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Electronic Starter for Flourescent Lamps



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Formerly a Division of Motorola

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APPLICATION NOTE

INTRODUCTION

In lighting applications for fluorescent lamps the choice of the starter switch to be used is always very important for the designers: the cost, reliability, ruggedness, and ease to be driven must always be kept in mind. This is especially important in lighting circuits where the designer has to optimize the operating life of the fluorescent lamps by using the right starter switch.

In the large family of electronic switches, the thyristor must be considered as a low cost and powerful device for lighting applications. Thyristors can take many forms, but they have certain features in common. All of them are solid state switches that act as open circuits capable of withstanding the rated voltage until triggered. When they are triggered, thyristors become low impedance current paths and remain in that condition (i.e. conduction) until the current either stops or drops below a minimum value called the holding level. Once a thyristor has been triggered, the trigger current can be removed without turning off the device.

Silicon controlled rectifiers (SCRs) and triacs are both members of the thyristor family. SCRs are unidirectional devices while triacs are bi-directional. A SCR is designed to switch load current in one direction, while a triac is designed to conduct load currents in either direction.

Structurally, all thyristors consist of several alternating layers of opposite P and N silicon, with the exact structure varying with the particular kind of device. The load is applied across the multiple junctions and the trigger current is injected at one of them. The trigger current allows the load current to flow through the device setting up a regenerative action which keeps the current flowing even after the trigger is removed.

These characteristics make thyristors extremely useful in control applications. Compared to a mechanical switch, a thyristor has a very long service life and very fast turn on and turn off times. Because of their fast reaction times, regenerative action, and low resistance, once triggered, thyristors are useful as power controllers and transient over voltage protectors, as well as simply turning devices on and

off. Thyristors are used to control motors, incandescent and fluorescent lamps, and many other kinds of equipment.

Although thyristors of all sorts are generally rugged, there are several points to keep in mind when designing circuits using them. One of the most important parameters to respect is the devices' rated limits on rate of change of voltage and current (dV/dt and di/dt). If these are exceeded, the thyristor may be damaged or destroyed.

DEFINITIONS

Ambient Sound Levels. Background noise generated by ballast and other equipment operating in a building.

Arc. Intense luminous discharge formed by the passage of electric current across a space between electrodes.

Ballast. An electrical device used in fluorescent and high intensity discharge (HID) fixtures. It furnishes the necessary starting and operating current to the lamp for proper performance.

Electrode. Metal filament that emits electrons in a fluorescent lamp.

Fluorescent lamp. Gas filled lamp in which light is produced by the interaction of an arc with phosphorus lining the lamp's glass tube.

Fluorescent light circuit. Path over which electric current flows to operate fluorescent lamps. Three major types of fluorescent lighting circuits are in use today, preheat, instant start (slimline) and rapid start.

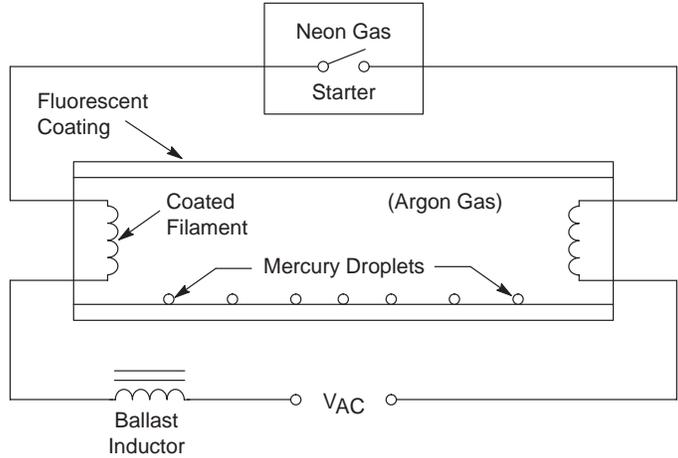
Instant start (slimline). A class of fluorescent. Ballast provides a high starting voltage surge to quickly light the lamp. All instant start lamps have a single pin base and can be used only with instant ballast.

