memory (DM), the instructions used is the MOV instruction (21), the value used is #1-#255 then initialized to DM1-DM255 which also represents Detector 1-Detector 255. The P_On instruction is used because the command instructions in this initial data section must always be active or the always on the flag as shown in Figure 6 below.

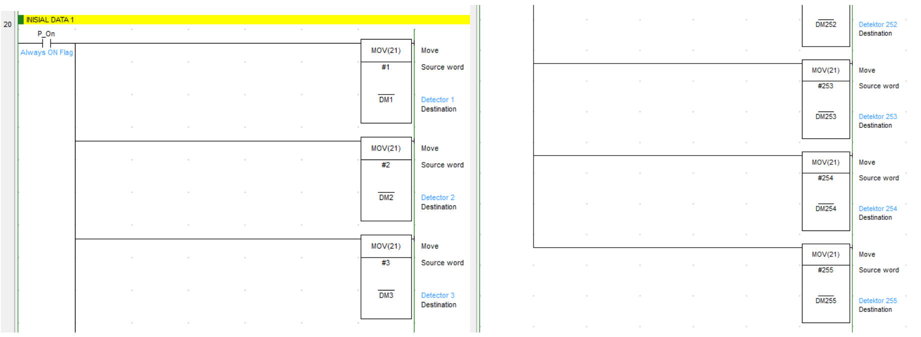

Figure 6. Ladder Diagram of Initial Data

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To activate the alarm there is only one option, namely when the LR9.04 alarm occurs. On the bell LR9.04 when a logic 1 will activate the 10.00 output, which is the bell output, LR9.02 is used to activate LR.9.03 which will activate T0001 i.e. the timer to pause the time the alarm is deactivated, If T0001 is active then the 10.00 outputs will be active again or the bell will ring. When the alarm is in progress and the bell is deactivated, if a new alarm is entered, the bell can be reactivated because LR9.04 is the main input. For strobe LR9.04 will activate output 10.01 which is the strobe output address on the PLC, output 10.01 will be off if input 1.01 is a logic reset address 1. During the alarm the strobe will remain active can be seen in Figure 7 below.

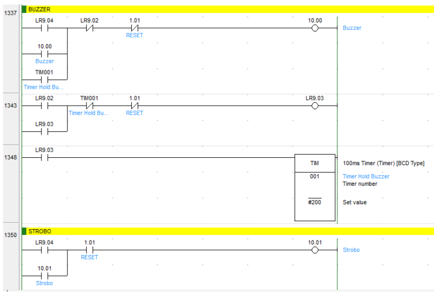

Figure 7. Ladder Diagram of Alarm

III. Results and Discussion

Testing the device is carried out to determine the performance of each component used. This test is expected to get good results where all components of ~~the~~ the plumbing leakage detection system work according to their functions.

When the start button (channel 1.00) is pressed on the main menu on the HMI screen, the system is completely disabled in monitoring status. When a puddle on one floor has crossed the water level limit of 30 mm, the detection rod connected to the water causes a resistance value in ~~the Water Level Detector (~~WLD) circuit which then puts the transistor in the saturation position. This causes the current from the collector of the transistor to flow to the emitter so that the relay coil gets a voltage of 12 VDC and the relay works. Furthermore, the NO terminal on ~~the Water Level Detector (~~WLD) gives an output of +12 VDC so that it triggers the Channel Relay Module (CRM). The design of this the plumbing leakage detection system uses 10 ~~Water Level Detectors (~~WLD) with addresses 1 to 10. Active relays on the Channel Relay Module (CRM) module will send bits to the PLC input group, namely addresses 0.00 to 0.07 (8 bits). The 8-bit signal from the sensor circuit to the PLC is initialized with DM0 ~~(Data Memory 0)~~ and will be compared with DM1 to DM 255 which is the initial decimal address 1 to 255. If DM0 is the same as data memory 1 to 255 then the alarm will be active on the screen monitoring the status of ~~Water Level Detector (~~WLD) with the output address used for alarm status is IR20.00 to IR35.14. The new alarm will still be displayed on the

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HMI screen, even though the alarm on the other ~~Water Level Detector (~~WLD) is still in alarm status. When the alarm is active, the PLC activates the bell output (10.00), strobe (10.01).

