Thyristors for Ignition of Fluorescent Lamps

Introduction

One of the many applications for Thyristors is in fluorescent lighting. Standard conventional and circular fluorescent lamps with filaments can be ignited easily and much more quickly by using Thyristors instead of the mechanical starter switch, and solid state Thyristors are more reliable. Thyristors produce a pure solid state igniting circuit with no mechanical parts in the fluorescent lamp fixture. Also, because the lamp ignites much faster, the life of the fluorescent lamp can be increased since the filaments are activated for less time during the ignition. The Thyristor ignition eliminates any audible noise or flashing off and on which most mechanical starters possess.

Standard Fluorescent Circuit

The standard starter assembly is a glow switch mechanism with option small capacitor in parallel. (Figure AN1010.1)

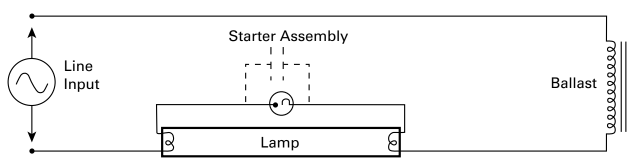

Figure AN1010.1 Typical Standard Fluorescent Circuit

The glow switch is made in a small glass bulb containing neon or argon gas. Inside the bulb is a U-shaped bimetallic strip and a fixed post. When the line input current is applied, the voltage between the bimetallic strip and the fixed post is high enough to ionize and produce a glow similar to a standard neon lamp. The heat from the ionization causes the bimetallic strip to move and make contact to the fixed post. At this time the ionization ceases and current can flow through and pre-heat the filaments of the fluorescent lamp.

Since ionization (glowing) has ceased, the bimetallic strip begins to cool down and in a few seconds opens to start ionization (glowing) again. The instant the bimetallic ceases to make contact (opens), an inductive kick from the ballast produces some high voltage spikes 400 V to 600 V, which can ignite (strike) the fluorescent lamp. If the lamp fails to ignite or start, the glow switch mechanically repeats its igniting cycle over and over until the lamp ignites, usually within a few seconds.

In this concept the ballast (inductor) is able to produce high voltage spikes using a mechanical switch opening and closing, which is fairly slow.

Since Thyristors (solid state switches) do not mechanically open and close, the conventional fluorescent lighting circuit concept must be changed in order to use Thyristors. In order to ignite (strike) a fluorescent lamp, a high voltage spike must be produced. The spike needs to be several hundred volts to quickly initiate ionization in the fluorescent lamp. A series ballast can only produce high voltage if a mechanical switch is used in conjunction with it. Therefore, with a Thyristor, a standard series ballast (inductor) is only useful as a current limiter.

Methods for Producing High Voltage

The circuits illustrated in Figure AN1010.2 through Figure AN1010.5 show various methods for producing high voltage to ignite fluorescent lamps using Thyristors (solid state switches).

Note: Due to many considerations in designing a fluorescent fixture, the illustrated circuits are not necessarily the optimum design.

One 120 V ac circuit consists of Triac and DIAC Thyristors with a capacitor to ignite the fluorescent lamp. (Figure AN1010.2)

This circuit allows the 5 µF ac capacitor to be charged and added to the peak line voltage, developing close to 300 V peak or 600 V peak to peak. This is accomplished by using a Triac and DIAC phase control network set to fire near the 90° point of the input line. A capacitor-charging network is added to ensure that the capacitor is charged immediately, letting tolerances of components or temperature changes in the Triac and DIAC circuit to be less critical. By setting the Triac and DIAC phase control to fire at near the 90° point of the sinewave, maximum line voltages appear across the lamp for ignition. As the Triac turns on during each half cycle, the filaments are pre-heated and in less than a second the lamp is lit. Once the lamp is lit the voltage is clamped to approximately 60 V peak across the 15 W to
20 W lamp, and the Triac and DIAC circuit no longer functions until the lamp is required to be ignited again.

