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Research Article

The Design and Development of Micro Grid Electrical Power Supply for Seismo Sensor with An Artificial Perceptron Neural Network

Jarun Khonrang[1]
Faculty of Industrial Technology, Chiangrai Rajabhat University, Thailand
jarun.kho@crru.ac.th

Kamol Boonlom[2]
School of Computer and Information Technology, Chiangrai Rajabhat University, Thailand
b-kamol@hotmail.com

Atikhom Siri[3]
School of Computer and Information Technology, Chiangrai Rajabhat University, Thailand
atikhom.sir@crru.ac.th

Jumrus Klinhnu[4]
School of Computer and Information Technology, Chiangrai Rajabhat University, Thailand
k_jumrus@hotmail.com

[2] Corresponding Author: Email: b-kamol@hotmail.com

Abstract

This research presented the application of the neural network theory in order to solve the problems of the electrical power supply system used in seismo sensor equipment with no continuity vibration and the system requiring the multiple power supply resources for the alternative power. Therefore, the designed system applied a perceptron mathematical model as a function to stimulate this system in making a decision to choose the micro grid power sources between solar power cells at 300 watts, 24 volts and the external power source at 720 watts, 24 volts. From testing its performance, it indicated that when the power supply source system did not use the artificial perception neural network, the system slowly responded to the decision - making time in an average time of 120 milliseconds while the ripple voltage was increased at peak to peak 0.5 volts. This could affect the power system to the seismo sensor which had no stability and continuity. However, it was applied to the system which was likely more effective and reliable due to having a decision-making from the data set, size 100. Moreover, the decrease of the delay time was over 0.8 which caused the ripple voltage at peak-to-peak 0.26 volt. As a result, it could conclude that the studies were able to help the electrical power supply system for a seismo sensor have more effectiveness and it could be adapted for the smart grid system in the future.

Keywords
Neural network theory, Perceptron, The micro grid, Power supplies, The smart grid

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Introduction

Nowadays, the problems of instability in electrical systems are used in measurement tasks that require precision and efficiency. But That is a significant issue that must be addressed and remedied. The smart grid principle has already been used to tackle the problem of power metering and to switch the power source to a system that isn't working (Atilla Donuk, Ihab El-Aff and Mumtaz Yilmaz, 2016: 1) (Wei-qing Tao and Xin-xi Yuan, 2012: 172). Later, it was enhanced to integrate with IT systems (Taein Hwang, et al.,2012: 89) and to add information processing for usage in the workplace. Moreover, the management of renewable energy sources began in 2013, Asian countries such as Singapore and Malaysia began to widely implement smart grid concepts (Akshay Deshpande, et al., 2015: 22) (Yanwen Luo, et al., 2014: 185). Also, It has played a role in the sector since the inception of smart grid work. such as automatic control systems and backup power systems (Mukesh Gujar, et al., 2013: 5) (Rui Huang, et al., 2014: 362). However, artificial intelligence, on the other hand, has begun to be integrated into smart grid systems in computer applications. The notion of neural network theory has been used to aid in the calculation and decision-making for the system in order to improve its efficiency (Devi Rani Guha and Sarat Kumar Patra, 2010: 356) (M. Hirahara and N. Oka, 1993: 2157) (Seok Bae Yun, et al., 2002: 2147). Therefore, As a result, it has been introduced as a solution to the aforementioned issues. Artificial intelligence aids in the selection of an external power supply for the seismo sensor in order to optimize performance and reduce system noise. As a result, the researcher has devised and implemented. This research presents the design and development of the electrical power supply system in order to apply to the seismo sensor station through the application of the artificial perceptron neural network. This network will make a decision in choosing two outside electrical power supply sources; solar energy and electrical system network from Electricity Generating Authority of Thailand. From this technique, can help the system have higher efficiency when comparing with general operating system. From the past electrical power supply system, it indicated that the system was quite simple and not complicated. However, many problems were found; when the main electrical power supply had lower voltage and the system had changed the electrical power supply reserved, the system worked too slow because of having no proper decision-making which caused the voltage value at the output with the low voltage at the beginning for a long time (Δd) resulting in the seismo sensor to start again during that time which made the measuring lack of continuity and had an effect on the seismo sensor equipment. Moreover, the output voltage of the system had an interrupting signal and the VRP size was high causing the system stability which would result in the damage of the equipment in long run.

