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High Resolution Digital Dimmer

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APPLICATION NOTE

INTRODUCTION

Phase Control with Thyristors

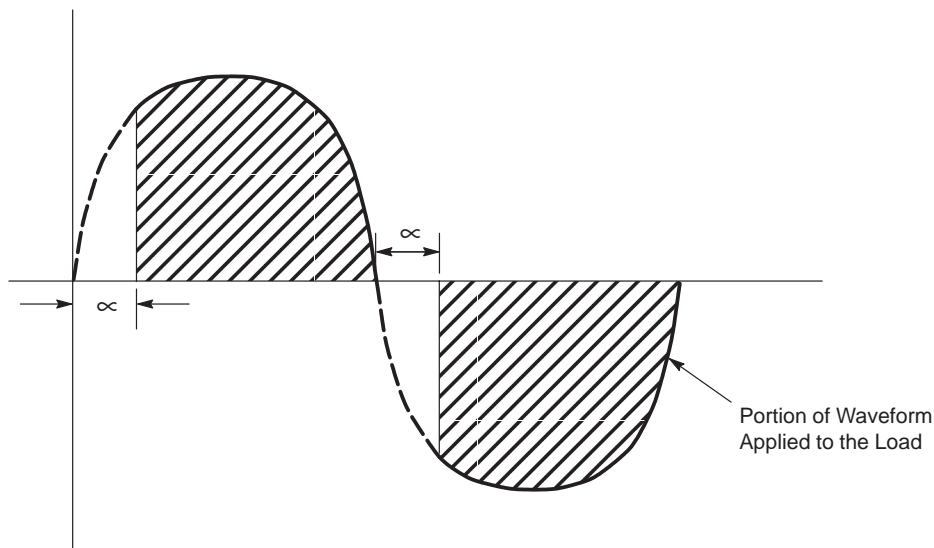
An effective and widely used method of controlling the average power to a load through a triac is by phase control. Phase control is a method of utilizing the triac to apply the ac supply to the load for a controlled fraction of each cycle. In this mode of operation, the triac is held in an off or open condition at a time in the half cycle determined by the control circuitry. In the on condition, the circuit current is limited only by the load i.e., the entire line voltage (less the forward drop of the triac) is applied to the load.

As one might expect, in spite of its usefulness, phase control has some disadvantages. The main disadvantage in

using phase control in triac applications is the generation of electromagnetic interference (EMI). Each time the triac is triggered the load current rises from zero to the load limited current value in a very short time. The resulting di/dt generates a wide spectrum of noise that may interfere with the operation of nearby electronic equipment unless proper filtering is used.

The following figure shows the function of the phase control.

