



# Power consumption analysis using deep sleep method on NodeMCU 8266 for power efficiency in IoT system

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## ABSTRACT

The Internet of Things has been implemented in various fields. The implementation of the Internet of Things is mostly carried out in remote areas that use batteries and solar panels as power sources. However, the efficiency of solar panels is still low while battery capacity is limited. For this reason, it is necessary to find a way so that an Internet of Things system only requires low power. One way is to use deep sleep mode on the microcontroller. This research was conducted by designing an IoT System for agriculture using the Nodemcu 8266 microcontroller. Furthermore, measurements of voltage, current and power consumption of the system were carried out using normal mode and deep sleep mode. Furthermore, a comparison was made between the measurement results between normal mode and deep sleep mode. Based on the measurement results, it is obtained that the voltage consumption of both normal mode and deep sleep mode results are the same, while the current consumption and power consumption of deep sleep mode are only 20% of the current consumption and power consumption of normal mode. This illustrates that deep sleep mode is more efficient in electrical power consumption, so it is very suitable for use for an IoT system implemented in remote areas.

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## 1. INTRODUCTION

The development of Internet of Things technology today is very rapid (Minh Dang et al., 2019)(Sivanraju, 2018)(Almalki et al., 2021). The Internet of things has become one of the supporting technologies for the development of Industry 4.0 (Belli et al., 2019) (Mastos et al., 2020). The Internet of Things is changing many things in the real world into smarter devices (Farooq et al., 2022). The Internet of Things has been applied in various fields such as industry, government, agriculture, education, and other fields (Belli et al., 2019)(Bagheri & Movahed, 2017)(Kumari et al., 2018). The application of the Internet of Things is mostly done in remote areas (Shafique et al., 2020) where the device requires a portable power source with a system that requires low electrical power (Dhananjaya &

Reddy, 2017)(Rana et al., 2021). These Internet of Things devices generally use batteries (Raj & Steingart, 2018) or solar panels (Wong & Chow, 2020) (Wong & Chow, 2020) considering their considerable availability and ease of implementation.

However, the efficiency of solar panels is still low (Maninder Singh et al., 2016), which is around 24.7% (Ali, 2020). For weather conditions In Indonesia itself the efficiency obtained is around 17.1% (Arfittariah & Wisyahyadi, 2022). The change in weather from light to dark either due to weather or the change of day to night makes the energy produced by solar panels relatively smaller than their size so that in some applications it becomes less effective (Zeadally et al., 2020).

The use of batteries also still has problems because they have limited capacity so the battery life is not long (Kim et al., 2018). Batteries periodically have to be replaced which makes them less effective and efficient (Ju & Zhang, 2018). The use of batteries that can be charged is constrained in addition to having to have a charging routine also related to environmental pollution problems due to the increasing number of devices that use electrical resources including for the charging process (Zeadally et al., 2012).

It is necessary to find a way so that an Internet of Things system only requires low power (Cerchecci et al., 2018). One way that can be applied is to use the mode on the microcontroller so that power usage in the Internet of Things system can be more efficient (Kaur & Sood, 2017)(Vo, 2018). Therefore, it is necessary and important to do this research so that an Internet of Things system that has high power usage efficiency can be produced. This study aims to conduct an analysis of electrical power efficiency using deep sleep mode on an Internet of Things system based on nodemcu 8266 microcontroller. The benefit of this research is that other researchers can use the deep sleep method to design a power-efficient NodeMCU-based IoT system.

## 2. RESEARCH METHOD

This research method uses literature studies, quantitative data analysis, and experimental observations by designing and assembling IoT systems for Agriculture. The system uses environmental temperature and humidity sensors, rain sensors, soil temperature and moisture sensors and soil pH sensors. The use of these sensors represents parameters for an IoT system for agriculture (zuchriadi et al., 2023). There are two sub-systems, the first is the sensor sub-system that will be placed in the remote area and the second is the receiving sub-system in the room. Both sub-systems use LoRa as a communication medium. The system design drawings can be seen in the figure 1.

