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AN ANALYSIS OF THE BENEFICIAL OF ENERGY SAVING DEVICE

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ABSTRACT

This paper discusses about the energy saving device product which claim that it can reduce the electrical consumption in domestic building when connected to any point of power line bus or improve the energy conversion of electrical appliances. In 2014, electricity saver product had claimed losses amounting to USD 1 million in Malaysia alone. Power factor correction is proven to reduce electricity consumption in commercial and industrial building but do it applies to the domestic building as well? To prove or disprove this case, an energy saving device is constructed and tested in real situation. Multiple appliances are connected with and without the energy saving device. The result shows an insignificant amount of losses being reduced by the device and in some cases further increase the power consumption due to LED's indicator that continuously switched ON once it is connected. The result of this study provides the awareness to the consumer to be more critical and stop supporting a non-beneficial product that is theoretically and practically faulty.

Keywords: energy efficiency, capacitor system, power factor correction.

1. INTRODUCTION

Power plant requires fossil resource such as petroleum and coal to generate electricity. When this resource beginning to deplete, the oil price is sky rocketing so did the electrical taarif. This situation prompt the household consumer to find a solution to reduce their electrical billing. Multiple researches were carried out regarding the method of reducing the losses incurred in electrical appliances. Equation 1 is the fundamental equation of how electrical energy is converted to useful energy when it is connected to any electrical machine or product.

$$P_{in} = P_{out} + P_{loss} \quad (1)$$

$$\eta = \frac{Pin}{Pout} \quad (2)$$

An electrical machine or product that uses electricity as its source of power are all an energy converter. The ability of the product to convert all the electrical energy into useful energy is calculated as efficiency shown in equation 2. As the energy conversion technology progress, the efficiency of the energy converter also increase but it can never reach the value of 1.

Electricity provider are charging domestic and commercial consumer in different ways. For domestic consumer, we will charge us based on the real power we consumed. The real power is always composed of voltage, current and power factor not voltage and current only. If the current is high with a constant voltage, the real power will be the same since the power factor is low. If the current is low, then the power factor may be high. For industrial consumer, a penalty will be charged if the system power factor is lower than what is set by the electricity provider. This is because due to its large power drawn from power network, low power factor may cause large line losss.

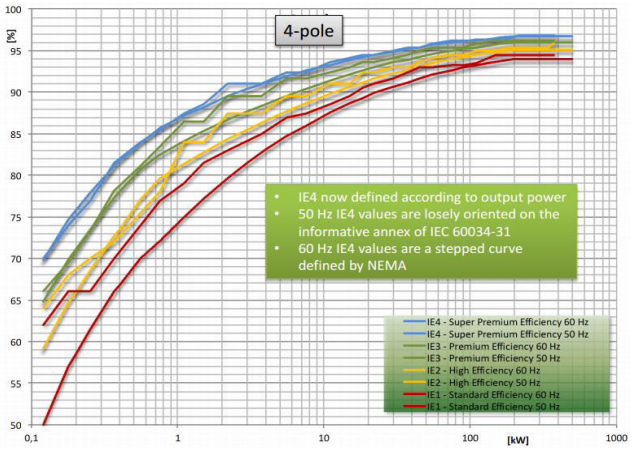


Figure-1. Motor efficiency versus output power.

Figure-1 shows the efficiency versus the output power of a 4 pole motor for various efficiency grade [1]. The maximum efficiency approved by the international standard to date is 96% and according to the graph, the efficiency may not have much room left to grow. If there is ESD claimed to save energy really exist, theoretically the saving is very minimal and will not exceed 4%.

The discussion about ESD has begun over two decades ago during the first energy price crisis in 1970s in the United States. The product becomes more popular as the consumer start sharing their positive review and testimony after using it. There were negative reviews and critics mostly coming from the engineering society unfortunately the theme of saving money through utility bills is favorable compared to product functionality and reliability aspects. Only in late 2009, National Institute of Standards and Technology (NIST) published a technical note that warned the consumer about power factor correction device would not result in reducing the energy bill [2]. As a result the marketing of ESD product subsided

and the consumer started to become critical when dealing with the ESD seller.