A. Power Supply Measurement

When a 220 VAC power supply which is the main power source is supplied to the system by activating a single phase MCB which supplies a 220 VAC voltage source to the power supply, the system works normally. By measuring three types of power supplies that have three types of power supplies, 12 VDC, 24 VDC and 5 VDC which makes the PLC ON and connected to the CRM. In the initial observations, all components after the 220 VAC power supply was provided could work well or normally. Measurement of the voltage issued by the power supply is carried out when the system is working (ON) and not working (OFF).

Table 2. Measurement Results of Power Supply Voltage Performance

No	Measurement	Vinput (Volt)	Voutput (Volt)		Function
			No load (OFF)	Under load (ON)	
1	Melan Well LRS-75-24	220	24.2	24	HMI dan AVR
2	Yamasaki	220	12.1	11.8	Modul 3B3D dan WLD
3	ETA-SEI SVM05SC24	24	5.2	5	8 channel relay modul

From the results of the power supply measurements in Table 2 above, it can be analyzed that the output voltage when there is a load (the system is working) decreases by 0.15 to 0.2 VDC when compared to the output voltage when there is no load (the system is not working). This decrease is still within the safe tolerance value as the supply voltage of the components. All power supplies work well because from the measurement results obtained no-load values of 24.2 VDC, 12.1 VDC, 5 VDC which indicate the output voltage according to the specifications of the power supply.

B. Water Level Detector Measurement

From Table 3 below, the results of the transistor work measurements can be analyzed.

Table 3. Measurement Results of Transistor Performance

No	WLD	Condition of E1 dan E2	Transistor	Vcc (Volt)	Ic (mA)	Ib (mA)	Description
1	1	connected	Q1	0.205	117.5	1.73	saturation
2		disconnected		12	0	0	cut off
3	2	connected	Q2	0.204	116.8	1.73	saturation
4		disconnected		12	0	0	cut off
5	3	connected	Q3	0.206	117.8	1.73	saturation
6		disconnected		12	0	0	cut off
7	4	connected	Q4	0.205	117.8	1.73	saturation
8		disconnected		12	0	0	cut off
9	5	connected	Q5	0.203	116.8	1.73	saturation
10		disconnected		12	0	0	cut off
11	6	connected	Q6	0.205	117.6	1.73	saturation
12		disconnected		12	0	0	cut off
13	7	connected	Q7	0.206	117.8	1.73	saturation
14		disconnected		12	0	0	cut off
15	8	connected	Q8	0.205	117.8	1.73	saturation
16		disconnected		12	0	0	cut off
17	9	connected	Q9	0.203	117.8	1.73	saturation
18		disconnected		12	0	0	cut off
19	10	connected	Q10	0.206	118.8	1.73	saturation
20		disconnected		12	0	0	cut off

When the electrodes (E1-E2) are connected by water, the transistor in the WLD module will work as a switch or transistor in saturation position. At saturation, the average collector current (Ic) is 1.73 mA and the base current (Ic) is 117.8 mA while the Vce voltage is 205 mV. In this

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position, the relay on the WLD will work because the relay coil gets a voltage of 12 VDC. When E1-E2 is disconnected or not connected, the transistor will be cutoff, i.e. the transistor acts as a switch in the open position. In the cutoff position, it can be seen that Vce has a value of 12 VDC and Ic 0 mA and Ib 0 mA. In this position, the relay in the WLD will be off because the relay coil does not get a voltage or 0 VDC. All transistors can work well because from the measurement results obtained values when saturation Vcc 0.203-207 VDC, Ic 116-118 mA, Ib 1.73 mA and when cut off Vcc 12 VDC, Ic 0 mA, Ib 0 mA which shows the transistor is working properly.

Table 4. Measurement Results of WLD Relay Function

No	WLD	Relay Status	Coil Voltage (Volt)	Output Contact (Volt)	
				NO	NC
1	1	ON	11.8	12	1.8
2		OFF	0	1.8	12
3	2	ON	11.8	12	1.8
4		OFF	0	1.8	12
5	3	ON	11.8	12	1.8
6		OFF	0	1.8	12
7	4	ON	11.8	12	1.8
8		OFF	0	1.8	12
9	5	ON	11.8	12	1.8
10		OFF	0	1.8	12
11	6	ON	11.8	12	1.8
12		OFF	0	1.8	12
13	7	ON	11.8	12	1.8
14		OFF	0	1.8	12
15	8	ON	11.8	12	1.8
16		OFF	0	1.8	12
17	9	ON	11.8	12	1.8
18		OFF	0	1.8	12
19	10	ON	11.8	12	1.8
20		OFF	0	1.8	12