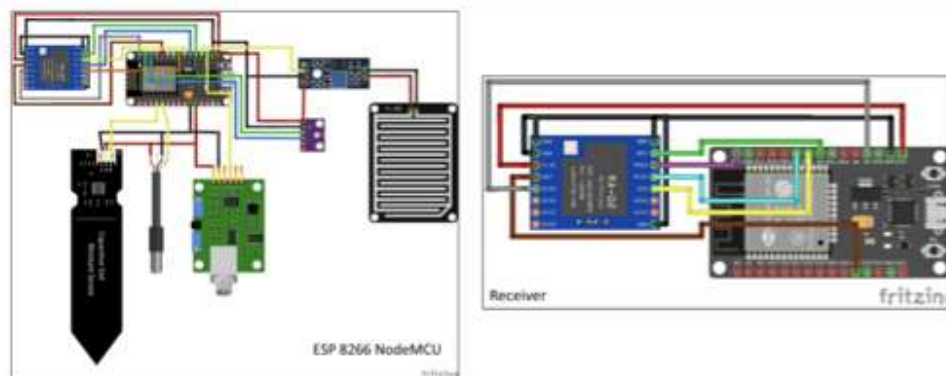


Figure 1. System Design

The research step can be seen in figure 2. The first process is to collect literature studies and literature reviews on problems related to the system, followed by designing

the system. Then the design is made and continued with system testing. If the test results are not appropriate, a design check will be carried out to improve the system. If the test goes as expected, the activity continues with data collection.

The data collected is current, voltage and power consumption data from the prototype in normal mode and continued with testing the current, voltage and power consumption of the prototype in deep sleep mode (Alexander et al., 2017)(Peerasak & Nuttapun, 2018). Then a comparative analysis of current, voltage and power consumption in normal mode with deep sleep mode was carried out. Based on the results of the analysis, conclusions will be made from this study.

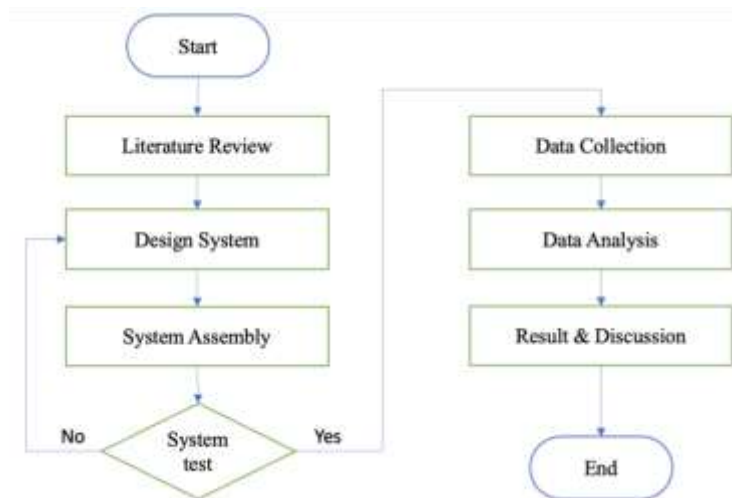


Figure 2. Research step

### 3. RESULTS AND DISCUSSIONS

The system that has been made is immediately tested with successful results. For this reason, it is continued with data collection through measurement. Measurements are made using two multimeters, one multimeter to measure current and one multimeter to measure voltage. Documentation of data retrieval can be seen in figure 3.