Nevertheless ESD product is still produced and sold online. It may not getting the hype in the United States but for developing countries, it is just the beginning. When one brand of ESD is debunked, another brand is born. The products looks different but unfortunately the internal circuitry is 90% similar. There were even people who bought ESD online and replicate the same device to make fast cash. This situation opens up a new problem where nobody can differentiate which is the original ESD or which one is copied. The ESD itself is waste of money but the copied product can be worse as it doesn't follow the safety standard of electrical product. Adding a capacitor in an electrical network that does not automatically switched off when no other load is connected could bring the line voltage to dangerous value.

2. EXPERIMENTING ON ENERGY SAVING DEVICE

There are two patents in the past 3 years registered under United States Patent and Trademark Office (USPTO) about the ESD circuit configuration [4]. The circuit layout of the patented ESD however is not similar to the ESD in the market which come by name Electricity-Saving Box (ESB). The ESB that is aggressively advertised and sold is made user-friendly, where the user simply need to plug it to any power outlet within the network unlike the patented ESD where the device has to be installed between the load and the power supply. Figure-3 shows the ESD location within an electrical network. The ESB itself is not identical. There were at least two different circuit configuration with the same casing shape design and packaging. Both claim to adapt latest Germany technology but come with no manufacturer name or address. The ESB circuit layout is redrawn in Figure-4. This device were put into test for 3 different load. Besides that, an actual characterization results on refrigerator power consumption were performed to see the behavior of the power consumption with respect to the change in power factor. Power factor correction is the term given to a technology that has been used since the turn of the 20th century to restore the power factor to as close to unity as is economically viable. This is normally achieved by the addition of capacitors to the electrical network which compensate for the reactive power demand of the inductive load and thus reduce the burden on the supply. There should be no effect on the operation of the equipment [3].

Figure-2. Simulation panel made to show how ESD could reduce the current.

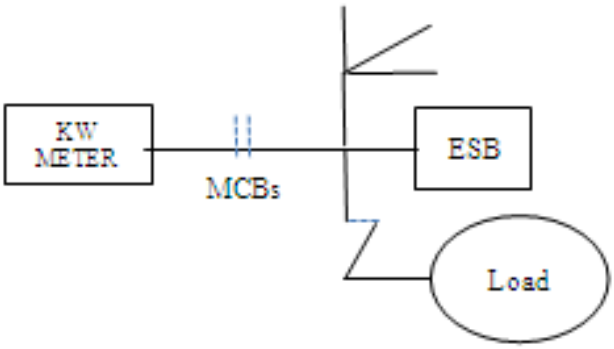


Figure-3. Location of the ESB.

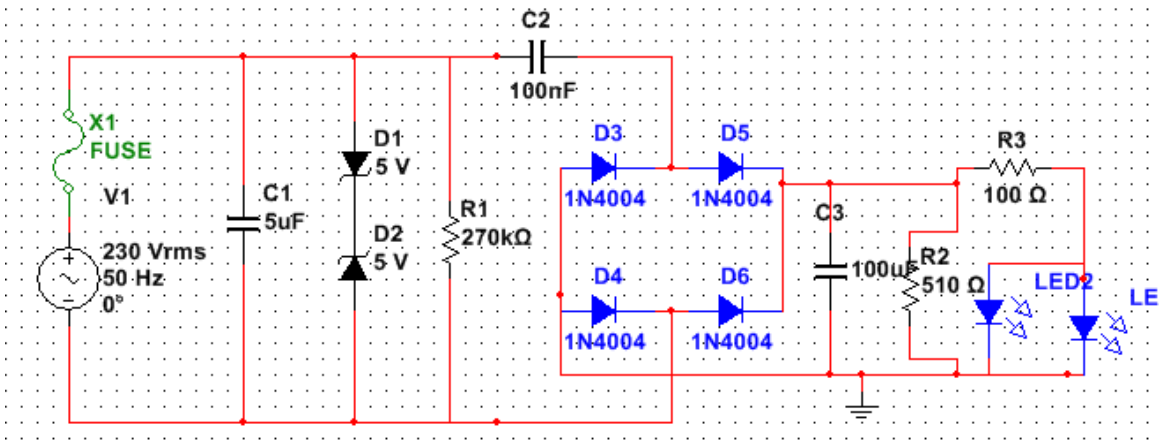


Figure-4. ESB circuit layout (Redrawn with Multisim).