Rapid Start Lamps. Fluorescent lamps that glow immediately when turned on and reach full brightness in about 2 seconds.

Preheat Lamp. A fluorescent lamp in which the filament must be heated before the arc is created.

This application note is designed for Preheat Start Lamp circuit. The description of the functionality of this Lamp is described below:

HOW THE LAMP WORKS (Using the conventional glow-tube starter)



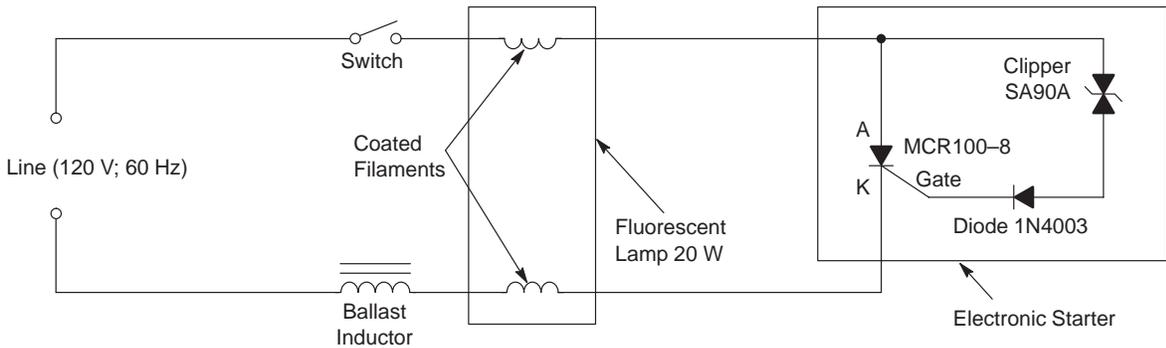
The above Figure illustrates a fluorescent lamp with the conventional glow-tube starter. The glow-tube starter consists of a bimetallic switch placed in series with the tube filament which closes to energize the filaments and then opens to interrupt the current flowing through the ballast inductor, thereby, generating the high voltage pulse necessary for starting. The mechanical glow-tube starter is the circuit component most likely to cause unreliable starting.

The principle disadvantage of the conventional glow-tube starter is that it has to open several times in the filament circuit to interrupt the current flowing through the

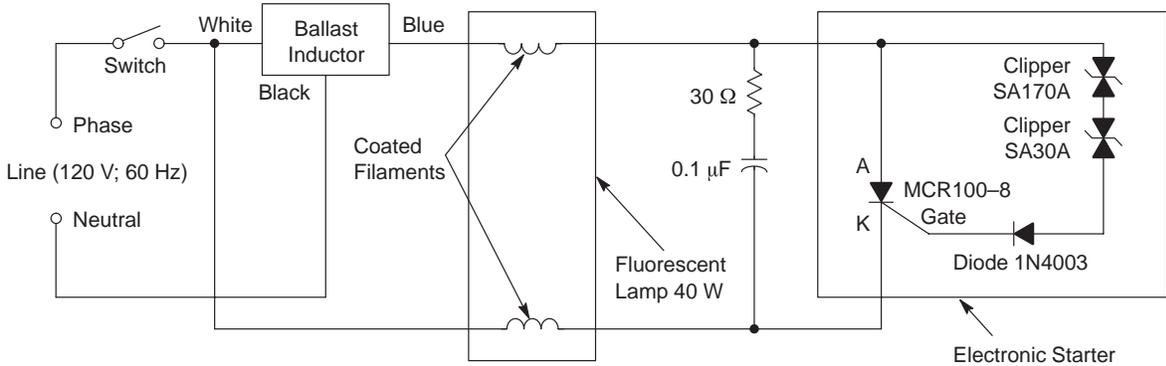
ballast inductor in order to generate the high voltage necessary for turning-on the fluorescent lamp. However, those interactions decrease the life of the lamp considerably. Besides, the lamp turns-on in around 3 seconds when it is using the conventional glow-tube starter and it also causes degradation to the lamp.

