The Performance of Permanent Magnet Core of Reducing Sag Voltage in Personal Computer (PC)

To cite this article: H Ys and A D Simanjuntak 2019 *IOP Conf. Ser.: Mater. Sci. Eng.* **526** 012034

IOP Conf. Series: Materials Science and Engineering **526** (2019) 012034 doi:10.1088/1757-899X/526/1/012034

The Performance of Permanent Magnet Core of Reducing Sag Voltage in Personal Computer (PC)

H Ys *, A D Simanjuntak
Electrical Engineering Department, Universitas Kristen Maranatha, Bandung, Indonesia.

*Corresponding author: siti_herawati_aminah@yahoo.com

Abstract. The power quality has a significant effect on all system devices. The voltage factors are usually modulated caused by the excessive load changes which produce a sag voltage. One of the techniques used to reduce the voltage sag is to design a Cuk converter with PI controller coupled with two inductances (L) at the Cuk converter in order to make a non-ideal transformer with a permanent magnet core made by ferrite material. The experimental results revealed that, the non-ideal transformer with a permanent magnetic core would stabilizes the input voltage on personal computer (PC), thus the sag voltage can be minimalized. From the experiment, the optimum results were obtained with top gap was 1mm and the bottom gap was 6mm. It can be concluded that by using a ferrite core magnet with high coercivity, the output voltage can be stabilized thus there will be no sag at the input voltage on the PC.

1. Introduction

The power interruption is often occurred in electrical systems, the sensitivity of modern electronic devices today is more susceptible to the quality of the power supply [1]. Power quality is more related to the ability of the electrical system to provide uninterrupted power. However, there are some power quality problems such as sag, swell, harmonic distortion, imbalance, flicker and transients. Among them, sag voltage occurs more often compared to other problems [2]. The power sag quality problems arise about 60% larger than the swell voltage (29%), transient (8%) and disruption problem (3%) [1]. Although the duration time of the sag voltage is short (from 0.5 to 1 minute) but gives impact to the operation of the equipment (motor, trip on sensitive load and inaccurate control equipment) [3]. In addition, the instantaneous sag voltage can cause serious problems with computer systems or electronic equipment [4].

The power system demands a reliable electrical system. The system is said to be reliable if it continues to supply an electricity need, with a constant voltage and frequency thus meet the consumers' urgency. If there is a tension sag then the voltage becomes unstable, the swell voltage should be muted in order to make a stable voltage. In this study, the design of permanent magnet core was done to stabilize the electrical voltage with the standard input voltage personal computer. The design will be simulated using PSIM (power sim).

2. Perfomance of Permanent Magnet Core of Reduce Sag Voltage

Referred to IEEE-1559-1995 standard, sag voltage is defined as a sudden reduction of RMS value from 10-90% at nominal voltage for duration of 0.5 to 1 minute [5]. Specific ranges of input power

IOP Conf. Series: Materials Science and Engineering **526** (2019) 012034 doi:10.1088/1757-899X/526/1/012034

quality and load parameters for computer manufacturing are voltage distortion parameters (all phases) if sag occurs then the range is -18% for a maximum of 0.5 s [6]. Cuk converter can raise and lower the voltage, so it can work on various input voltage range. This input voltage modulation is done by varying the duty cycle, since the duty cycle will keep the output voltage constant [7]. In designing the Cuk converter circuit, 3 modification stages were simulated which were simulated using PSim (Power Simulation) software. The first stage is to design a closed loop converter loop circuit using the PI controller. From the Cuk converter circuit the following formula is obtained:

$$Duty\ cycle = -\frac{Vo}{Vs-Vo} \quad (1)$$

Simulation of the Cuk converter is done by changing the parameter values of Li, Lo, Ci and Co [8], then we get one example of output voltage in Cuk converter circuit when: V_{in} = 220 V, Li = 56 mH, Lo = 58.5mH, Ci = 1e-4F, Co = 1e-5 F as shown in Figure 1.