3. RESULT AND DISCUSSIONS

Theoretically ESB that employs this circuit layout doesn't reduce the energy consumed by electrical appliances. Diode D1 and D2 is a substitution of the metal oxide varistor (MOV) which function as spike suppressor. C1 and R1 is acting as the leakage sink. The rectifier circuit is used to power the LEDs according to its rating while C2 and C3 creates a capacitive of lagging load characteristic or power factor correction function. The overall circuit did something useful but definitely not a device to save energy. It smoothen the input current and reduce the apparent power. In theory, if there is persistent over-voltage in the supply, a voltage regulator will reduce consumption since power is voltage times current and for a fixed resistance both will rise. In practice, under-voltage is more common and so a voltage regulator will tend to increase energy consumption, though only to the level it would be if the supply was over the specification. Table-1 shows the comparison of kilowatt usage of three different load with ESB and without ESB.

Table-1. Power consumption for 3 loads with and without EBS.

		Load			
		No Load	Driller	Grinder	Refrigerator
Power Consumption (Watt)	Energy Saving Box (EBS)	0.15	121	124.5	0.13
	Without Energy Saving Box	0	120.3	123.5	0.13

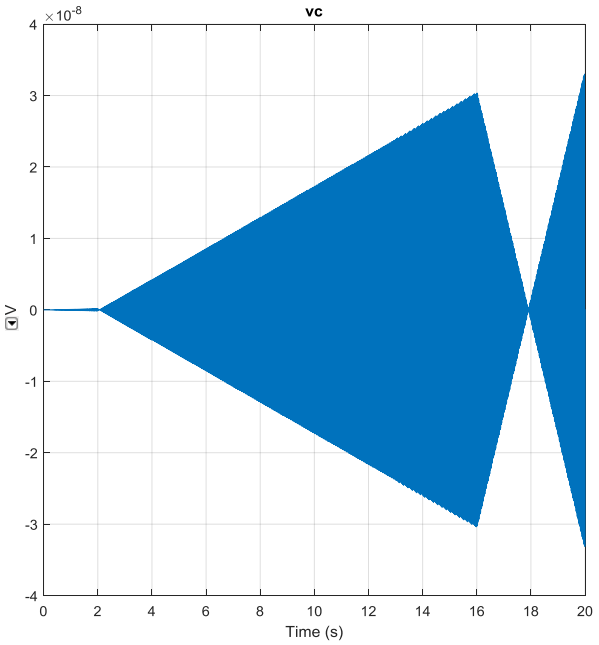
Table-2. Actual characterization results on a refrigerator power consumption.

Input Voltage (V)	Current Drawn (A)	Power Factor	Power Consumption (W)
230	0.64	0.88	130
230	0.62	0.9	130
230	0.59	0.95	130

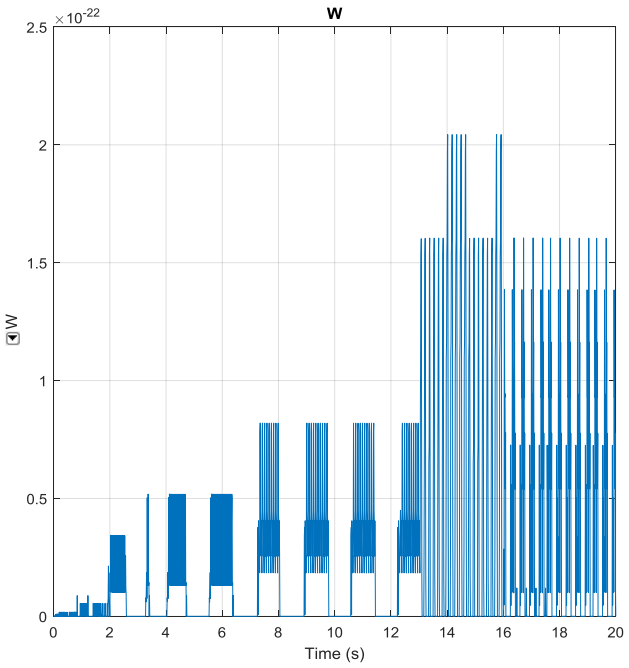
The EBS manufacturer may not pleased with the result. It clearly shows that instead of saving the energy, the device actually waste 0.15 Watt every hour. If it is connected for the whole day in a month, more than 100 Watt is wasted.