On the other hand, the following schematic diagrams show the electronic circuitry which substitutes the conventional glow-tube starter for fluorescent lamps applications of 20 Watts and 40 Watts using a diode, SCR, and a TVS or zener clipper(s):

Fluorescent Lamp of 20 Watts



Fluorescent Lamp of 40 Watts



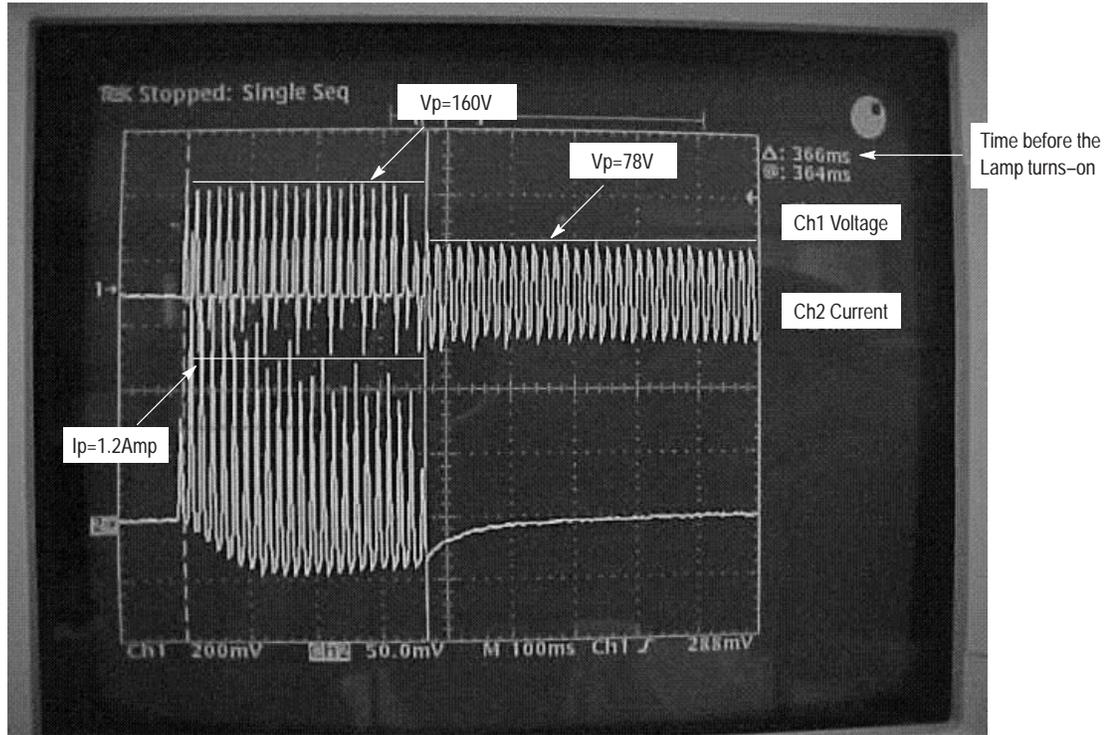
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The main reason why the previous circuits are different is due to the high voltage must be generated for each kind of lamp. This means, the inductor ballast for fluorescent lamps of 40 Watts provides higher voltage than the inductor ballast for lamps of 20 Watts, that is why, the electronic circuits have to be different. As an observation, even the conventional glow-tube starters have to be selected

Fluorescent Lamp of 20 Watts:

according to the power of the lamp, it means, there is not a general glow-tube starter who can operate for all kinds of fluorescent lamps.