As mentioned earlier, the team designed and created the electrical power supply system in order to be applied with the seismo sensor station in increasing the data procession through an artificial perceptron neural network. This network had an easiness and rapidity in decision-making leading to the system more quickly changing the power source than the old one which could reduce the voltage at the beginning time causing the Δd time shorter. Furthermore, it could prevent an error from the electrical power supply dropped for a while and also the designed system was added the circuit system of filtering the interrupting signal to maintain the output of the power supply source had continuity and reduced the interrupting signal occurring in the power supply system.

Research Methodology

The design and development of the electrical power supply system was used with the seismo sensor station by applying the process system through the artificial perceptron neural network, starting from several parts as shown in figure 1. The artificial perceptron neural network topology is depicted in figure 2 to describe the process from input to output.

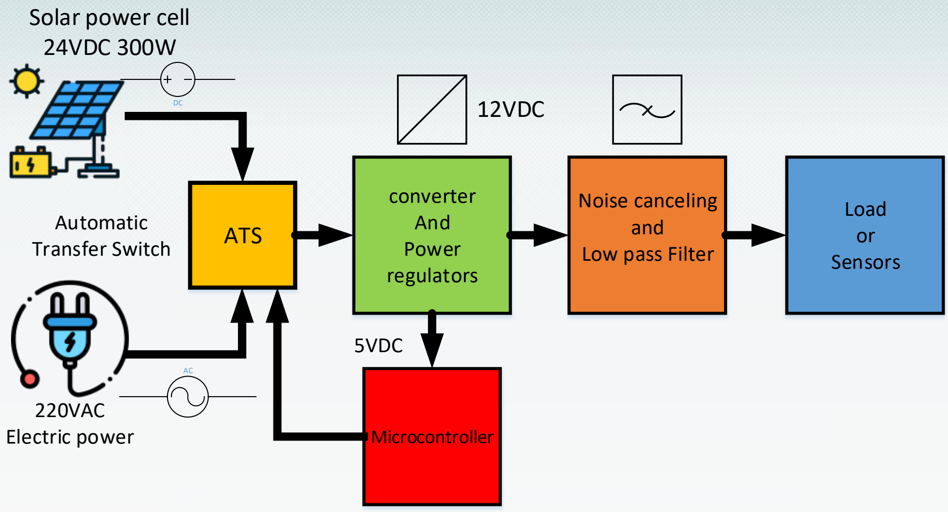

Figure 1 The diagram of the electrical power supply system for a micro grid seismo sensor by using the artificial perceptron neural network.

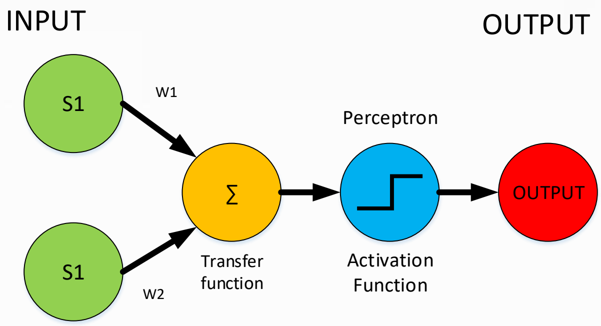

Figure 2 Illustrating the theory of the artificial perceptron neural network

The design of the artificial perceptron neural network

Table 1
Table determining the weight value

Input 1 (S1)	Input 2 (S2)	Input (Op)
1	2	1
2	2	0
3	0	1
0	1	0

Determine the weight value W1 and W2 as 0.3 as 0.7 respectively according to the bias value which values as 2 functions activated as

$$= \begin{cases} 1\ if \sum_{i=1}^{n} (s_i \times w_i) + b_1 = 0 \\ 0\ otherwise \end{cases}$$

From the model designed, n values as 2 Starting to calculate from input 1 and input 2 and determining the output from transmitted function as t_{out} from the equation below.

$$Op = (s_1 \times w_1) + (s_2 \times w_2) + b_1$$

When substituting for S_1 , S_2 , $W_{1,\ 2}$ and b_1 as the following result.

$$O_p = (1 \times 0.3) + (2 \times 0.7) + 2$$
$$O_p = (0.3) + (1.4) + 2$$
$$O_p = 3.7$$

Taking the value O_p into the activated function as shown below;

$$f(x) = \begin{cases} 1\ if\ (S_1 \times W_1) + (S_2 \times W_2) + b_1 > 0 \\ 0\ otherwise \end{cases}$$

$$f(x) = \begin{cases} 1\ if\ O_p > 0 \\ 0\ otherwise \end{cases}$$

$$f(x) = \begin{cases} 1\ if\ 3.7 > 0 \\ 0\ otherwise \end{cases}$$

$$f(x) = 1$$

By the expected output = 1 (From table) Thus, the error can be calculated as shown below.

