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POWERING LIGHT APPLIANCES WITH 4-WIRE SYSTEM FOR REMOTE CONTROL OR LOCAL CONTROL

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Abstract: *Using a 2-wires system in order to powering light appliances is nowadays a common practice. Despite the fact that this system is simple and reliable, it is very old and impossible to be controlled with cheap devices. The future is definitely to internet of things and to smart houses. In this paper a 4-wire system will be developed in order to supply light appliances in a smart house using an optimal configuration and changing a minimum in electricians practice, but keeping the cost of devices as low as possible. These approaches keep the reliability of the 2-wire system and transform a house in a smart home.*

Key words: *smart house, internet of things, powering systems, green energy.*

1. Introduction

The usual practice in present houses is to use a 2-wire system to power the light appliances. This system is very simple and reliable but is impossible to use it for remote control or automatic control over the light in the room. For a common user these issues imply a great financial effort and the results are not so reliable on a decent price. Connecting this system to internet becomes a very difficult task and beside the cost of the project, the manpower cost is also high because of the level of expertise. Nowadays, the internet of things becomes more and more popular and the price for developing platforms becomes attractive on a large scale [6].

The idea behind a 4-wire system for powering light appliances is to prepare an ordinary house to be connected to internet and to become a smart house at a decent price with minimum invasion on the already existing electrical system.

In the same time the light appliances switch rapidly to the new LED technology. This technology is already gaining major factories and the future is promising in this direction [2], [5], [7].

At a price of almost 3 times higher that "economically" bulbs based on fluorescent technology and at 5 times lower power, the lighting LED technology conquers our houses day by day. Also the automobiles, the buses, the factories, the main hypermarkets are already using this technology because of the green energy issues and because of the marketing issues.

The LED technology also is greener than the previous because of the lower energy consumption but also because it is a lead free technology [1].

With all these considerations is logical to admit that the thickness of electrical cables

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used to power the light appliance suffer a significant decrease and a new 4-wire cable have to has the old thickness of a 2-wire systems.

The other 2 wires will be used to connect the appliance to a control device, which could be a desk computer, a cloud computer or an embedded computer.

2. Related Issues

2.1. Internet of Things

The Internet was a big revolution in human communications and knowledge. The next step was introduction of the machines that communicate each other's without human intervention. The Internet of things (IoT) provides the connection between humans, computers and internet. A triangle is more stable that a single line so we can expect to a long life of this configuration. In this moment there are many "things" that can connect to internet; they have their own IP and their physical (including wireless) connections and they decide when to connect to internet. In the next years we expect, according to researchers, to have a growing of numbers of such things. According to Gartner, there will be nearly 26 billion devices on the Internet of Things by 2020 [4], [6].

In these perspectives using a smart home which is able to remote control the light via internet is a natural consequence.

2.2. LED Technology

The LED technology is on market from beginning of 50's. It consists in a relatively low-energy means of emitting light, namely light emitting diode (LED). This technology is used in many electronic devices used frequently in the average home. LED is different from the standard light bulb seen in most homes because it uses an electrified semi-conductive material to produce light instead of an electrified filament. We are already used to meet nearly omnipresent LED technology in computers, televisions, remote controls, and flashlights, as well as in signs, traffic lights, and recently in architectural and stage lighting.

Any student learns in his first years of college that a LED light is obtained because electrified energy causes the semiconductor contained inside the LED bulb to emit light. Used to produce blue or white light, nitride is one of the most common semiconductors applied in LED modules [1], [3].

Though the use of LED technology for simple lighting is more costly to set up than lighting with standard bulbs, LED technology offers a number of advantages. Because the tiny metal thread known as the filament is prone to heat weakening and breakage, LED bulbs are more durable and long-lasting than standard filament bulbs. They are less prone to breakage than fluorescent bulbs and they consume much less energy than either standard light bulbs or fluorescent bulbs.

2.3. 4-Wires System

The traditional 2-wire system is already used in every home. In Figure 1 it can be seen the actual schematics used on large scale in home light system. Also in the figure, main represents the main distribution point; Rx's represents the distribution box; L's represents the light appliances and Sw's represents the switches controlled by humans. The only aspect that is relevant is that the schematic shows the possibilities of controlling. It brings power from main distribution to a switch and then to the light appliance. Every electrician is familiar to connect and to solve problems in such a system. The main issue is that the power is everywhere: on the wires, on the switch, all over.