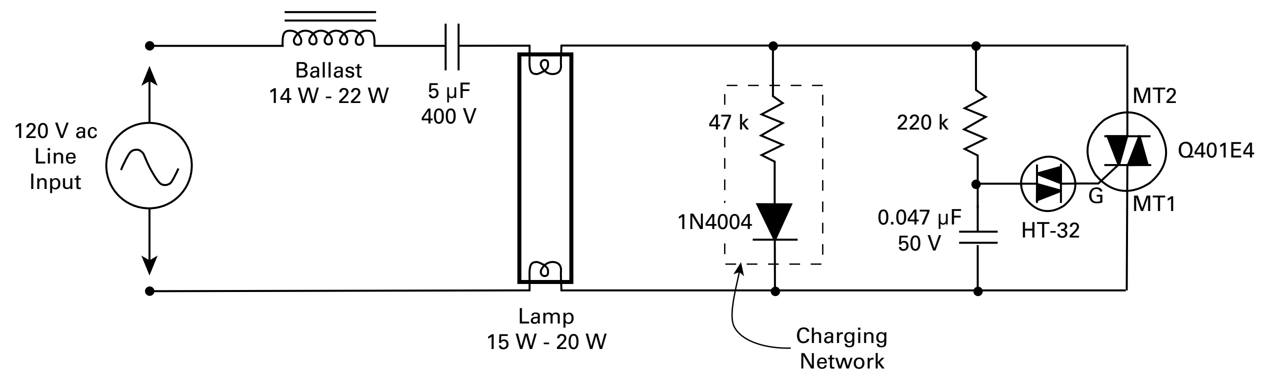

Figure AN1010.2 120 V ac Triac/DIAC Circuit

Figure AN1010.3 illustrates a circuit using a SIDAC (a simpler Thyristor) phase control network to ignite a 120 V ac fluorescent lamp. As in the Triac/DIAC circuit, the 5 µF ac capacitor is charged and added to the peak line voltage, developing greater than 200 V peak or 400 V peak to peak. Since the SIDAC is a voltage breakover (V_{BO}) activated device with no gate, a charging network is essential in this circuit to charge the capacitor above the peak of the line in order to break over (turn on) the SIDAC with a V_{BO} of 220 V to 250 V.

As the SIDAC turns on each half cycle, the filaments are pre-heated and in less than 1.5 seconds the lamp is lit. Once the lamp is lit, the voltage across it clamps to approximately 60 V peak (for a 15 W to 20 W lamp), and the SIDAC ceases to function until the lamp is required to be ignited again.

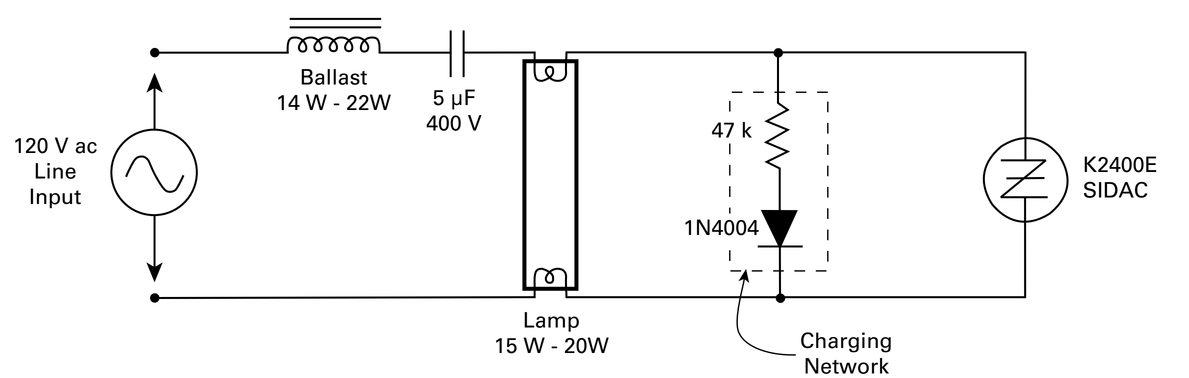

Figure AN1010.3 120 V ac SIDAC Circuit

The circuits illustrated in Figure AN1010.2 and Figure AN1010.3 use 15 W to 20 W lamps. The same basic circuits can be applied to higher wattage lamps. However, with higher wattage lamps the voltage developed to fire (light) the lamp will need to be somewhat higher. For instance, a 40 W lamp is critical on line input voltage to ignite, and after it is lit the voltage across the lamp will clamp to approximately 130 V peak. For a given type of lamp, the current must be limited to constant current regardless of the wattage of the lamp.