Error = $Output_{desired}$ - $Output_{result}$

When substituting for $Output_{desired}$ from the table = 1 and $Output_{result}$ = 1 as the result below.

Error = 1-1
Error = 0

When bringing the error result to be calculated for Δweight result taken to adjust the weight value of each input by using Loss Function shown below.

Δweight = error X Input

At input S1, the result should be;

$\Delta weight_{S1}$ = 0 X 1
$\Delta weight_{S1}$ = 0

At input S2, the result should be;

$\Delta weight_{S2}$ = 0 X 2
$\Delta weight_{S2}$ = 0

Then taking the Δweight value to adjust the weight value of each input by using this equation.

$Weight_{NEW}$ = weight + Δweight

At input S1 as the result shown below.

$Weight_{NEWs1}$ = W_1 + $\Delta weight_{s1}$
$Weight_{NEWs1}$ = 0.3 + 0

$Weight_{NEWs1} = 0.3$

At input S1 as the result shown below.

$Weight_{NEWs2} = W_1 + \Delta weight_{S2}$
$Weight_{NEWs2} = 0.7 + 0$
$Weight_{NEWs2} = 0.7$

Thus, the result gained from W1 and W2 are 0.3 and 0.7 respectively. After adjusting each weight value, the input order No. 2 from the table is taken into learning process as a passing function below.

$$Op = (s_1 \times w_1) + (s_2 \times w_2) + b_1$$

$$Op = (2 \times 0.3) + (2 \times 0.7) + 2$$

$$Op = (0.6) + (1.4) + 2$$

$$Op = 4$$

After that taking Op value into the activated function as shown below.

$$f(x) = \begin{cases} 1\ if\ O_p > 0 \\ 0\ otherwise \end{cases}$$

$$f(x) = \begin{cases} 1\ if\ 4 > 0 \\ 0\ otherwise \end{cases}$$

$$f(x) = 1$$

When substituting for $Output_{desired}$ from the table = 1 and $Output_{result}$ = 1 as the result shown below.

Error = 0-1
Error = -1

And the Δweight value at input S1 as the result shown below.

$\Delta weight_{S1} = (-1) X 2$
$\Delta weight_{S1} = -2$

At input S2 as the result below.

$\Delta weight_{S2} = (-1) X 2$
$\Delta weight_{S2} = -2$

After that taking the Δweight value to adjust the weight value of each input by using the equation at input S_1 as the result shown below.

$Weight_{NEWs1} = W_1 + \Delta weight_{S1}$
$Weight_{NEWs1} = 0.3 + (-2)$
$Weight_{NEWs1} = (-1.7)$

At input S1 as the result shown below.

$Weight_{NEWs2} = W_1 + \Delta weight_{S2}$
$Weight_{NEWs2} = 0.7 + (-2)$
$Weight_{NEWs2} = (-1.3)$

Here are the new values of W1 and W2 converted into (-1.7) and (-1.3) respectively. In terms of input order No.3 from the table is taken into learning process as a passing function below.

$$O_p = (3 \times (-1.7)) + (0 \times (-1.3)) + 2$$
$$O_p = (-5.1) + (0) + 2$$
$$O_p = -3.1$$

After that taking Op value into the activated function as the result shown below.

$$f(x) = \begin{cases} 1\ if\ O_p > 0 \\ 0\ otherwise \end{cases}$$

$$f(x) = \begin{cases} 1\ if -3.1 > 0 \\ 0\ otherwise \end{cases}$$

$$f(x) = 0$$

When substituting for $Output_{desired}$ from the table = 1 and $Output_{result}$ = 0 as the result shown below.

Error = 1- 0
Error = 1

And the Δweight value at input S_1 as the result shown below.

$\Delta weight_{S1}$ = 1 X 3
$\Delta weight_{S1}$ = 3

At input S_2 as the result shown below.

$\Delta weight_{S2}$ = 1 X 0
$\Delta weight_{S2}$ = 0

After that taking the Δweight value to adjust the weight value of each input by using the equation at input S_1 as the result shown below.