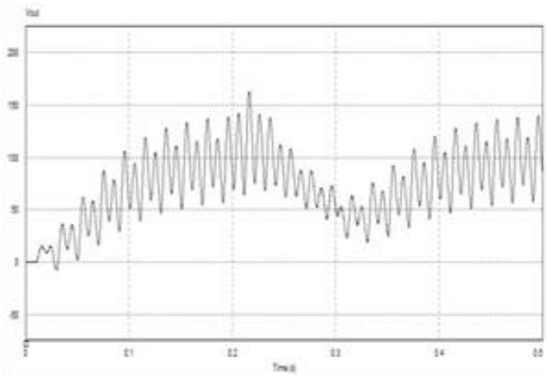

Figure 1. Cuk Converter Output Voltage Results

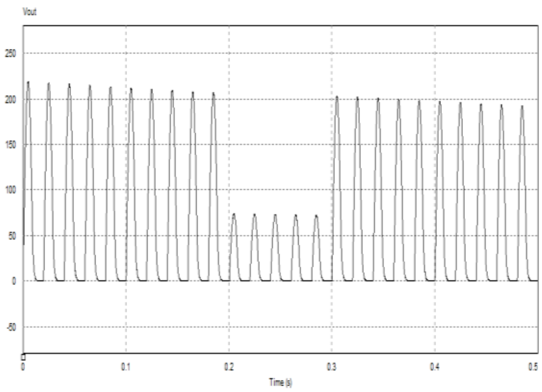

Figure 2. Output Results Using Ideal Transformer

In the figure 1 we can see that the output voltage is unstable with a peak value of 165 V. Because the sag voltage converter circuit has not been able to be muted, the next step is to couple the two inductance (L) on the Cuk converter circuit becomes the ideal transformer. The ideal transformer uses 5 primary windings and 5 secondary windings. Output results using ideal transformer are shown in Figure 2. It can be seen in figure 2 that the output voltage is still not stable and at 0.2 s - 0.3 s there are also some voltage sag. Then the last step taken is the transformer is not ideal to use a magnetic core. The permanent magnet can be a current source and control the voltage source [9]. In this non-ideal transformer, the important values that have to be known are copper wire resistance and the cross-sectional area of the magnetic air gap [10]. The air gap is given a range of 1-10 mm, and the saturation value of the hysteresis curve corresponds to the hysteresis curve of the ferrite magnet. The crane of the converter converter with the non-ideal transformer is shown in Figure. 3.

2.1. Air Gap Magnet

The magnetic core used is type-E which has 6 air gaps; 3 on the top and 3 on the bottom. The cross-sectional area of each air gap in the magnet is shown in Table 1. The air gap is used in the range of 1-10 mm.

Table 1. Sectional Area of the Air Gap

	Cross-sectional area (m^2)		
Top Gap	Gap 1	Gap 2	Gap 3
	7.04E-05	1.33E-04	7.04E-05
Under Gap	Gap 4	Gap 5	Gap 6
	7.04E-05	1.33E-04	7.04E-05

2.2. Ferrite Magnetic Hysteresis Curve

B-H curve which resulted from the PSim software simulation on the ferrite magnet was shown in Figure 4. Ferrite magnets have high coercivity with stability level against external field influence and good temperature [11].

Figure 3. Permanent Magnet Shaped E

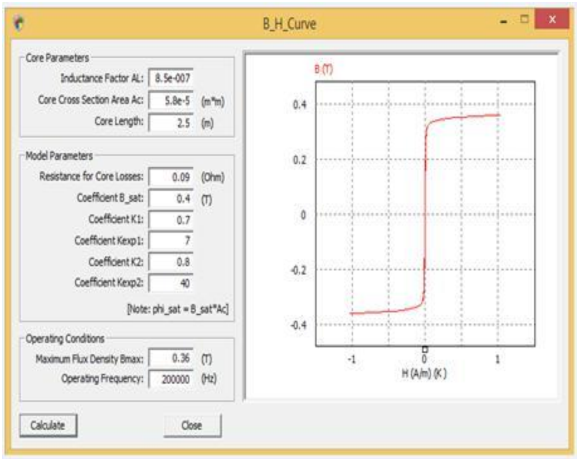

Figure 4. B-H Curve

From Figure 4, there are parameter values. These parameter values are then fed into the core component of PSim.

2.3 Resistance (R) on Copper

The resistivity (ρ) of copper is used following the conductor material type. The purpose of using R value in the copper wire is because there are losses on the copper wire which will show on how the result a non-ideal transformer. Value resistance (R) on copper is 0.011 Ω.

