

Title:

Lamp Control Circuit with Selectable Brightness Level

Technical Field

The present invention relates to circuits for controlling lamps in response to ambient light levels.

Background Art

The need for evermore economical systems of lighting and the parallel desire to save energy has seen advances in two directions. More effective and efficient forms of illumination have been devised including, very significantly, the fluorescent lamp. This lamp has undergone vast technical improvements in recent years, and it is quite common to find entire buildings lit only with fluorescent lamps. Other advances have been in the improvement of automatic switching systems for fluorescent and other lamps. These systems are designed to avoid the unnecessary consumption of energy when ambient lighting levels render artificial lighting unnecessary, or to reduce the level of artificial lighting when ambient light levels are merely less than optimal. There are a number of existing automatic switching systems. These include, mechanical photo-sensors which incorporate a heating element attached to a bi-metallic strip, which mechanically activates a switch. These devices lack sensitivity, and are inconsistent in their operation.

It is known to provide night light devices having photocells within the package, typically plugged into a wall socket, which switch on and off depending on ambient light. However these lack precision and cannot be used with a bright incandescent bulb, as the photocell tends to respond to the lamp light, causing oscillation.

A simple form of automatic switch is the timer switch.

These devices are passive, and are simply programmed to switch a lamp on or off at pre-determined times. They are inflexible and their programming must be renewed at different times of the year to allow for differing lighting conditions. In the case of a power failure their programming may be lost.

More sophisticated devices have been developed (see for example US Patent 5404080). However, these devices are commonly highly complex, requiring transformers, complex light gathering stages and provide a complexity of functions which together make the devices too expensive and too bulky for ready incorporation in existing lamps or for wide spread use.

Summary of the Invention

It is, therefore, an object of the present invention to provide a lamp control circuit, which will enhance the energy efficiency of a lamp by providing an inexpensive means for the automatic switching on and off of the lamp.

The invention has been developed for use with fluorescent lamps but it will be clear to a person skilled in the art that the invention need not be restricted to such lamps.

According to the present invention there is provided a control device for a lamp incorporating a light detection circuit operable to switch the lamp on or off via a switching means in response to ambient light impinging on a light detector, characterized in that a first threshold of ambient light intensity (L_x) at which the light detection circuit switches the lamp off in response to increasing ambient light intensity is greater than a second threshold of ambient light intensity (L_y) at which the light detection circuit switches the lamp on in response to decreasing ambient light intensity, thereby preventing the

switching means from oscillating due to influence of light generated by the lamp being detected by the light detector.

Preferably the light detection circuit incorporates a Schmitt trigger.

Preferably the light detector is located at a knockout opening of the lamp.

Preferably the light detection circuit incorporates a manual override means to switch the lamp on when the ambient light levels are above the first threshold (L_1).

Preferably the manual override means is manually resettable.

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Preferably the light detection circuit incorporates a lamp brightness selection circuit.

Preferably means are provided to allow selection of two lamp brightness levels.

Preferably a second of the two brightness levels is selectable by switching off and then on power to the device within a maximum brightness-selection time period.

Preferably said light detector comprises a photocell.

Brief Description of the Drawings

Embodiments of the present invention are described further with reference to the accompanying drawings in which:

Figure 1 is a circuit diagram of a solid state electronic lamp control circuit incorporating a switching means and a light detection circuit;

Figure 2 is a circuit diagram of the light

detection circuit;

Figure 3 is a circuit diagram of an alternative embodiment of the light detection circuit incorporating a manual override;

Figure 4 is a circuit diagram of a further embodiment of the lamp control circuit, without the light detection circuit;

Figure 5 is a circuit diagram of the light detection circuit shown in figure 4;

Figure 6 is a schematic diagram of a fluorescent light fitting fitted with the lamp control circuit.

