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# 공연장에서 사용하고 있는 SSR조광기를 새로운 IGBT 싸인웨이브 조광기로 교체시 효율성에 관한 연구

# A Study on the Efficiency when replacing SSR Dimmer with IGBT SINEWAVE Dimmer in Concert Halls

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**요 약** 현재 에너지 절감에 대한 사회적 요구가 높다. 이번 기회에 IGBT 딤머시스템이 기존 SSR,SCR 딤머시스템과 비교하여 얼마만큼의 효율성을 갖는 것에 대한 목적을 가지고 연구를 하였다. 방법은 2가지로 첫째는 디머시스템의 조광시 출력에 따른 정현파 변형의 비교실험으로 전력손실이 얼마나 나타나는지에 대하여 오슬로스코프로 비교 측정 실험을 진행하였고, 둘째는 조광시 장비가 갖는 소리에 대한 데시벨 크기를 측정하여 장비 배치에 대한 소음에 대하여 데시벨 측정기로 실험을 진행하였다. 결과는 전력손실에 따른 효율성과 공간에 따른 소음이 많은 SSR,SCR 딤머보다 IGBT 딤머가 효율적이라는 것을 확인 하였다.

**Abstract** Today, High Social demand for Energy Saving. This have been Studied for the purpose, Having an Efficiency of much it, in IGBT DIMMER SYSTEM compared to the existing SSR,SCR Dimmer System.
The Method Two, The First is Dimming in Dimmer System How much Power loss Appears of A Comparison Experiment According to the output a SINEWAVE Strain, Comparative Measurements Experimental were Conducted with Oscilloscope. Second, When Dimming the sound has equipment by measuring the relative Size Decibel Experiment was conducted in Decibel Meter about the Equipment Noise. Results Thus Confirm SSR,SCR Dimmer IGBT SINEWAVE Dimmer more Efficiently.

**Key Words :** SINEWAVE DIMMER, SSR,SCR DIMMER, THEATERS, ENERGY EFFICIENCY

## I. Introduction

### 1. Background and Research Purpose

Concert lighting is closely related to the science and technology. The application of new technology brings the new method in lighting art creation. The development of modern stage lighting technology means the development of the art function. Only when possessing diverse technological means can high-level art processing be realized. I argue that this is the important in the development of stage lighting.

When dimming with previous SSR, SCR dimming

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system, the waveform is distorted and produce harmonic wave, which makes it impossible to used with sound and audio connected. Because the wave form is not distorted when dimming with this system, noise is not produced from the filament of lamps and also harmonic wave doesn't come out. Thus this paper aims to study on the Efficiency resulting from replacing SSR Dimmer with IGBT SINEWAVE Dimmer in Concert Halls. The wave form of IGBT SINEWAVE dimming system is 1:1 switch rate.

### 2. Research Method

This research is going to conduct comparative experiments with SSR,SCR dimmers and IGBT SINEWAVE dimmer.

The experiment is going to measure the percent of output and wave loss when the dimmers are dimmed and the noise produced by the equipments and lamps when dimming.

The first experiment is going to measure the data when dimmers are dimmed to 25%,50%,75% with oscilloscope, The second experiment is going to measure the noises of the lamps connected to the dimmers when they are dimmed to 25%,50%,75% with decibel measuring machine.

## II. Main Points

### 1. SINEWAVE Dimmer

SINEWAVE dimmer connects SSR, SCR or the Rheostats or transformers in the era using SSR, SCR in our mind. At that time, the change of dimming output voltage is only the chang of wave size. The basic SINEWAVE form does not change and of course will not interfere other equipments such as video or audios.

The birth of SSR, SCR dimmer enables the control with computer, but also brings problems such as external interference.

In order to reduce the electric interference that SSR, SCR dimmers gives out to other equipments, exclusive application of choke coil for SINEWAVE dimmers is applied. With the efforts of the manufacturers and research institutions, special metal pin materials are produced, which can reduce the interference when the SSR, SCR dimmers are operating. And the special design of lighting lamps wiring and the guard lamp for video and audio electricity provision system also come to be possible.

SINEWAVE dimmers using IGBT can divide the cycle of SINEWAVE voltage input in electricity into several equal parts with high-speed switch technology and can control the ratio of circuit and suspension time of every part. When the circuit time of every part is reduced and the suspension time increases, the output voltage becomes lower.

By changing the ratio of circuit time and suspension time, the output voltage is also changed, through which lighting effects are realized.

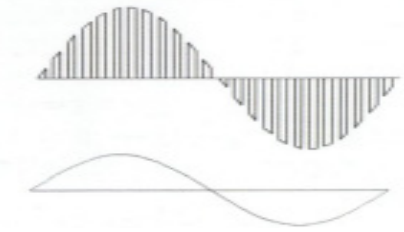

그림 1. IGBT 사인파형
Fig. 1. IGBT SINEWAVE

The mechanism of SINEWAVE dimmer using IGBT is shown in Fig 1. It is a wave form of 1:1 switch ratio.