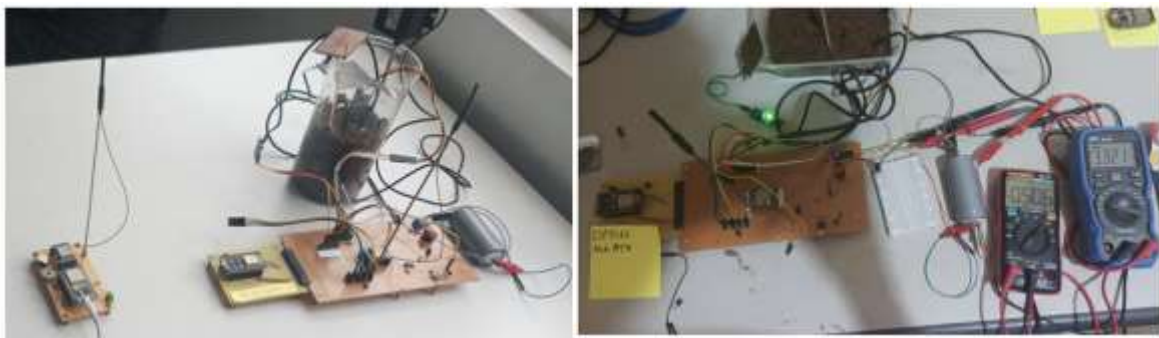


Figure 3. Documentation of data retrieval

Each measurement was taken at normal 5-second intervals and 295 seconds for deep sleep mode for a total of 300 seconds or 5 minutes for every single data capture. The trial was conducted 30 times so the total data collection time was 150 minutes. The measurement data can be seen in Table 1.

Table 1. Measurement data

No	Normal			Sleep		
	Current (mA)	Voltage(V)	Power (mW)	Current (mA)	Voltage(V)	Power (mW)
1	50,3	3,321	167,05	9,8	3,321	32,55
2	52,1	3,321	173,02	9,6	3,321	31,88
3	48,6	3,321	161,40	9,7	3,321	32,21
4	46,9	3,321	155,75	9,8	3,321	32,55
5	45,5	3,321	151,11	9,9	3,321	32,88
6	50,6	3,321	168,04	9,7	3,321	32,21
7	50,4	3,321	167,38	9,7	3,321	32,21
8	49,8	3,321	165,39	9,7	3,321	32,21
9	49,3	3,321	163,73	9,7	3,321	32,21
10	51,7	3,321	171,70	9,7	3,321	32,21
11	48,4	3,32	160,69	9,6	3,321	31,88
12	47,9	3,32	159,03	9,6	3,321	31,88
13	51,2	3,32	169,98	9,8	3,321	32,55
14	45,9	3,32	152,39	9,7	3,321	32,21
15	50,5	3,32	167,66	9,8	3,321	32,55
16	49	3,32	162,68	9,8	3,321	32,55
17	49,4	3,32	164,01	9,6	3,321	31,88
18	51	3,32	169,32	9,6	3,321	31,88
19	45,2	3,321	150,11	9,8	3,321	32,55
20	48,8	3,32	162,02	9,8	3,321	32,55
21	47,2	3,32	156,70	9,8	3,321	32,55
22	50,7	3,321	168,37	9,6	3,321	31,88
23	48,4	3,32	160,69	9,7	3,321	32,21
24	48	3,32	159,36	9,7	3,321	32,21
25	48,3	3,32	160,36	9,7	3,321	32,21
26	48,1	3,32	159,69	9,7	3,321	32,21
27	46,9	3,32	155,71	9,8	3,321	32,55
28	49,3	3,32	163,68	9,7	3,321	32,21
29	44,1	3,32	146,41	9,8	3,321	32,55
30	51	3,32	169,32	9,8	3,321	32,55

Based on the table above, the average value of normal mode for current consumption is 48.82 mA, voltage consumption is 3.320 Volt and power consumption is 162.09 mW. The average value of deep sleep mode for current consumption is 9.72 mA, voltage consumption is 3.321 Volt and power consumption is 32.29 mW. For details can be seen in picture 4, picture 5 and picture 6.



Figure 4. Voltage consumption comparison

From the voltage consumption comparison figure, the voltage consumption of deep sleep mode is relatively the same as the normal mode voltage consumption of 3.320 mA.



Figure 5. Current Consumption Comparison

From the current consumption comparison picture, the sleep mode current consumption is only 9.72 mA, much smaller than the normal mode current consumption of 48.82 mA. If calculated, it is obtained that the current consumption of the sleep mode is only 20% of the current consumption of the normal mode.



Figure 6. Power Consumption Comparison

From the power consumption comparison picture, the power consumption of deep sleep mode is only 32.29 mW, much smaller than the normal mode power consumption of 162.09 mW. If calculated, the power consumption of deep sleep mode is only 20% of the power consumption of normal mode.