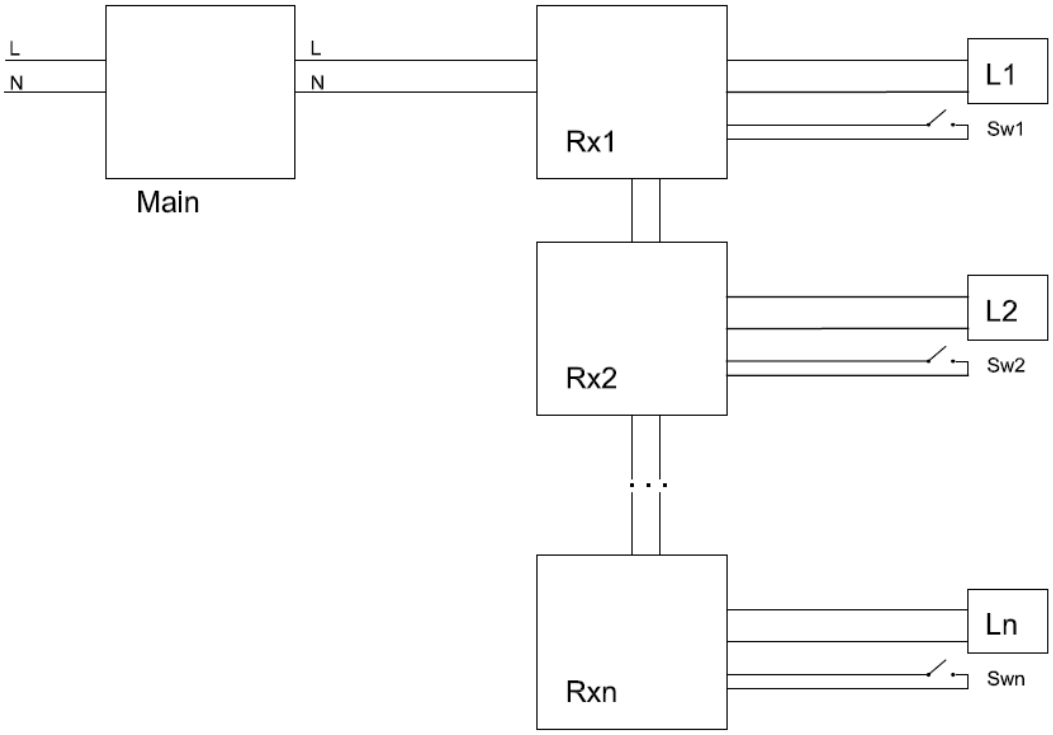

Fig. 1. *2-wires system used in light systems*

A malfunction could appear on every part of the system and is difficult to locate precisely.

The 4-wire system separates the power from the control. 2 wires are still transferring the power and the other 2 transfer the control signal. The main advantage is that any person does not interfere with main power and that the control system can operate with or without human in any moment.

3. The System Design

3.1. Block Schematics

The new schematics will use the same structure from 2-wires system but will add special control elements, which will connect the control device to the old wire system. It can be seen in Figure 2. In this picture (in addition to Figure 1) we have 4 wires from main distribution system (Main) to new distribution boxes (Rx's) and the old 2 position switches (on-off) were replaced by new push buttons. The light appliances (L's) remain the same and also the 2 wires between the new distribution boxes and the old light appliances remain.

This structure is convenient because of minimum invasion on old schematic and also because only the distribution system is changed.

The modular boxes prevails the old structure of schematics which is very convenient for manpower. In this situation the electricians keep the old configuration, replacing only the distribution box; but the structure is the same and training time for electricians is very low (hours).

Also the Ct controller on Main distribution in Figure 2 can be made using different approaches.