$Weight_{NEWs1} = W_1 + \Delta weight_{S1}$
$Weight_{NEWs1}$ = (-1.7) + 3
$Weight_{NEWs1}$ = 1.3

At input S_1 as the result shown below.

$Weight_{NEWs2} = W_1 + \Delta weight_{S2}$
$Weight_{NEWs2}$ = (-1.3) + 0
$Weight_{NEWs2}$ = (-1.3)

Here are the new values of W_1 and W_2 converted into (-1.7) and (-1.3) respectively. In terms of input order No.4 from the table is taken into learning process as a passing function below.

$$O_p = (0 \times (-1.3)) + (1 \times (-1.3)) + 2$$
$$O_p = 0 + (-1.3) + 2$$
$$O_p = 1.8$$

After that taking O_p value into the activated function as the result shown below.

$$f(x) = \begin{cases} 1\ if\ O_p > 0 \\ 0\ otherwise \end{cases}$$

$$f(x) = \begin{cases} 1 \; if \; 1.8 > 0 \\ 0 \; otherwise \end{cases}$$

$$f(x) = 1$$

When substituting for $Output_{desired}$ from the table = 1 and $Output_{result}$ = 0 as the result shown below.

Error = 1- 0
Error = 1

And the Δweight value at input S_1 as the result shown below.

$\Delta weight_{S1}$ = (-1) X 0
$\Delta weight_{S1}$ = 0

At input S_2 as the result below

$\Delta weight_{S2}$ = (-1) X 1
$\Delta weight_{S2}$ = (-1)

After that taking the Δweight value to adjust the weight value of each input by using the equation at input S_1 as the result shown below.

$Weight_{NEWs1}$ = W_1 + $\Delta weight_{S1}$
$Weight_{NEWs1}$ = 1.3 + 0
$Weight_{NEWs1}$ = 1.3

At input S_1 as the result shown below.

$Weight_{NEWs2}$ = W_1 + $\Delta weight_{S2}$
$Weight_{NEWs2}$ = (-1.3) + (-1)
$Weight_{NEWs2}$ = (-2.3)

Here are the new values of W_1 and W_2 converted into (-1.7) and (-1.3) respectively. It is clearly seen that when taking the values of four input and output data sets to be applied in learning process which the actual correctness must have the value more than 0.8.

The design of the voltage regulator

In designing the voltage regulator, the feedback voltage regulator is mainly used as shown in figure 3.

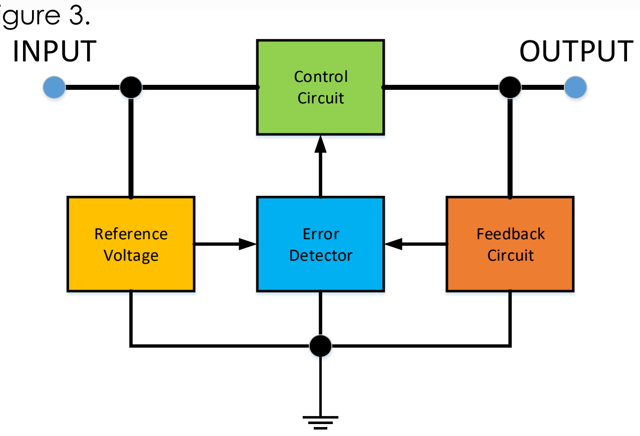

Figure 3 The block diagram of the voltage regulator

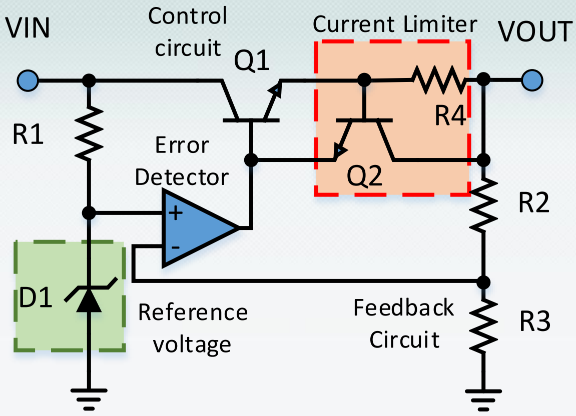

Figure 4 The simulated regulator of the voltage regulator designed

Choose the Zener voltage of which the referred voltage equals 6 volts that chooses the Zener diode No. 1N5233BTA which we can calculate the value of the voltage at the output from Figure 4.

