BirEx JOURNAL
Budapest International Research in Exact Sciences
Medical, Biological, Argiculture, Engineering
Science and other related areas
e-ISSN : 2655-7827
p-ISSN : 2655-7835
http://www.bircu-journal.com/index.php/birex

The Design of Energy Storage Circuits for Efficient Use of Electric Power on Computer Devices

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Abstract: *The use of electricity with large capacity sometimes faces problems. These problems include a decrease in voltage that occurs in the channel. With the improvement of the quality of electric power on computer equipment at the Faculty of Engineering, University of Muhammadiyah, North Sumatra, it is expected to be able to improve the quality of electrical power. This improvement is expected to reduce the cost of electricity usage in the Faculty of Engineering, Muhammadiyah North Sumatra. To carry out improvements in the quality of electrical power, it is necessary to calculate the active power and apparent power. After doing these calculations, the determination of the capacitor value will be used. By carrying out these stages it is expected that the installation of Energy storage devices can improve the quality of electrical power. And by using energy storage devices will be clearly seen before and after the use of energy storage devices with the value of efficiency before and after namely: 87% (active power) and 91% (apparent power).*
Keywords: *current; active power; apparent power; power tech energy saver*

I. Introduction

The use of electricity with large capacity sometimes faces various kinds of problems. These problems include a decrease in voltage that occurs in the channel bill. Recent technological developments are experiencing rapid progress marked by the presence of electronic equipment or commonly referred to as electrical loads. The use of electricity loads is indeed far more complex compared to the use of electricity loads in the past. The use of electricity loads is widely used both in households, office buildings, and in industry so as to affect and cause a decrease in the supply system and power quality. (Erviana, M, & Handoko, S., 2012)

1.1 Capacitors

The ability of a capacitor to store an electric charge is called capacitance of a capacitor, with the symbol C. The unit of capacitance is farad whose symbol is F One farad is defined as the amount of electric charge that can be stored (in coulombs) / one volt voltage (FI Pasaribu., 2017):

$$C = \frac{Q}{V} \quad (1)$$

Wherein: C = Capacitance
Q = Cargo
V = Voltage

1.2 Working Principle of Capacitors

Where a capacitor is closely related to the ability to store an electric charge that is useful in controlling an electric current. On one hand, capacitors are like batteries. Although capacitors and batteries work in completely different ways, the process of working capacitors is that if two objects are charged and different signs are separated by a dielectric object, there will be capacitance between the two objects. (Rinaldo, 2013), (Hidayat, R, 2015), (FI

Pasaribu, 2020).

1.3 Power

Power is the energy expended to do business in the electric power system, power is the amount of energy used to do work or business Electric power is usually expressed in units of Watt (Muhammad Adam, 2014).

The amount of real power is proportional to the square of the electric current flowing at the resistive load and expressed in units of Watt (Rinaldo, 2013).

$$P=V \times I \times \cos\varphi \quad (2)$$

Where: P = Power (*Watt*)
V = Voltage (*Volt)*
I = Current (*Ampere*)
Cos φ = Power factor

1.4 Power Factor

The power factor denoted cos cos is defined as the ratio between the current that can produce work in a circuit to the total current that enters the circuit or can be said to be the ratio of active power (KW) and apparent power (VA). (Teguh, Prayudi, W, 2006), (Fahri raumta sebayang, 2013), (Ir.H.Muhammad amir, M.Eng, 2017)

$$\text{Cos } \rho = \frac{P}{S} \quad (3)$$

1.5 Efficiency

Efficiency is an effort made with the aim of reducing the amount of energy needed to use an equipment or even an energy-related system, (Syamsudin Noor, W 2012), (Sulistyo, E., Garniwa, I. 2018), the efficiency formula is as following:

$$\eta\ \% \quad \begin{matrix}\text{After} \\ : \\ \text{Before}\end{matrix} \frac{\text{sesudah}}{\text{belum}} \times 100\ \% \quad (4)$$

1.6 Energy Storage Devices

Energy Storage is an electricity-saving electronic equipment that has a function as a Capacitor Bank. (Nowolo, A & Kusmantoro, A, 2000), (Muhammad Fahmi Hakim, 2014). Energy Storage Equipment does not change the voltage in the electricity network, but rather functions as a capacitor that stores pseudo power that is not used, but will release it when there is equipment that needs So that it can extend the life of electrical equipment, because it can divide the current as needed and prevent excess current from entering into equipment. (Muhammad Chanif et al, 2014), (S.Bandri, 2015)

Energy storage devices do not reduce network capacity but reduce amperage in active loads, especially during initial pull, so that maximum power consumption.