Detailed Description of the Preferred Embodiments

In a preferred embodiment of the invention a lamp control circuit 10 is shown generally in figure 1. An AC source is connected to neutral terminal 11 and live terminal 12. Neutral terminal 11 is connected to point 13, to 220 μ F capacitor 14 and to the cathode of 6.2 V zener diode 16. The other terminal of capacitor 14 and the anode of zener diode 16 are connected to ground. The neutral terminal 11 is further connected to MT₁ of 2N6075B triac 18. The gate terminal of triac 18 is connected to light detection circuit 20 via the output 21 of light detection circuit 20. Terminal MT₂ of triac 18 is connected to one terminal of lamp 22. This lamp is preferably a fluorescent lamp but may be any form of electric lamp. The other terminal of lamp 22 is connected to the live terminal 12 and to the first terminal of 27.3 k Ω resistor 24. The other terminal of resistor 24 is connected to the cathode of 1N4002 diode 26. The anode of diode 26 is connected to ground.

A power supply is formed at point 13 by means of resistor 24, diode 26, zener diode 16 and capacitor 14. The voltage at point 13 is approximately equal to the zener breakdown voltage.

The output 21 of light detection circuit 20 may be either high or low. When this output is low, the triac 18 acts as a short circuit and switches lamp 22 on. When the output 21 of light detection circuit 20 is high the triac 20 creates an open circuit and switches lamp 22 off.

Referring to figure 2, the light detection circuit 20 comprises a power supply 30 connected to the first terminal of 1.5 k Ω resistor 32, the second terminal of which is connected to the first terminal of 100 k Ω variable resistor 34. The second terminal of variable resistor 34 is connected to the first terminal of Heimann A90.12 photocell 36 and to the inverting input of LM393 operational amplifier 38. The second terminal of the photocell 36 is connected to ground. Power supply 40 is connected to the first terminal of 47 k Ω resistor 42, the second terminal of which is connected to both the first terminal of 47 k Ω resistor 44 and the noninverting input of operational amplifier 38. The second terminal of resistor 44 is connected to ground. The output of the operational amplifier 38 is connected via 22 k Ω resistor 46 to the noninverting input of operational amplifier 38. The output of operational amplifier 38 is also connected via 56 k Ω resistor 48 to power supply 50.

The output potential of the above described first stage of light detection circuit 20, which may be measured at the output of operational amplifier 38, may be either high or low. The point at which the output changes between its two possible levels can be controlled with the voltage divider comprising resistor 32, variable resistor 34, and photocell 36. When the light incident upon photocell 36 is at a high level, for instance during daylight, the resistance of photocell 36 is negligible. The resistances of resistors 32, 34, 42 and 44 are such that, under these conditions, the inverting input voltage of operational amplifier 38 is

less than the noninverting input voltage of the operational amplifier 38. Consequently, the output of the operational amplifier will be high. As ambient light levels decrease, the resistance of photocell 36 rises, and consequently the inverting input voltage of operational amplifier 38 also rises. When the inverting input voltage exceeds the noninverting input voltage of operational amplifier 38 the output voltage will go low. Consequently, even though the ambient light level varies continuously, the output of operational amplifier 38 assumes either a high or low level. The first stage of light detection circuit 20 thus operates as a Schmitt trigger, and the output of operational amplifier 38 will exhibit hysteresis. As a result, small fluctuations in the level of ambient light as this level generally increases or decreases will not cause the output of operational amplifier 38 to oscillate rapidly between high and low levels.

The output of operational amplifier 38 is additionally connected to the first terminal of 2.2 M Ω resistor 52 and to the cathode of 1N4148 diode 54. The second terminal of resistor 52 and the anode of diode 54 are both connected to the first terminal of 47 μ F capacitor 56, the second terminal of which is connected to ground. The second terminal of resistor 52 and the anode of diode 54 are further connected to the noninverting input of LM393 operational amplifier 58. Power supply 60 is connected to the first terminal of 110 k Ω resistor 62 the second terminal of which is connected to 100 k Ω resistor 64 and also to the inverting input of operational amplifier 58. The second terminal of resistor 64 is connected to ground. The output of operational amplifier 58 is connected to the anode of 1N4148 diode 66, the cathode of which is connected to the noninverting input of operational amplifier 58. Diode 66 is provided to eliminate the effects of ripples in power supply 60. The output of operational amplifier 58 is

additionally connected to the first terminal of 1.5 k Ω resistor 68, the second terminal of which forms the output 21 of the light detection circuit 20. Point 13 is the power source for power supplies 30, 40, 50 and 60 of light detection circuit 20.