EBS seller usually demonstrate the functionality of their product by showing the current value. This is missleading since the power supply company charges their client based on real power. The load with low power factor of 0.6 supplied by 240V consumed 72 Watt. When the EBS is used, the power factor is corrected to 0.8 hence the current is reduced from 0.5A to 0.375A. The real power remain the same, 72 Watt same goes to the utility bill. EBS seller also claim that their product could reduce the voltage spike or fluctuation. The spike can cause the electrical appliance to consume unnecessary voltage. The fluctuation can be between -6% to 10% [5]. By taking the same load situation of 72 Watt, the increase of the voltage by 10% could increase the real power consumption by 4.2 Watt or 5%. Luckly the fluction does not happen frequently. Usually the voltage fluctuates a few times in an hour and most of the time it is undervoltage hence the energy waste due to overvoltage is negligible.

On the other hand, power factor correction used in the industry may help the industry to save some energy. According to Table-2, the efficiency of an equipment such as induction motor can be improve if the losses due to lower copper loss possibly at stator and rotor [6]. Figure-5 is the charging and discharging value of capacitor C1 using matlab simulation constant solver. Figure-6 is the power consumption of the LED's that used as light indicator on the ESD. Basically this simulation result proves that the circuit does nothing other than consuming some energy to light up the LED's.



Capacitor C1 volatge values



Power consumed by LED's.

4. CONCLUSIONS

Correcting the power factor improve power quality but generally do not effect energy efficiency of the electrical appliances. EBS sales have been steadily increased in recent years as consumer try to reduce their expenses on the utility bill. Unfortunately the consumer tend to reject the best practice of reducing the utility bill such as monitoring the electrical usage and using energy efficiency appliances while adopting the hoax device that promises illogical saving especially EBS. In [7], just by relocating the light in our house would some money.

Several argument and analysis has been presented here. First, domestic consumer is not charged for KVA/hour usage, but by kilowatt-hour usage. This means that any savings in KVA/hour would result in waste of effort. Second, the only potential for real power savings would occur if the EBS were placed near the reactive load (such as air conditioner) were running and remove it when the load is not running. This is impractical, given that there are several motors in a domestic housing that has no schedule (refrigerator, air conditioner and fan.), but the EBS itself is intended for permanent, unattended connection anywhere in the network. Besides that, placing the EBS near the distribution board could create dangerous voltage spike when no inductive loads is running.

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REFERENCES

[1] Martin Doppelbauer. IEC International Electro technical Standard IEC 60034-30-1 Motor Efficiency Classes Motor. Summit Zurich, Oct 2014 IEC 60034-30-1.

[2] A Primer, Martin Misakian Thomas L. Nelson. 2009. Regarding Electric Energy Savings, Power Factors, and Carbon Footprints: National Institute of Standards and Technology. U.S. Department of Commerce.

[3] John Ware. 2006. Power Factor Correction. IEE Wiring Matters, Spring.

[4] Sheng-Lian Lin, Yu-Ying Lin, Tung-Yi Lin. 2013. Energy-Saving Device with a Voltage-Regulating Function. Patent.

[5] Distribution Division, Tenaga Nasional Berhad. 2011. Steady State Supply Voltage Performance. Electricity Supply Application Book 3rd Edition.

[6] Sapna Khanchi and Vijay Kumar Garg. 2013. Power Factor Improvement of Induction Motor by Using Capacitors. International Journal of Engineering Trends and Technology. 4(7): 2967-2970.

[7] Ab Halim M.F.M., Azlan U.A.-A., Harun M.H., Annuar K.A.M., Mustafa M., Johari S.H., Abdullah A.R., Hushim M.F. 2017. Lighting retrofit scheme economic evaluation. Indonesian Journal of Electrical Engineering and Computer Science. 5(3): 496-501. (Journal).