Benefits of Energy Storage Devices:

1. Save electricity usage by 10-30%
2. Extend the life of electrical equipment
3. Increase the efficiency of the installed power
4. Making an automatic skring / MCB is not easy turning.

Figure 1. *Energy Storage Equipment*

1.7 Components of Energy Storage Equipment

a. Switch

The switch is used to control the flow of current into the circuit. Current flows when the switch contacts touch each other.

Figure 2. *Press Switch on Energy Storage Devices*

b. Fuses

Fuses are used to protect the device and humans from hazards caused by electrical damage

Figure 3. *Energy Storage Fuse*

c. Digital Volt Meter

For simple use a measuring device has been produced which can be used for measuring volts, at various measuring limits, using a rotary coil, which is placed in a box.

Figure 4. *Volt Meter in Energy Storage Devices*

d. Capacitors

The meaning of capacitance or capacity is the ability to store, in this case storing an electric charge. The tool or object is called a capacitor. Capacitors are often called condensers or codensors. Capacitors also include harmonic filters for nonlinear loads combined with a resistor known as an RC filter and combined with an inductor, the LC fiter. (Erviana, M, & Handoko, S., 2012), (FI Pasaribu, 2020)

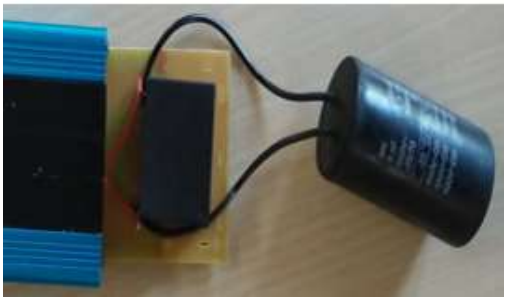

Figure 5. *Capacitors in Energy Storage Devices*

II. Research Methods

The research methodology is carried out through several stages as follows:

1. Determine the theme of the problem to be investigated by conducting a literature study in order to obtain various theories and concepts that will support the research to be carried out.
2. Finding data from testing before use and after using Energy Storage Devices on computer devices so that the data needed for processing is obtained.

2.1 Installation Before and After Using Energy Storage Devices

Analyzing the results of PM-15 power meter measurements before and after the use of Energy Storage Devices to get the desired efficiency values, here are the circuit installations before and after the use of Energy Storage Devices (FI Pasaribu, 2020).

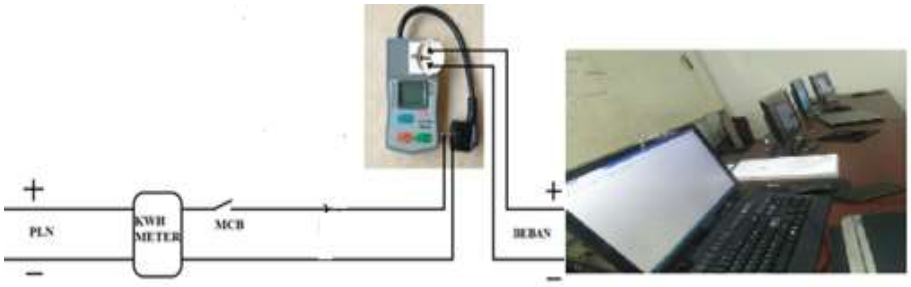

Figure 6. *Series before Using Energy Storage Devices*

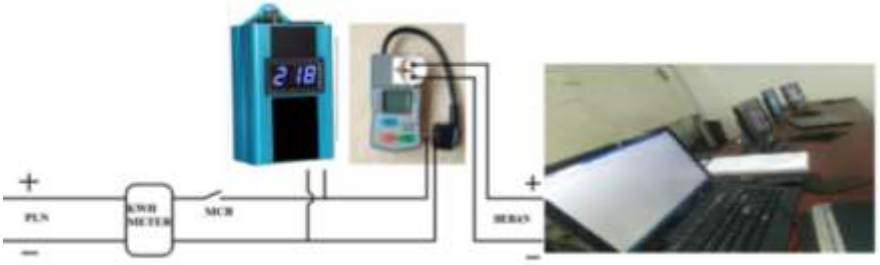

Figure 7. *The circuit after the use of energy storage devices.*

Information:
PLN = As a source of electrical energy.
Energy Storage Equipment = As equipment to be examined.
Power meter PM-15 = As a measurement tool in research.
Computer = As a burden in research.