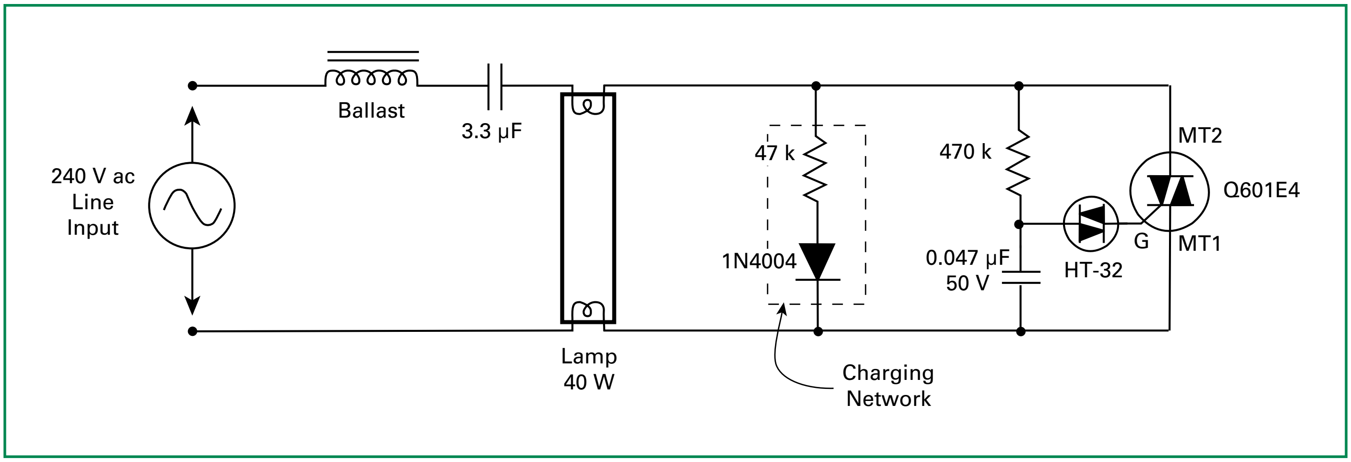

Figure AN1010.4 240 V ac Triac/DIAC Circuit

Figure AN1010.4 shows a circuit for igniting a fluorescent lamp with 240 V line voltage input using Triac and DIAC networks.

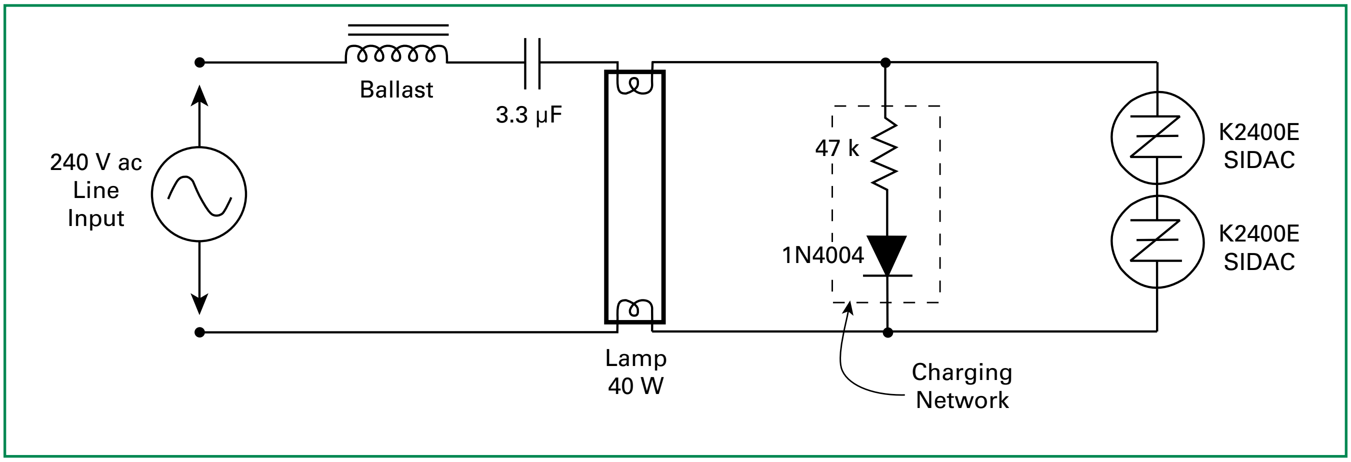

Figure AN1010.5 240 V ac SIDAC Circuit

Figure AN1010.5 illustrates a circuit using a SIDAC phase control network to ignite a 240 V ac fluorescent lamp. This circuit works basically the same as the 120 V circuit shown in Figure AN1010.3, except that component values are changed to compensate for higher voltage. The one major change is that two K2400E devices in series are used to accomplish high firing voltage for a fluorescent lamp.