2.4 The output voltage of non-ideal transformer with a magnetic Core

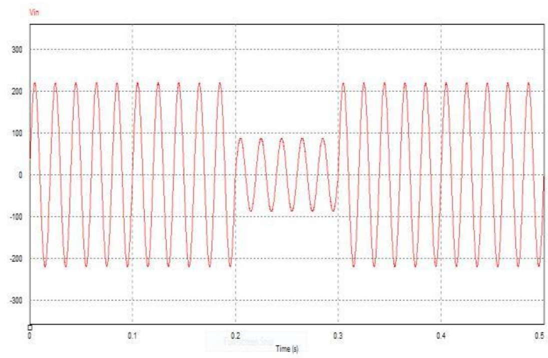

Figure 5. Input Voltage Sag

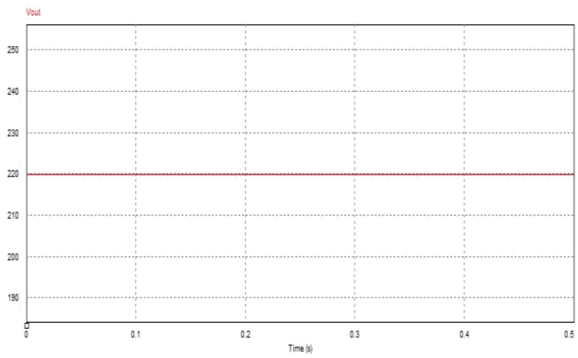

Figure 6. Output Voltage

The input voltage power supply on the PC still has a sag problem as shown Figure 5. However, after sag damping using magnetic core, the input voltage on the PC becomes stable at 220 V. The output voltage of the ideal transformer with the magnetic core is shown in Figure 6.

3. Conclusions

From result and discussion, it is revealed that:

1. The initial sag voltage of 60% of 220V, can be reduced to 0%. In other word the sag voltage is totally lost.
2. Sag voltage can occur due to the voltage drop at the input voltage. This will affect an unstable voltage which will damage computer equipment especially the one with power supply. A transformer with a high permeability magnet core is able to stabilize the input voltage, thus the sag voltage can be reduction.
3. From the experimental results, the best result was obtained when the top gap = 1mm and the bottom gap = 6mm.

4. References

[1] M. Ravilla and R. R. G, "Modeling and Simulation of a Distribution STATCOM (D-STATCOM) for Power Quality Problems-Voltage Sag and Swell Based on Sinusoidal Pulse Widht Modulation (SPWM)," *IEEE-International Conf. Adv. Eng. Manag.*, pp. 436– 441, 2012.

[2] K. Yamamoto, S. Ehira, M. Ikeda, S. I. Hase, and M. A. C.Onverter, "Synchronous Frame Control for Voltage Sag / Swell Compensator Utilizing Single-Phase Matrix Converter," *IEEE*, 2017.

[3] D. V. Tien and R. Gono, "Analysis and Simulation of Causes of Voltage Sags Using EMTP," *IEEE*, no. **4**, pp. 7–11, 2017.

[4] U. V. Reddy, P. C. Babu, and S. S. Dash, "Space Vector Pulse Width Modulation Based DVR to Mitigate Voltage Sag and Swell,"*IEEE*, pp. 5–9, 2013.

[5] A. Tavighi, H. Abdollahzadeh, and J. Martí, "Fast Response DVR Control Strategy Design to Compensate Unbalanced Voltage Sags and Swells in Distribution Systems," *IEEE*, 2013.

[6] P. Systems and E. Committee, *IEEE Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications*, vol. 1995. 1995.

[7] A. Triandini, Soeprapto, and R. Mochammad, "Perancangan Battery Control Unit (BCU) Dengan Menggunakan Topologi Cuk Converter Pada Instalasi Tenaga Surya," pp. 1–6, 2013.

[8] Rheesabh Dwivedi, Vinay Kumar Dwivedi, and Rahul Sharma, "Parametric variation analysis Of CUK converter for constant voltage applications", *IJAREEIE*, Vol. 3, Issue 2, February 2014.

[9] H. Yusuf, E. T. Raharjo, and I. Ganiwa, "Prototipe Magnet Ferrit untuk Mengendalikan Akumulasi Tegangan Cuk Konverter," *J. Elektron. dan Telekomun.*, vol. **9**, no. 2, pp. 209–212, 2009.

[10] David M. Pozar. 2012. "*Microwave Engineering, Fourth Edition*".

[11] N. A. Zen, W. Widanarto, and T. Cahyanto, "Karakterisasi Struktur dan Sifat Magnetik Manganese Ferrite sebagai Bahan Magnet Permanen Isotropik," in *Prosoding Pertemuan Ilmiah XXVIII HFI*, 2014, no. April, pp. 268–271.