III. Result and Discussion

3.1 Research Load Data

Knowing the total power of computer equipment used in computer labs is very important, especially if we want to install an energy saving system (FI Pasaribu, 2020). From the table of computer equipment used is not absolutely valuable as indicated on the table, the authors want to tell the results of research conducted from observations carried out that the study of data collection in the field can be concluded that differences will occur before and after the use of Energy Storage Equipment.

Table 1. Data on Reduction Results before Using Energy Storage Equipment

Trial Time	Power meter
Monday 08 -06- 2020 11.00 WIB	

Table 2. Data Measurement Results after Use of Energy Storage Equipment.

Trial Time	Power Meter
Monday 08-06- 2020 14:00 WIB	

3.2 Calculations Before and After Using Energy Storage Devices

a. Active Power (Before)

Note: V = 220.9 Volts
I = 1.11 Amperes
Cos φ = 0.805

Asked: P .....?
P = V x I xCos φ
= 220.9 x1.11x 0.805
= 197.38 Watt

b. Active Power (After)
Note: V = 227.1 Volts
I = 0.99 Ampere
Cos φ = 0.772
Asked: P .....?
P = V x I x Cos φ
= 227.1 x 0.99 x 0.772
= 173.56 Watt

3.3 Quasi Power Calculation Before and After

a. Pseudo Power (Before)
Note: V = 220.9 Volts
I = 1.11 Amperes
Asked: S .....?
S = V. I
= 220.9 x 1.11
= 245.19 VA

b. Pseudo Power (After)
Note: V = 227.1 Volts
I = 0.99 Ampere
Asked: S .....?
S = V. I
= 227.1 x 0.99
= 224.82 VA

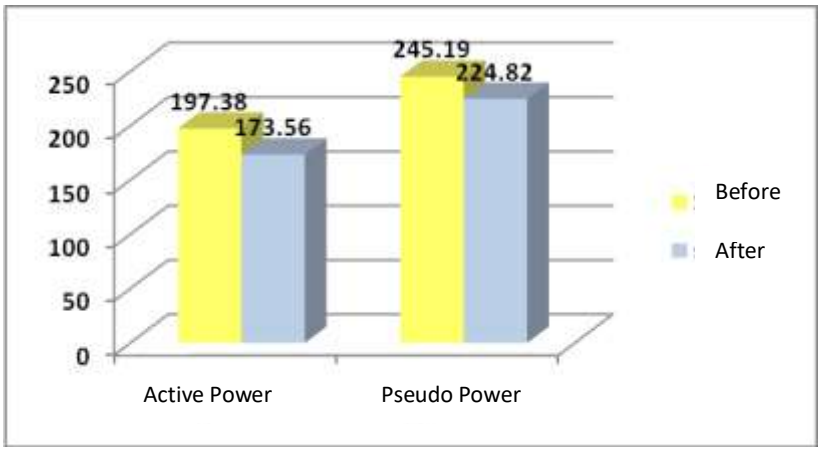

Figure 8. *Comparison Graph of Power Consumption before and after Using an Energy Storage Device*

3.4 Efficient Power Use, and False

a. Active Power Efficiency

Tested: P after: 173.56

P before: 197.38

Asked: Efficiency ……?

$$\eta\%: \frac{(P\ after)}{(P\ before)} \times 100\%$$

: 173.56 / 197.38 x 100%

: 0.87 x 100%

: 87%

b. Pseudo Power Efficiency

Determined: S after: 224.82

S before: 245.19

Asked: Efficiency ……?

$$\eta\%: \frac{(S\ after\ )}{(S\ before)} \times 100\%$$

: 224.82 / 245.19 x 100%

: 0.91 x 100%

: 91%

IV. Conclusion

From the research conducted on computer equipment used as test material in the study, the following conclusions are obtained:

1. The use of energy storage devices can reduce electrical power in computer equipment in the general engineering faculty of computer labs with the results of the decrease before and after, namely: 197.38 (before) and 173.56 (after).
2. By using Energy Storage Devices, the efficiency that can be seen is 87% (active power) and 91% (apparent power).

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