#### 4. CONCLUSION

Based on the results of data collection and analysis, it can be seen the consumption of deep sleep mode current of 9.72 mA is only 20% of the normal mode current consumption of 48.82mA. The voltage consumption of normal mode and deep sleep mode is relatively the same, which is 3.320. The deep sleep mode power consumption of 32.29 mW is only 20% of the normal mode power consumption of 162.09 mW. The use of deep sleep mode on NodeMCU 8266 can reduce the current and electrical power consumption of an IoT system so this deep sleep mode is very suitable for use in IoT systems in remote areas. Deep sleep mode if applied to IoT systems based on NodeMCU 8266 will reduce power requirements by 20% from normal mode. This research only analyzed the power consumption of one microcontroller, namely nodeMCU 8266. For the development of this research in the future, it is recommended to compare the use of deep sleep for other microcontrollers, such as ESP32 or Wemos D1 mini so that it can be analyzed which microcontroller has the lowest power consumption. This research contributes to related

research where other researchers can use the deep sleep method in the design of a power-efficient NodeMCU-based IoT system.

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#### REFERENCES

- Alexander, M., Andrew, S., & Yuriy, V. (2017). Comparative Analysis and Practical Implementation of the ESP32 Microcontroller Module for the Internet of Things. *2017 Internet Technologies and Applications (ITA) : Proceedings of the Seventh International Conference* .
- Ali, H. M. (2020). Recent advancements in PV cooling and efficiency enhancement integrating phase change materials based systems – A comprehensive review. *Solar Energy*, *197*, 163–198. <https://doi.org/10.1016/j.solener.2019.11.075>
- Almalki, F. A., Alsamhi, S. H., Sahal, R., Hassan, J., Hawbani, A., Rajput, N. S., Saif, A., Morgan, J., & Breslin, J. (2021). Green IoT for Eco-Friendly and Sustainable Smart Cities: Future Directions and Opportunities. *Mobile Networks and Applications*. <https://doi.org/10.1007/s11036-021-01790-w>
- Arfittariah, & Wisyahyadi. (2022). Efisiensi dari Solar panel terhadap Efek Partial shading di Wilayah Karang Joang. *ELEMENTER*, *8*(1), 53–62.
- Bagheri, M., & Movahed, S. H. (2017). The Effect of the Internet of Things (IoT) on Education Business Model. *Proceedings - 12th International Conference on Signal Image Technology and Internet-Based Systems, SITIS 2016*, 435–441. <https://doi.org/10.1109/SITIS.2016.74>
- Belli, L., Davoli, L., Medioli, A., Marchini, P. L., & Ferrari, G. (2019). Toward Industry 4.0 With IoT: Optimizing Business Processes in an Evolving Manufacturing Factory. *Frontiers in ICT*, *6*. <https://doi.org/10.3389/fict.2019.00017>
- Cerchecci, M., Luti, F., Mecocci, A., Parrino, S., Peruzzi, G., & Pozzebon, A. (2018). A low power IoT sensor node architecture for waste management within smart cities context. *Sensors (Switzerland)*, *18*(4). <https://doi.org/10.3390/s18041282>
- Dhananjaya, M., & Reddy, M. (2017). A Survey of Energy Harvesting Sources for IoT Device. *International Journal of Advanced Engineering, Management and Science (IJAEMS)*, *3*(1). [www.ijaems.com](http://www.ijaems.com)
- Farooq, M. S., Sohail, O. O., Abid, A., & Rasheed, S. (2022). A Survey on the Role of IoT in Agriculture for the Implementation of Smart Livestock Environment. *IEEE Access*, *10*, 9483–9505. <https://doi.org/10.1109/ACCESS.2022.3142848>
- Ju, Q., & Zhang, Y. (2018). Predictive Power Management for Internet of Battery-Less Things. *IEEE Transactions on Power Electronics*, *33*(1), 299–312. <https://doi.org/10.1109/TPEL.2017.2664098>
- Kaur, N., & Sood, S. K. (2017). An Energy-Efficient Architecture for the Internet of Things (IoT). *IEEE Systems Journal*, *11*(2), 796–805. <https://doi.org/10.1109/JSYST.2015.2469676>
- Kim, Y., Shin, D., Lee, J., Lee, Y., & Yoo, H. J. (2018). A 0.55 v 1.1 mW artificial intelligence processor with on-chip PVT compensation for autonomous mobile robots. *IEEE Transactions on Circuits and Systems I: Regular Papers*, *65*(2), 567–580. <https://doi.org/10.1109/TCSI.2017.2727510>
- Kumari, S., Karupiah, M., Das, A. K., Li, X., Wu, F., & Kumar, N. (2018). A secure authentication scheme based on elliptic curve cryptography for IoT and cloud servers. *Journal of Supercomputing*, *74*(12), 6428–6453. <https://doi.org/10.1007/s11227-017-2048-0>
- Maninder Singh, Jaspreet Singh, Anshula Garg, Ekambir Sidhu, Vatanjeet Singh, & Aman Nag. (2016). Efficient Autonomous Solar Energy Harvesting System Utilizing Dynamic Offset Feed Mirrored Parabolic Dish Integrated Solar Panel. *2016 International Conference on Wireless Communications, Signal Processing and Networking (WiSPNET)*.
- Mastos, T. D., Nizamias, A., Vafeiadis, T., Alexopoulos, N., Ntinias, C., Gkortzis, D., Papadopoulos, A., Ioannidis, D., & Tzovaras, D. (2020). Industry 4.0 sustainable supply chains: An application of an IoT enabled scrap metal management solution. *Journal of Cleaner Production*, *269*. <https://doi.org/10.1016/j.jclepro.2020.122377>
- Minh Dang, L., Piran, M. J., Han, D., Min, K., & Moon, H. (2019). A survey on internet of things and cloud computing for healthcare. *Electronics (Switzerland)*, *8*(7). <https://doi.org/10.3390/electronics8070768>
- Peerasak, S., & Nuttapun, N. (2018). Smart Farm Monitoring via the Blynk IoT Platform - Case Study: Humidity Monitoring and Data Recording. *IEEE - Sixteenth International Conference on ICT and Knowledge Engineering* .
- Raj, A., & Steingart, D. (2018). Review—Power Sources for the Internet of Things. *Journal of The Electrochemical Society*, *165*(8), B3130–B3136. <https://doi.org/10.1149/2.0181808jes>