$$V_{out} \cong \left(1 + \frac{R_2}{R_3}\right) \times V_{ref}$$

$$V_{out} \cong \left(1 + \frac{10k\Omega}{10k\Omega}\right) \times 6V = 12V$$

Design the highest electric current value controlling the voltage via calculating from choosing the current used which is limited not more than 3 Amperes. Thus, in choosing for working, the resistor, a R_4, will be calculated in order to limit the flow of the electric current of the control circuit as shown in the equation below.

$$R_4 = \frac{0.7V}{I_{Max}} = \frac{0.7V}{3} = 0.233\Omega$$

We choose the resistor which is widely used and has the value nearly 0.24Ω with the error value at 1 percent. This will increase the highest current for functioning at round 2.91 Amperes.

The design of the low pass filter circuit or LPF

In using the equipment, it consumes the current at moderate level causing the noise in the system which is not too high. Thus, the low pass filter circuit,1st order type, can filter the unwanted frequency and can help reduce using more equipment which can design and calculate as follows.
To calculate for the cutoff frequency value in the low pass filter circuit or LPF is very important because the measurement system of the sensor relies on the voltage and the current passing smoothly and regularly. In the design, the low noise signal will make the measurement system stable. In this research, the low pass filter circuit or LPF, RC filter type, is designed and applied as it is easy to design, the equipment used in welding or connecting is not complicated. Thus, the low pass filter circuit is used in this study as the equation below.

$$\omega_c = \frac{1}{RC} = 2\pi f c$$

ω_C stands for angle - cutting frequency, its counting unit as Radian/Second

f_C stands for the line- cutting frequency, its counting unit as Hertz (Hz)
R stands for the electrical resistance, its counting unit as Ohm (Ω)
C stands for the capacity of capacitor, its counting unit as Farad (F)
In the low pass filter circuit, we determine R = 3 Ω and C = 4,700 μF thus,

$$\omega_c = \frac{1}{3 \times 4{,}700 \times 10^{-6}} = 71\ rad/s$$

Thus $f_c = \frac{\omega_c}{2\pi} = \frac{71}{2 \times 3.14} = 11.3\ H_z$

Research Experimental Results

From measuring and testing results, When measuring the ripple voltage passing through the output circuit, it showed that the ripple voltage was at 0.26 volts peak to peak while the ripple voltage of the input circuit before filtering the signal was at 0.5 peak to peak which the reduction rate of the signal was around 3dB as shown in figure 4 by the current for working of the electrical power used for the seismo sensor was 18 Watts. It was clearly seen that the effectiveness of the designed circuit could be well applied to the seismo sensor the seismo sensor and had low interrupting signal as the result shown in figure 5.

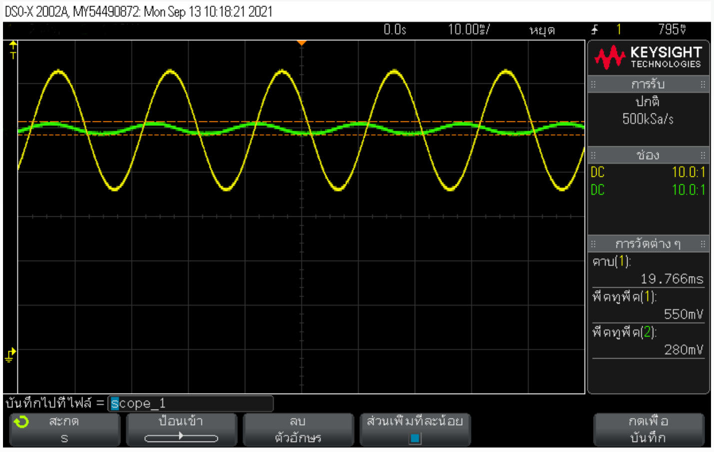

Figure 5 showed the ripple signal occurring in the ripple circuit and signal which occurring after passing the low pass filter circuit when the seismo sensor having the electrical power consumption rate at 18 Watts.

The result of time measurement in making a decision to choose the electrical power supply source responding was at an average range of time 60 millisecond before turning back to steady state when having the artificial neural network system.
Meanwhile the old system had the responding time at an average range of time 120 millisecond It indicted that the system when using the artificial neural network system, the system would make a decision in choosing the power source having the appropriate electrical power level, and resulted in making the system have good working efficiency and did not need to start a new system from figure 6. Moreover, the fabrications of the circuits have illustrated in figure 7.