From the measurement results of the WLD relay in Table 4, it can be analyzed that the relay coil measured 11.8 to 12 VDC. When the relay does not work, the measurement of the relay coil results in 0 VDC, the breakdown voltage at the NO terminal which should be in the open position is 1.8 VDC. Even though there is a leakage from the relay contacts of 1.8 VDC, it is still considered in a safe condition because to provide a trigger to the 3B3D Module a minimum of 12 VDC. When the relay is not working or off, the measurement at the NC terminal is 12 VDC. All relays on the WLD are functioning well because from the measurement results, the coil input value is 11.8 to 12 VDC and when the coil does not get a voltage input, the relay will turn off which indicates it is in accordance with the relay specifications.

IV. Conclusions

The main conclusions of the this research are:

1. All power supplies work well because from the measurement results obtained no-load values of 24.2 VDC, 12.1 VDC, 5 VDC which indicate the output voltage according to the specifications of the power supply.
2. All transistors can work well because from the measurement results obtained values when saturation Vcc 0.203-207 VDC, Ic 116-118 mA, Ib 1.73 mA and when cut off Vcc 12 VDC, Ic 0 mA, Ib 0 mA which shows the transistor is working properly.

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3. All relays on the WLD are functioning well because from the measurement results, the coil input value is 11.8 to 12 VDC and when the coil does not get a voltage input, the relay will turn off which indicates it is in accordance with the relay specifications.

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Add more new/current references.

Review #560

Title page

- Title cannot be abbreviated.
  Rewrite the Title: Plumbing Leakage Detection System With Water Level Detector Controlled by P... L... C... C...P...M...M...A... (PLC and CPLM2A should not be abbreviated)
- Corresponding author should provide email and telephone. **The author should add phone number.**

Abstract & Keywords

- Abstract should contain **brief introduction, research aim, methods, result/finding, and conclusion. The author should rewrite the abstract.**
- Keywords shouldn't be one word, write in two or more words for one keyword. **Rewrite the keywords become: P...L...C... (PLC); Water Level Detected (WLD); ...Leakage or Leakage (shouldn't be one word); H...M...I... (HMI).**

Instruments

- Figure should be readable. **Figures 3 to 7 are not clear. The author must enlarge the words contained in the picture so that it can be read clearly by the reader.**
- Figures should have a brief description in the main body of the manuscript.
- Please submit tables as editable text and not as images. **All tables in the manuscript are in images, change all table as editable text.**
- Table should have one header.

Conclusion

- **Rewrite the conclusion briefly, clearly and concisely in 1 paragraph.**

References

- **There are no citations in the body of the manuscript from the reference list. All references must have citation in the body of manuscript, whether in introduction, methodology, etc. The author must add citations from all reference lists. For example:**

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I. Introduction

Electric vehicles require traction motors having simple construction that makes them easy to maintenance and manufacture and have high efficiency, reasonable price, and high torque density in a wide speed range [1][2]. However, PMMs develop torque ripple stemming from, among others, the cogging torque and the non-sinusoidal electromotive force waveform (EMF) in the air gap. This torque ripple causes acoustic noise and vibration, which can reduce the performance of position control and speed control systems, especially at low speeds and high load torque [3][4][5]. Studies to eliminate or reducing cogging torque in PMMs were discussed by [6][7]. A sinusoidal EMF waveform can be obtained by arranging a sinusoidal winding distribution in the stator slots. Brushless ac electric motors generate lower electromagnetic torque ripple (about 2 to 8 %) than brushless dc electric motors (about 7 to 30 %) [8].

The improvement of motor performance presented by the torque-speed characteristic is mainly to get an extensive field weakening (FW) range with high torque, as is conducted by [9][10] through controlling the current. However, contradictive problems are usually faced when trying to fix one of the parameters. For example, the FW region can be extended by reducing the flux linkage, but this resulting in lower output torque. Also, output torque can be improved by increasing the saliency ratio (L_q/L_d), but it does not affect the width of the FW region [11].

- Primary references **(journal, proceeding, or thesis)** should be at least 80%.
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- References should be taken **80% from the late ten years**.
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