Noise produced by such different harmonic waves can be filtered out easily by a very small wave filter. SINEWAVE voltage shown in Picture 1 after pressed strongly will be output.

Compared with the cut and distorted wave forms output from SSR, SCR dimmers , output wave form of IGBT is relatively smooth and it produces relatively less interference to external environment. Also the effect on the electric fence is small and when the lamp is lightening, filament does not produce noise. The modern SINEWAVE dimming circuit has reinforced the protection of overloaded electricity, which improves the

usage safety.

IGBT SINEWAVE dimmer has a lot of strengths, which makes it an important role in the trend of the development of dimming circuit. However, it is more complex and expensive than the commonly used SSR, SCR dimming circuit. But I suggest that with the development of society and technology, SINEWAVE dimmer will be more and more widely used.

## 2. Dimming System

### (1) SSR, SCR Dimming System

Firstly we are going to introduce SSR, SCR dimming system. The mechanism of this system is that the phase shift adjusts the alternative chopper output voltage by controlling conduction angle.

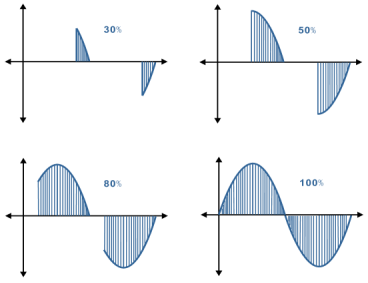


그림 2. SSR,SCR 출력 파형
Fig. 2. SSR,SCR Output Waveform

### (2) IGBT SINEWAVE Dimming System

The mechanism of SINEWAVE dimming system is a time-sharing control method by adjusting output voltage and wave form with AC-AC reversal.

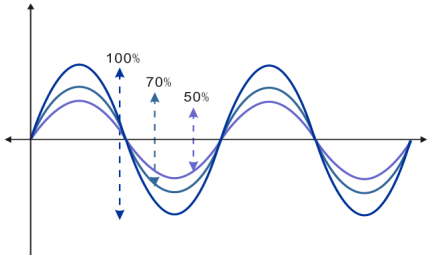


그림 3. IGBT SINEWAVE 출력 파형
Fig. 3. IGBT SINEWAVE Ouyput Waveform

### (3) Comparation of Fimming Control

When dimming with SSR, SCR dimming system, wave form is distorted, thus producing harmful harmonic which makes the usage dangerous and also When dimming with IGBT SINEWAVE dimming system, wave forms not distorted are totally output into SINEWAVE amplitude, thus producing little harmonic wave and causing little power loss.

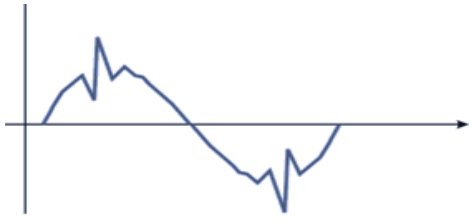

그림 4. SSR, SCR 조광 제어시 출력 파형
Fig. 4. Output Wave form when SSR, SCR is Dimming

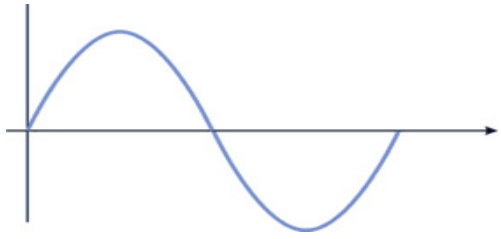

그림 5. IGBT 사인웨이브 조광 제어시 출력 파형
Fig. 5. Output Waveform When IGBT SINEWAVE is dimming

## 3. Experiment Results

### (1) SSR, SCR Dimming System

The following Fig 6. show the measuring system to measure the wave forms of IGBT SINEWAVE dimming system and SSR, SCR dimmer.

The following Fig 7. compares the measurement of wave form, speaker and decibel when SSR, SCR dimming system and IGBT SINEWAVE dimming system use the same power supply dimmer system and sound system.

The experiment method is going to measure the decibel of lamps and speakers by connecting lamps with 3 1KW PAR64 lights and setting the dimming

values as 25%, 50%, 75% and 100%. Fig 8. and Fig 9. show the wave forms when dimming.