- Rana, B., Singh, Y., & Singh, P. K. (2021). A systematic survey on internet of things: Energy efficiency and interoperability perspective. *Transactions on Emerging Telecommunications Technologies*, 32(8). <https://doi.org/10.1002/ett.4166>
- Shafique, K., Khawaja, B. A., Sabir, F., Qazi, S., & Mustaqim, M. (2020). Internet of things (IoT) for next-generation smart systems: A review of current challenges, future trends and prospects for emerging 5G-IoT Scenarios. In *IEEE Access* (Vol. 8, pp. 23022–23040). Institute of Electrical and Electronics Engineers Inc. <https://doi.org/10.1109/ACCESS.2020.2970118>
- Sivanraju, K. (2018). IoT in Agriculture : Smart Farming. *International Journal of Scientific Research in Computer Science, Engineering and Information Technology*, 181–184. <https://doi.org/10.32628/cseit183856>
- Vo, H. M. (2018). Implementing Energy Saving Techniques for Sensor Nodes in IoT Applications. *EAI Endorsed Transactions on Industrial Networks and Intelligent Systems*, 5(17), 1–7. <https://doi.org/10.4108/eai.19-12-2018.156076>
- Wong, A., & Chow, Y. T. (2020). Solar-supplied satellite internet access point for the internet of things in remote areas. *Sensors (Switzerland)*, 20(5). <https://doi.org/10.3390/s20051409>
- Zeadally, S., Khan, S. U., & Chilamkurti, N. (2012). Energy-efficient networking: Past, present, and future. *Journal of Supercomputing*, 62(3), 1093–1118. <https://doi.org/10.1007/s11227-011-0632-2>
- Zeadally, S., Shaikh, F. K., Talpur, A., & Sheng, Q. Z. (2020). Design architectures for energy harvesting in the Internet of Things. In *Renewable and Sustainable Energy Reviews* (Vol. 128). Elsevier Ltd. <https://doi.org/10.1016/j.rser.2020.109901>
- zuchriadi, A., Rahayu, F., Anggraeni, S., Alif Razi, M., & Oktaviandri, M. (2023). Agricultural monitoring system using esp32 microcontroller with IOT-Based LORA transmission. *Jurnal Mantik*, 7(2), 2685–4236.