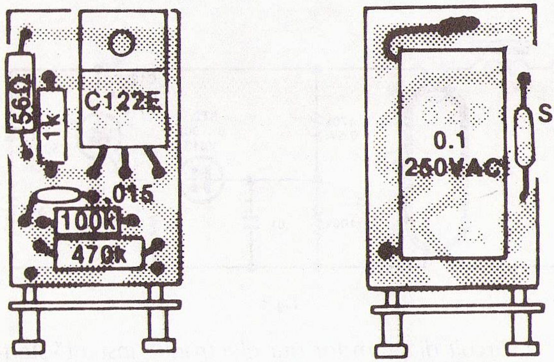

component side

copper side

Component overlays for both sides of the PC board.

Construction.

☐ The starter circuitry is mounted on a small PCB. The assembled PCB is then housed inside a conventional starter case. The first thing to do will then be to cannibalise an old (worn out) starter. You need to remove the starter innards without damaging the circular lid which carries the two connector pins. Clip off the starter lamp and the capacitor but leave about 5mm of the leads, so that they can be soldered to the PCB assembly. For obvious reasons, you should not use a starter with a metal case.

You may find that some starter cases have an indent on the end. If so, you may have to grind a fraction off the PCB and probably the starter case too.

☐ Six components are mounted on the component side of the PCB, while two are mounted on the copper pattern side. Mount the four resistors first, then the .01uF greencap.

☐ Now bend the leads close to the SCR body before installing it. Use a pair of long nose pliers to avoid undue strain on the case/lead join. Now install the .1uF capacitor and the DIAC on the copper pattern side of the board.

☐ Finally, solder the PCB assembly to the starter lid terminals. Check all connections visually, or use a multimeter, switched to the "ohms" ranges, to check the circuit components for continuity. The DIAC should read open circuit and the SCR should be 570k between anode and cathode (this is the value of the resistor string).

☐ If all is well, carefully slide the whole assembly into the starter case. This is a squeeze, but it will fit. The electronic starter can be used on 20W or 40W fittings (65W fittings are NOT recommended). Just remove the existing starter, carefully install the electronic one and turn it on.

We should make a special note about the use of this starter in a dual 20W fitting which use two starters and one ballast. In some fittings, the electronic starter will not work, depending on the characteristics of the ballast and the polarity of the two starters. In view of this uncertainty, we do not recommend that the starter be used in these fittings, as well as the 65W fittings mentioned earlier. ●

Text and Illustrations courtesy of Electronics Australia

EDITION ③

Assembly Manual for the

Fluoro Starter

K-3082

THIS FLURO STARTER KIT WILL NOT OPERATE WITH THE NEW SLIMLINE FLURO TUBES CURRENTLY ON THE MARKET (DUE TO HIGHER STARTING CURRENTS REQUIRED). TO BE USED ONLY WITH STANDARD 20 OR 40 WATT TUBES.

PLEASE READ DISCLAIMER CAREFULLY AS WE CAN ONLY GUARANTEE PARTS AND NOT THE LABOUR CONTENT YOU PROVIDE.

DICK SMITH KIT

Reprinted in part by arrangement with Electronics Australia from their October, 1982 edition.

Do your fluorescent lights go blink, blink, blinkety-blink when you switch them on? This substitute electronic starter solves that problem and gives a smooth, rapid start every time you switch on. All the parts are housed in a standard starter case so the light wiring does not have to be modified.

This new electronic starter not only solves the problem of random flashing and temporary blindness when fluorescent lights are switched on but also reduces RF interference. It may also contribute to extended tube life. With that list of advantages we realise that you are just rearing to know how it works, so let us first discuss how a fluorescent light works and starts normally.

There are a surprisingly large number of fluorescent light circuits including instant start, rapid start, lead-lag ballast and so on but the configuration most commonly found in domestic and commercial lighting installations is still the starter-preheat system shown in Fig. 1.

While this circuit looks fairly simple, it is in fact quite complicated in operation, as are most types of fluorescent light circuit. However, we will attempt to give as straightforward a description as possible. Essentially, the circuit has two modes of operation, start and run. In the start mode, the starter is involved (no, we're not putting you on) and in the run mode, the starter is effectively out of circuit.

Basically, the glass tube has a filament heater at each end and contains a minute quantity of mercury and a mixture of inert or noble gases at very low pressure. In the start mode, current is passed through the two filaments to raise them to red heat. At this temperature they emit electrons freely (thermionic emission) which rapidly disperse in the tube so that an electric discharge can occur through the inert gas when a high voltage is applied between the two filament electrodes.

The electric discharge first occurs through the inert gas which rapidly heats up and thereby vaporises the small quantity of mercury. The mercury atoms are then excited by the arc discharge and they release energy which is mainly in the form of ultraviolet radiation at a wavelength of 253.7 nanometres.

This ultraviolet radiation then impinges onto the white phosphor coating on the inside of the tube which then "fluoresces" to emit visible light. About 20% of the ultraviolet radiation is transformed to visible light while the rest is liberated as heat.

Text and Illustrations courtesy of Electronics Australia

We can now return to the circuit of Fig. 1. When the electric discharge is established in the fluorescent tube, it has a low and essentially negative resistance. Effectively, this means that once the arc is started the current will rapidly increase until the tube overheats and burns out. To prevent this, a "ballast" is connected in series with the tube. The ballast is an iron-cored inductor which "saturates" at a predetermined current level and thereby limits the current through the tube to a safe level.

So that is how the ballast functions in the "run" mode. In normal operation, the tube actually strikes and extinguishes during every mains half-cycle so that it actually flashes at a rate of 100Hz.