The light detection circuit 20 operates as follows. If, initially, ambient light levels are low (for example at night), the resistance of photocell 36 will be high and the output of the first operational amplifier 38 will be low. Consequently, the output of the second operational amplifier will also be low, and the triac 18 will conduct. Thus, lamp 22 will be on. As the ambient light level increases (for example as daylight approaches), the resistance of photocell 36 will fall. Eventually the potential at the inverting input of the first operational amplifier 38 will be sufficiently low that the output of operational amplifier 38 will go high. After a short time delay, determined by the resistances of resistors 48, 52, 62 and 64 and the capacitor of capacitor 56, the output of the second operational amplifier 58 will also go high. The gate potential of the triac 18 will accordingly go high and the triac will behave as an open circuit. Thus, lamp 22 will be switched off. This time delay ensures that momentary increases in ambient light levels (produced, for example, by the head-lights of a passing car) will not cause the light to be switched off.

This process is essentially reversed when initial ambient light levels are high and then decrease as, for example, when night falls.

Owing to the behaviour of the first stage of the light detection circuit 20, the light level at which the switching occurs differs slightly depending on the direction of the change. This ensures that, should light

levels fluctuate about a generally increasing or generally decreasing level a lamp will not be switched rapidly on and off when the light level is near the necessary level for switching to occur. The difference between the two light levels at which switching on and switching off occur may be controlled with resistor 46. The greater the resistance of resistor 46, the smaller the difference between these two switching light levels.

It may be desirable to adjust the level of ambient light at which switching occurs. This can be performed by modifying the voltage division performed by resistor 32, variable resistor 34 and photocell 35, by means of variable resistor 34. An increase in the resistance of variable resistor 34 will decrease the potential at the inverting input of operational amplifier 38 at any particular ambient light level. Consequently lamp 22 will be switched on and off at lesser ambient light levels. This may be useful where it the minimization of power usage is required.

A second embodiment of the light detection circuit is shown in figure 3. Light detection circuit 70 incorporates light detection circuit 20, although in this embodiment variable resistor 34 has a maximum resistance of 50 k Ω . In light detection circuit 70, the output of the second operational amplifier 58 is connected to the anode of MCR102 semiconductor controlled rectifier 72. The cathode of semiconductor controlled rectifier 72 is connected to ground. Power supply 74 is connected to the first terminal of 3.3 μ F capacitor 76, the second terminal of which is connected to the gate of semiconductor controlled rectifier 72. Point 13 is the power source of power supply 74 also. The second terminal of capacitor 76 is also connected to the cathode of 1N4148 diode 78 and to the first terminal of 22 k Ω resistor 80. The anode of diode 78 and the second terminal of resistor 80 are connected to ground.

These additional circuit elements provide the light detection circuit with a manual override. This override is employed to switch lamp 22 on even though ambient light levels would normally dictate that lamp 22 be off. Under these conditions the output of second operational amplifier 58 would normally be high. If the power supply to the circuit is switched off and then on, these two operations occurring within 0.5 to 1.5 seconds of each other, a pulse will be generated by capacitor 76 which will cause semiconductor controlled rectify 72 to conduct and hence the output of operational amplifiers 58 will go low. Accordingly, as described above, lamp 22 will be switched on.

The manual override can be reset in two ways. This may be performed manually by switching the power supply off and then on again but with the interval between these operations greater than five seconds. Alternatively the resetting will occur automatically when the surrounding ambient light decreases to a level such that the second operational amplifier 58 would, under normal operating conditions, become low. This will make the potential at the anode of the semiconductor controlled rectifier 72 low and, consequently, the semiconductor controlled rectifier 72 will become an open circuit. Accordingly, the light detection circuit 70 will return to normal operational mode.