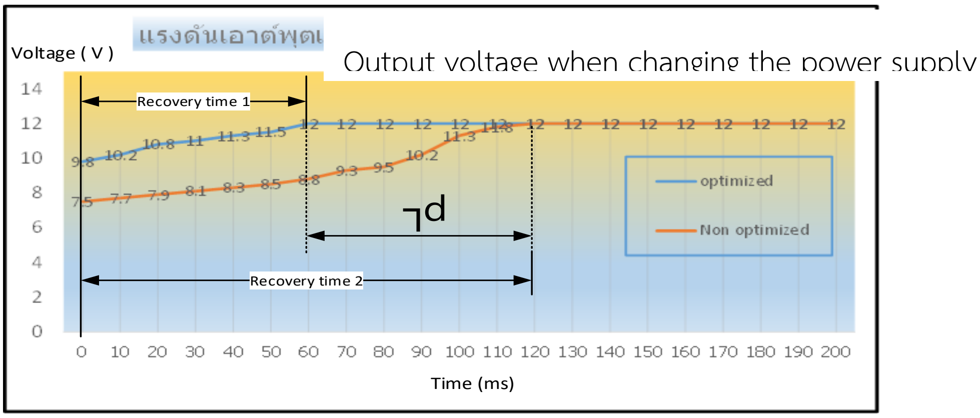

Figure 6 Show the graph of the signal voltage when the system chooses the power supply source between the old system without an artificial neural network and an artificial neural system.

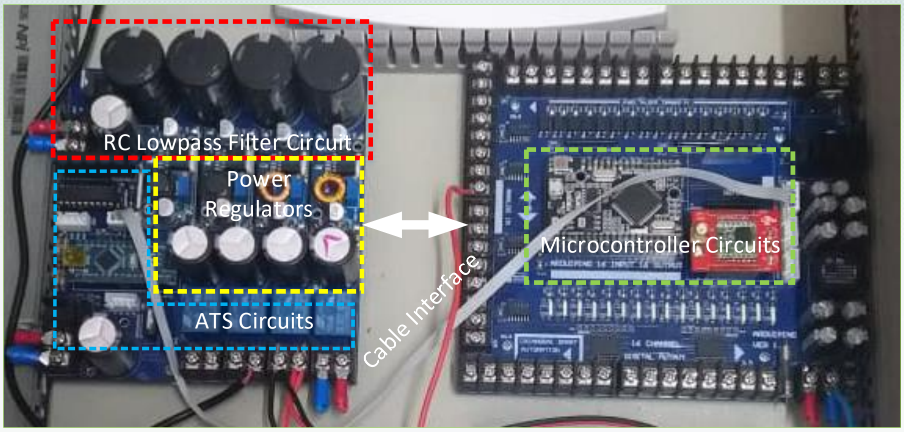

Figure 7 Show the electrical power supply system circuit for the micro grid electrical power supply for a seismo sensor with an artificial perceptron neural network

Conclusion

From the experimental result of the design and development the micro grid electrical power supply for a seismo sensor with an artificial perceptron neural network, it could conclude that when putting the artificial perceptron neural network into the system designed, it could help the system make a decision more quickly than the old one which has no artificial perceptron neural network. It was clearly seen that the output time value had low voltage at the beginning time (Δd) at 60 millisecond which made the system come back to the steady state more quickly when having the change of the power supply source. Moreover, when designing to add the low pass filter circuit system which caused the output voltage of the system having noise (Vrp) or the ripple voltage had the amplitude decreased from the output voltage without filtering frequency t 0.5 volt peak to peak until the ripple voltage at 0.26 volt peak to peak which had the signal-decreased value at around 3 decibels (3dBc). Thus, this research can conclude that the micro grid electrical power supply for a seismo sensor with an artificial perceptron neural network can increase the effectiveness and the stability of the electrical power supply circuit and on be Applied to the electrical power supply circuit for other works in the future.

Discussion Of Results

According to past researches, artificial intelligence systems have been employed in the past to assist in the decision-making of the power supply to be utilized with most of the power systems that are distinct from the system, according to a previous study. Low-power DC applications, such as those found in sensors and other devices. This necessitates a low-noise signal level and switches sensitivity to terminate the power source. As a result of the system that the researcher developed and designed, the system's efficiency in reducing noise and the switch's delay time in selecting the power supply could be increased, resulting in the system's high efficiency and stability. It's also suitable for sensor devices that require low noise.

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