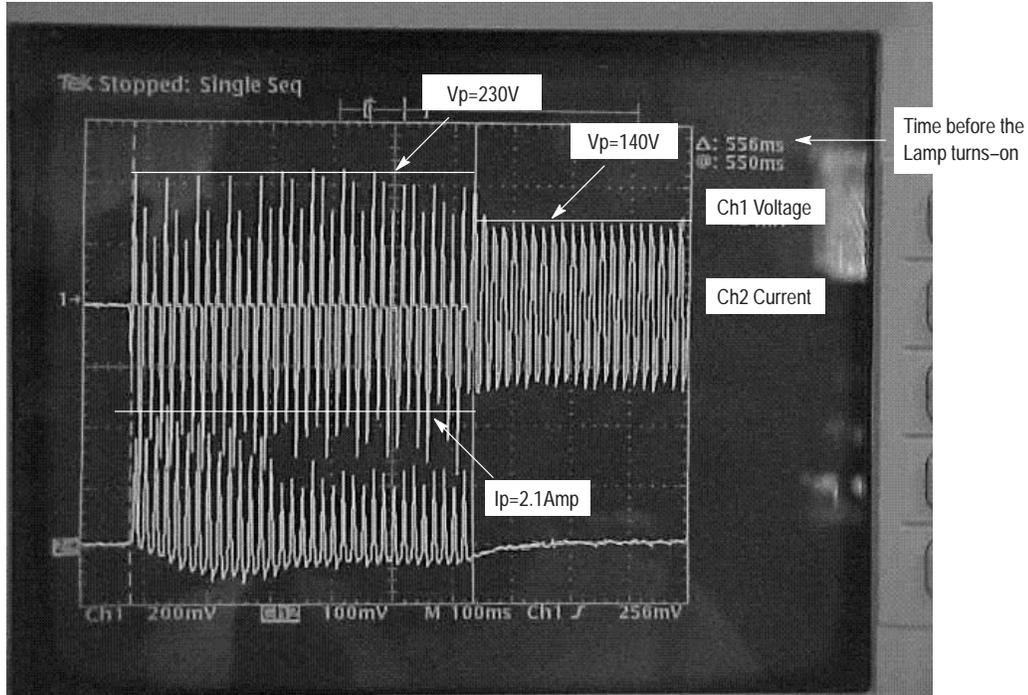
The following plots show the voltage and current waveform in the electronic starter circuitry when the fluorescent lamps is turned-on:



When the switch is turned-on, the voltage across the Clipper (SA90A) is the same as the voltage of the AC Line ($V_{peak} = 160V$), and since the Clipper allows current-flow through itself only once its VBR is reached (100V peak), the SCR (MCR100-8) turns-on and closes the circuit to energize the filaments of the fluorescent lamp. At this time, the current across the circuit is around 1.2A peak, and once the lamp has got enough heat, it decreases its dynamic resistance and permits current-flow through itself which causes the voltage across the Clipper to decrease to around

78 Vpeak. This effect makes the clipper turn off, since the voltage is less than the VBR of the device (SA90A), and because the clipper turns off, the SCR also turns-off, and opens the circuit to interrupt the current flowing through the ballast inductor, thereby, generating the high voltage pulse necessary for starting the lamp. The time that the fluorescent lamp will take before to turn-on is around 400 msec by using the electronic starter. It is a faster starter than when the lamp is using the conventional glow-tube starter.

Fluorescent Lamp of 40 Watts:



The operation of the electronic starter circuit of 40 watts is similar than for 20 watts, the only difference between them is that the Inductor Ballast of 40 watts generates higher voltage than the inductor ballast of 20 watts. That is why the schematic circuit for lamps of 40 watts has two clippers and one snubber inside its control circuit. Besides, the current flowing through this circuit is around 2.1A peak and it appears around 550 msec (which is the time that the lamp takes before it turn itself on), longer than in the electronic starter circuit of 20 watts.

In conclusion the electronic starter circuits (for 20 and 40 watts) are more reliable than the conventional glow-tube

starters since the lamps turn-on faster and more efficiently increasing their life-time considerably. Besides, the total price of the electronic devices is comparable with the current starters (glow-tube).

In summary, it is also important to mention that the range of the AC voltage supply to the electronic starter circuits must be from 115Vrms to 130Vrms for operating correctly.

If it is not within this voltage range the circuits may not be able to operate in the correct way causing unreliable starting of the lamp. Also, extreme environmental temperatures could effect the right functionality of the electronic starters but it is a fact that they can operate between 15°C to 40°C.

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