A third embodiment of the invention is shown in figures 4 and 5. In this embodiment it is possible to set the lamp's brightness at either of two levels, one being the standard brightness, the other corresponding to 50% current consumption. The lamp control circuit 90 of this embodiment is shown in figure 4, though without the light detection circuit. An AC source is connected to neutral terminal 92 and live terminal 94. Neutral terminal 92 is

connected to point 96, to 440 μ F capacitor 98 and to the cathode of 6.2 V zener diode 100. The other terminal of capacitor 98 and the anode of zener diode 100 are connected to ground. The neutral terminal 92 is further connected to MT₁ of 2N6075B triac 102 terminal MT₂ of which, as in earlier embodiments, is connected to lamp 104.

The other terminal of lamp 104 is connected to the live terminal 94 and to the first terminal of 27.3 k Ω resistor 106. The other terminal of resistor 106 is connected to the cathode of 1N4002 diode 108. The anode of diode 108 is connected to ground. Neutral terminal 92 is further connected to the first terminal of 47nF capacitor 110, the second terminal of which is connected to the first terminal of DB3 diac 112. The second terminal of diac 112 is connected to the gate terminal of triac 102. Neutral terminal 92 is further connected to MT₁ of 2N6075B triac 114 and to the first terminal of 100nF capacitor 116. MT₂ of triac 114 and the second terminal of capacitor 116 are connected to the first terminal of 10 k Ω resistor 118, the second terminal of which is connected to the first terminal of diac 112. MT₂ of triac 114 and the second terminal of capacitor 116 are also connected to the first terminal of 50 k Ω variable resistor 120, the second terminal of which is connected to MT₂ of triac 102 via 5.1 k Ω resistor 122. Light detection circuit 130 (figure 5) is connected at points 124 and 126, as discussed in detail below.

The light detection circuit 130 of this embodiment is shown in figure 5. The circuit 130 incorporates light detection circuit 20 (see figure 2), although in this embodiment variable resistor 34 has a maximum resistance of 50 k Ω , and the resistor 68 connected to the output of second operational amplifier 58 in light detection circuit 20 is replaced in light detection circuit 130 with 47 k Ω resistor 132. The second terminal of resistor 132 is connected to

The gate of BC337 transistor 134. The collector of transistor 134 is connected to 50% output 136 via 1.5 k Ω resistor 138. The emitter of transistor 134 is connected to ground.

The output of second operational amplifier 58 is also connected to 33 μ F capacitor 140, which is then connected both to power supply 142 via 470 k Ω resistor 144, and to the gate of BC337 transistor 146 via 560k Ω resistor 148. The collector of transistor 146 is connected to 100% output 150 via 1.5 k Ω resistor 152. The emitter of transistor 146 is connected to ground.

The output of second operational amplifier 58 is further connected to the first terminal of 1 k Ω resistor 154, the second terminal of which is connected to 100% output 156 via 510 k Ω resistor 159. The second terminal of resistor 154 is additionally connected to the emitter of BC327 transistor 160, the collector of which is connected to power supply 162. The gate of transistor 160 is connected via 47 k Ω resistor 164 both to 22 μ F capacitor 166 and to the cathode of MCR102 semiconductor controlled rectifier 168. The anode of semiconductor controlled rectifier 168 is connected to power supply 170, while the cathode is further connected to ground via 5.1 k Ω resistor 172. The gate of semiconductor controlled rectifier 168 is connected to the cathode of 1N4148 diode 174, the anode of which is connected both to power supply 176 via 3.3 μ F capacitor 178, and to ground via 47 k Ω resistor 180.

Power supplies 30, 40, 50, 60, 142, 162, 170 and 176 of light detection circuit 130 are connected to power source point 96 of lamp control circuit 90. 100% outputs 150 and 156 are connected to the gate terminal 124 of triac 102, and 50% output 136 is connected to the gate terminal 126 of triac 114.