Power factor correction

As well as limiting the current through the tube to a safe value during the "run" mode, the ballast also plays a crucial part in the "start" mode. This mode occurs as follows:

When power is first applied, a small current flows via the ballast, tube filaments and starter bulb which is filled with argon (or some other inert gas). Within a few milliseconds the ionising and resultant heating of this gas causes a set of bimetallic contacts in the starter to close and a relatively heavy current then flows through the tube filaments and ballast.

While the tube filaments heat up and begin emitting electrons, the starter bulb then cools again and the bimetallic contacts open to interrupt the filament current. The ballast does not like this and generates a large peak voltage which then fires the fluorescent tube, if all goes well.

In practice, though, the starter usually needs more than one attempt to fire the fluorescent tube. For example, the mains voltage may be a little low, the ambient temperature may also be low and the starter may interrupt the filament current just when it was low or passing through zero, in which case, little or no peak voltage would be generated by the ballast.

Note that the circuit of Fig. 1 shows a capacitor internally connected across the starter. The capacitor is usually a ceramic or Mylar dielectric type of about .005μF and is included to suppress RF interference which occurs at the moment of contact opening. The capacitor also provides some suppression of the RF interference produced by the electric discharge in the fluorescent tube itself.

The usual reason for the eventual tube failure is that the filament emissive material becomes exhausted or the filament goes open circuit. However, the starter will noticeably deteriorate long before the tube approaches the end of its life. So this is where our electronic starter comes in. It will not deteriorate, it will give a reliable start every time and should give a longer tube life (although we have no data to support this theory at the time of writing).

Parts List

☐ 1x .... 56R ½W (grn-blu-blk)
☐ 1x .... 1k (brn-blk-red)
☐ 1x .... 100k (brn-blk-yel)
☐ 1x .... 470k (yel-vio-yel)
☐ 1x .... 0.01 uF greencap
☐ 1x .... 0.1uF MPC capacitor
☐ 1x .... BR100/ST2 diac
☐ 1x .... SCR
☐ 1x .... PCB
☐ ½m .... solder

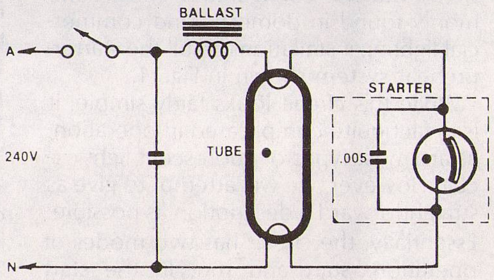

Fig. 1

Fig 1: Common fluorescent starter circuit.

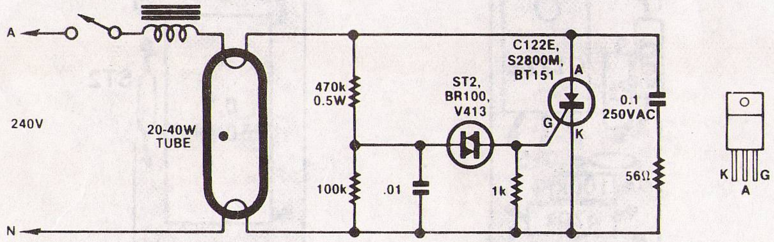

Fig. 2

Fig 2: Circuit diagram for our electronic "instant" starter.

Fig. 2 shows a fluorescent light fitting with the electronic starter in place of the conventional type. Essentially, the electronic starter is a silicon controlled rectifier (SCR) which feeds half-wave rectified AC to the filaments, via the ballast.

As the filament current drops to zero, at the end of every alternate half-cycle, the SCR turns off and the ballast generates a high voltage peak which then fires the tube. In effect then, the electronic starter gives the fluorescent tube a stream of repeated "strikes" until the tube fires sufficiently well to sustain conduction and give full illumination.

In practice, the tube comes on immediately the power is applied but at a relatively low level of brightness. Then, after one or two seconds it comes up to full brightness without flicker or any other drama. At the same time, the ballast makes a louder than normal buzzing noise during the brief turn-on period and thereafter makes no more noise than is normal.

The method of triggering the SCR is as follows: Mains voltage is applied via the ballast and tube filaments to a voltage divider network consisting of a 470kΩ and a 100kΩ resistor, to charge a .01μF capacitor rises to about 30V, the ST2 breaks down and dumps the capacitor's charge into the SCR gate. This fires the SCR which then continues to conduct until the ballast current drops to almost zero at the end of the mains half-cycle.

The resulting voltage peak generated by the ballast is damped by the RC network across the SCR. This has the desirable effect of preventing damage to the SCR (by limiting the peak voltage) and also lengthening the time for which high voltage is applied to the tube so that a "strike" can occur.

Looking at it another way, the 0.1μF capacitor could be regarded as providing a series resonant network, in conjunction with the inductance of the ballast. This resonance is then excited by the voltage spike, generated by the back-EMF action of the ballast, and is damped by the 56Ω resistor plus the series resistance of the ballast itself.

The 1kΩ resistor connected between gate and cathode of the SCR prevents any likelihood of spurious triggering of the SCR when the tube is in the "run" mode. Note that once the tube is fired and running, the voltage across the electronic starter is low enough at about 100VRMS to prevent the starter from playing any further part in circuit operation, as with a conventional starter.

There is, however, a further bonus provided by the electronic starter in the form of the 0.1μF snubber capacitor. This has the effect of improved suppression of RF interference from the fluorescent tube. The electronic starter also produces much less "hash" at initial turn-on than a conventional starter so it all adds up to a much "quieter" fluorescent light, in the RFI sense.