그림 6. IGBT 사인웨이브 디밍 시스템과 SSR, SCR 디밍 시스템 측정 방법

Fig. 6. Measuring System to Measure the Waveform of IGBT SINEWAVE Dimming System and SSR, SCR Dimmer System

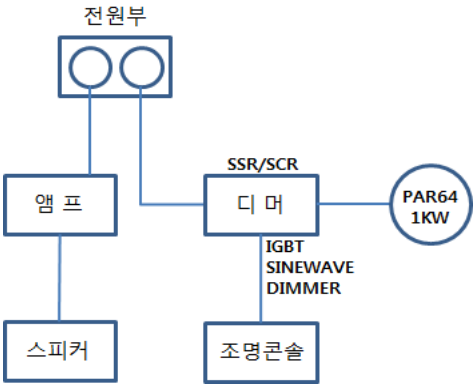


그림 7. 조광 시스템과 오디오 시스템 파형 및 데시벨 측정시스템 계통도

Fig. 7. Diagram of measuring system to measure form wave of dimming system audio system and decibel

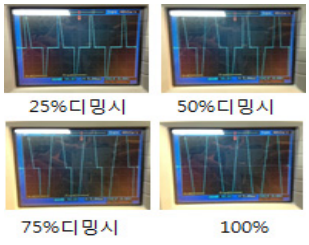


그림 8. SSR, SCR 조광기 조광 제어시 25%, 50%, 75%,100% 출력 파형

Fig. 8. Output waveform when SSR, SCR dimmer is dimming to 25%, 50%, 75%,100%

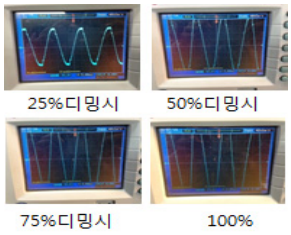


그림 9. GBT 싸인웨이브 조광기 조광제어시 25%, 50%, 75%,100% 출력 파형

Fig. 9. Output wave form when IGBT SINEWAVE dimmer is dimmed to 25%, 50%, 75%,100%

Measurement results are shown in Table 1. and Table 2.

표 1. SSR, SCR 방식의 조광기 조광시 스피커 및 조명 등기구 소음 데시벨(dB) 측정값

Table 1. Measured value of noise from speaker and lamps decibel when dimming with SSR, SCR dimmer

| 디밍(%) | 스피커(dB) | 조명등기구(dB) |
|---|---|---|
| 25% | 46.5 | 46 |
| 50% | 45 | 45 |
| 75% | 43.5 | 44.5 |
| 100% | 43 | 43 |

표 2. IGBT싸인웨이브 조광기 조광시 스피커 및 조명등 기구 소음 데시벨(dB) 측정값

Table 2. Measured value of noise from speaker and lamps decibel when dimming with IGBT SINEWAVE dimmer

| 디밍(%) | 스피커(dB) | 조명등기구(dB) |
|---|---|---|
| 25% | 43 | 43 |
| 50% | 43 | 43 |
| 75% | 43 | 43 |
| 100% | 43 | 43 |

Power factors measurement table of SSR, SCR dimming system and IGBT SINEWAVE dimming system are shown in Table 3.

표 3. SSR, SCR 조광기와 IGBT SINEWAVE 조광기의 역률 비교표
Table 3. Power factors measured values of SSR, SCR dimming system and IGBT SINEWAVE dimming system

| Power factors | | |
|---|---|---|
| Brightness | SSR / SCR dimmer | SINEWAVE dimmer |
| 25% | 0.25 | 0.99 |
| 50% | 0.5 | 0.99 |
| 75% | 0.75 | 0.99 |
| 100% | 0.99 | 0.99 |

Fig 8. shows how wave form is distorted when dimming with SSR, SCR dimming system and we can see that harmonic waves are produced. From Table 1. we can see that decibels vary when dimming value is 25%, 50%, 75%, and 100%. The more dimming, the more harmonic waves. In this experiment we use only about 3kW load capacity, but if more load capacities are used, then more harmonic waves will b produced, which also causes more noise. Through this comparative experiments we can see that there will be no problem to use IGBT SINEWAVE dimming system together with sound system.

Also, from Table 3, we can see that similar power factors come out when dimming values vary using SSR, SCR dimming system, but the power factors maintain 0.99 no matter how much the dimming value is. Thus we can see that it is more efficient. With less energy consumption, energy can be saved more than SSR, SCR dimming system.

## III. Conclusion

The High-tech functions that IGBT SINEWAVE dimming system possesses are still not available in Korean , but have become possible in Europe, America and China and a lot of concert halls have been equipped with IGBT SINEWAVE dimming systems.

However, it is hard to find a concert hall which has applied IGBT SINEWAVE dimming system to practical usage in Korea. I suggest the wide usage of IGBT SINEWAVE dimming system in grand concert halls or broadcasting stations. I advocate in the future Korean manufacturers or governmental institutions localize IGBT SINEWAVE dimming system and apply it to more concert halls and broadcasting stations.

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