The operation of this embodiment of the invention is similar to that of the second embodiment. When the power supply to the circuit is first switched on, semiconductor controlled rectifier 168 is triggered off causing the potential between resistors 154 and 158 to go high. During darkness triac 102 provides 100% current to the lamp 104, owing to the conduction of transistor 146 alone. However, the 100% current consumption is sustained for only a few seconds, determined by resistor 144 and capacitor 140. The output at 150 then ceases and the current to the lamp 104 drops to 50% of its previous level.

If, however, power to the circuit is switched off and then on within a period of 0.5 to 1.5 seconds, the semiconductor controlled rectifier 168 is triggered off and so does not affect 100% output 156. Therefore, during darkness the lamp is permanently at 100% brightness.

Figure 6 is a schematic diagram of the lamp control circuit, installed in an otherwise conventional fluorescent lamp fitting. The fluorescent lamp fitting 182 is provided with a fluorescent tube 184, a knockout opening 186 and two gaps 188 and 190. The photocell 192 and the sensitivity adjustment 194 (corresponding to variable resistor 34) are located at one end of the fitting.

The present invention therefore provides a simple, inexpensive device that may be integrated into a conventional fluorescent lamp using a standard ballast, and requiring no additional wiring. It may be located at a knockout opening of a lamp fitting. It is compact and suitable for mass production, but nevertheless incorporates several important features including variable light sensitivity, manual override, and selectable brightness. The variable sensitivity control may also be located at the knockout opening of the lamp fitting. The hysteresis of

the circuit ensures that the circuit will not oscillate owing to the influence of light generated by the lamp being detected by the light detector or uneven changes in the levels of ambient light.



THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A control device (10, 90) for a lamp (22, 104) incorporating a light detection circuit (20, 70, 130) operable to switch the lamp (22, 104) on or off via a switching means (18, 102, 126) in response to ambient light impinging on a light detector (36), characterized in that a first threshold of ambient light intensity (L_x) at which the light detection circuit (20, 70, 130) switches the lamp (22, 104) off in response to increasing ambient light intensity is greater than a second threshold of ambient light intensity (L_y) at which the light detection circuit (20, 70, 130) switches the lamp (22, 104) on in response to decreasing ambient light intensity, thereby preventing the switching means (18, 102, 126) from oscillating due to influence of light generated by the lamp (22, 104) being detected by the light detector (36).
2. A control device (10, 90) for a lamp (22, 104) as claimed in claim 1 characterized in that said light detection circuit (20, 70, 130) incorporates a Schmitt trigger.
3. A control device (10, 90) for a lamp (22, 104) as claimed in either of the preceding claims characterized in that the light detector (36) is located at a knockout opening (186) of the lamp (22, 104).
4. A control device (10, 90) for a lamp (22, 104) as claimed in any one of the preceding claims characterized in that the light detection circuit (20, 70, 130) switches the lamp (22, 104) off in response to increasing ambient light intensity after a time delay to prevent the turning off of the lamp (22, 104) during darkness due to momentary increases in ambient light.
5. A control device (10, 90) for a lamp (22, 104) as claimed in any one of the preceding claims characterized in that the light detection circuit (70) incorporates a manual override means (72, 74, 76, 78, 80) to switch the lamp (22,

13. A control device (10, 90) for a lamp (22, 104) as claimed in claim 12 characterized in that a second of the two brightness levels is selectable by switching off and then on power to the device (10, 90) within a maximum



brightness-selection time period.

14. A control device (10, 90) for a lamp (22, 10) claimed in any one of the preceding claims characterized in that said light detector (36) comprises a photocell.

15. A control device (10, 90) for a lamp (22, 104) as claimed in any one of the preceding claims characterized in that the light detection circuit (20, 70, 130) is provided with first threshold (L_1) and second threshold (L_2) adjustment means (34).

16. A control device (10, 90) for a lamp (22, 104) as claimed in claim 15 characterized in that said adjustment means (34) comprises a variable resistor.

This Sheet Has Been Replaced