Phase Control of AC Waveform



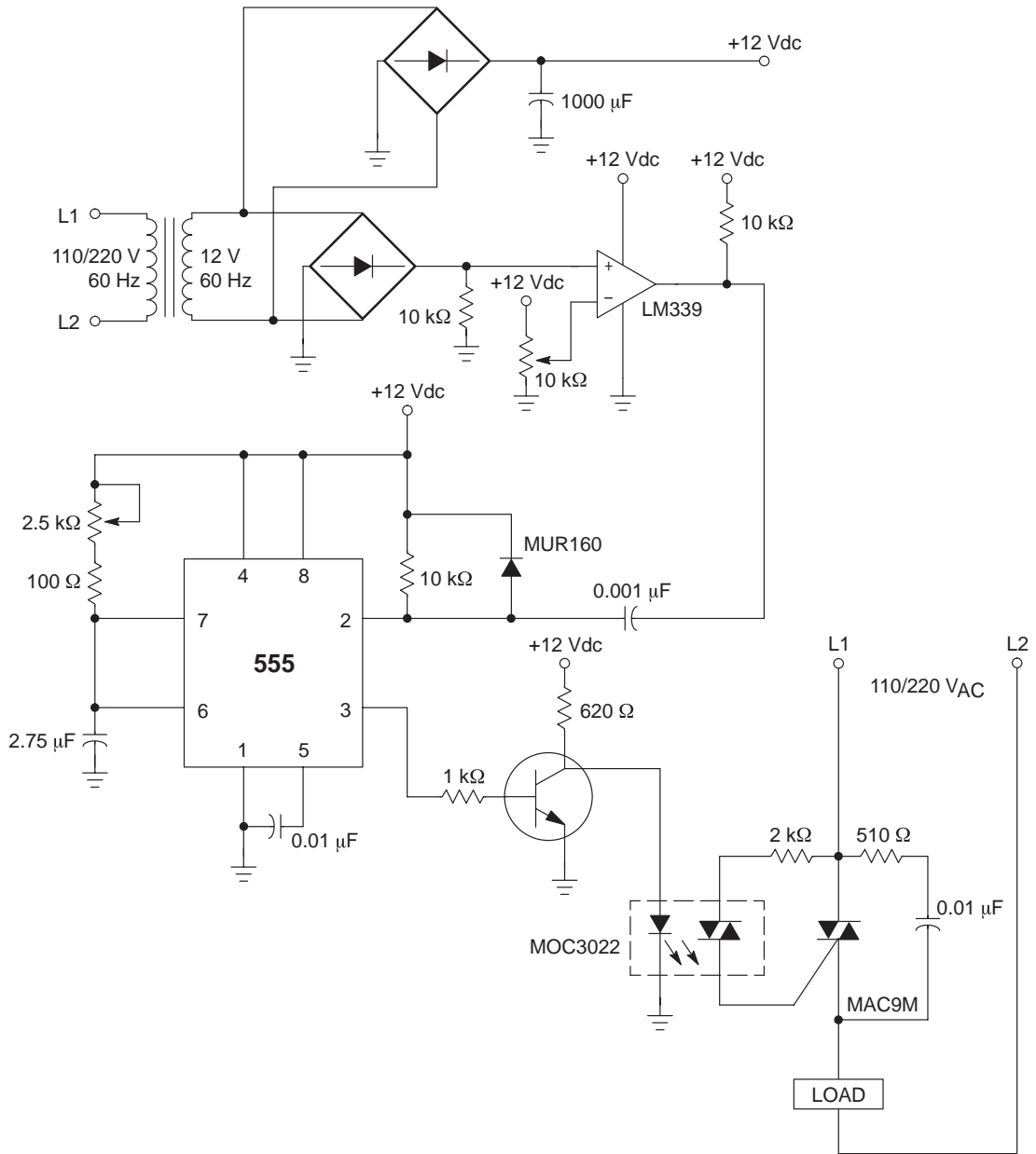
The above figure illustrates the concept of the phase control. During the first portion of each half cycle of the ac sine wave, an electronic switch is opened to prevent the current flow. At some specified phase angle (Alpha), this switch is closed to allow the full line voltage to be applied

to the load for the remainder of that half cycle. Varying Alpha will control the portion of the total sine wave that is applied to the load (shaded area), and thereby regulate the power flow to the load.

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The following schematic diagram shows a digital dimmer with phase control from 10% to 95% of the ac sine wave.


DIGITAL DIMMER



In the previous diagram, the operational amplifier (LM339) is performing a zero crossing function, and due to this, the integrated circuit (555) is being activated each time a zero crossing condition occurs. Therefore, once this integrated circuit (555) is activated (due to a zero crossing condition), it will wait a short delay time before it activates the transistor and in turn the triac (MAC9M). Due to this delay time, the triac (MAC9M) will be activated at different points (phase angles) of each half-cycle of the ac sine wave, so the load is going to receive only a portion of the current waveform which is determined for the kind of delay time set. This delay time is selected by the adjustable resistor, in this example, 2.5 k Ω . It is able to control almost 100% of the complete ac sine wave.

On the other hand, the kind of triac to be used in the dimmer circuit is determined by the load characteristics taking into consideration the current, voltage, power, and its physical characteristics (inductive or resistive load). Therefore, it is very important to select the proper triac according to the load requirements.

In conclusion, the Digital Dimmer described in this application note offers a very reliable control phase (from 10% to 95% of the ac sine wave). It can be a very useful and inexpensive option for lighting applications or one phase motor speed controls or any other kind of application circuits where a reliable control phase is needed. Nevertheless, it is important to mention that the main disadvantage of using phase control in the application circuits is the generation of electromagnetic interference (EMI). Therefore, proper filtering needs to be used in order to eliminate the EMI phenomena, otherwise the noise would interfere with the operation of nearby electronic equipment. Another factor that is important to take into consideration, is extreme environmental temperatures could cause poor operation of the dimmer and thus the wrong phase control for the load. Therefore, it is necessary that the designer determine under what conditions would the dimmer need to operate in order to make the proper calculations of the electronic devices according to those needs.

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