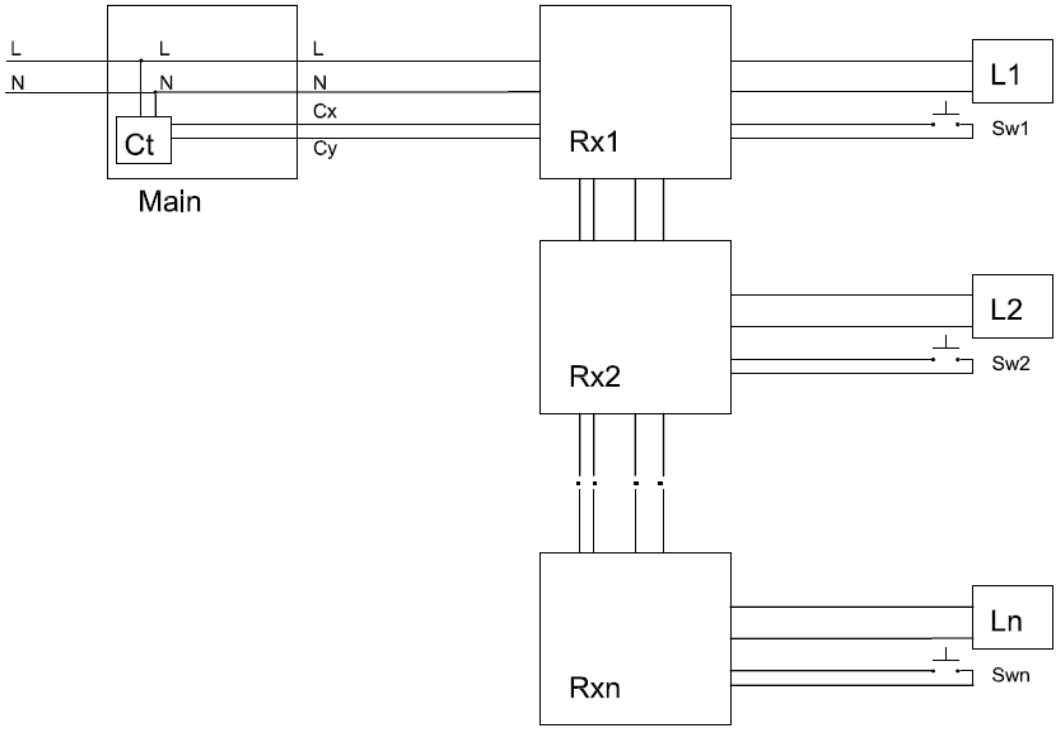

Fig. 2. *4-wires system proposed for light systems*

The easiest is to use a simple time controlled switch that can be placed on main distribution rail next to power switches or protections.

The most advanced is a special one with possibility to internet connection both wired or wireless. In this situation we transform the light system of the house in IoT.

Also in Figure 2 the Cx and Cy lines are connected together (parallel configuration) in order to control all the light appliances simultaneously. It is possible to use separate lines from Rx's to Main and to have separate control on each light appliance. This issue depends on local configuration and on control requirements, but this schematic can be used in both cases with minimum connection changes.

Using the push buttons instead of 2 state switches is also a main advantage of this schematic. Usually there is no rule to place the switches for lights. Different electricians have different ideas about switch positioning and also IEEE standards are easily avoided because there is no malfunction when the "ON" position of the switch is reversed. In case of the push buttons there is not this issue because they don't have memory. The first push will turn on and the second will turn off or vice versa.

Also the configuration will approach differently the blackout. On the old schematics (like those in Figure 1) after a blackout the light will keep the initial position. Of course that someone must switch all the switches in order to cut-off the light and to prevent power consumption after the power is restored. If there is no rule for switches in different rooms this is a big problem that cannot be solved. On proposed schematic this is very easy to be solved. On restoring the power all the lights will remain off until they receive a signal from control or push buttons. Also is possible to connect a special main

switch to control all the light in a house. This switch could be mounted near the entrance and before get out someone could turn off all the lights simultaneously.

3.2. Distribution Boxes

The main change in hardware device is relying on the new distribution boxes (Rx's in Figure 2). These distribution boxes are powered by main network and by control signals. The output is the same like on the old ones (Rx's in Figure 1).

In Figure 3 is presented the electrical schematic for these Rx's.

The main issues are given by the 4 connection inputs (connected to 4-wires system), the push button which is referred as S1 and the 2 outputs for light appliances (L's in Figure 2). These outputs are connected to a 2 pole relay with direct connection to main power. The relay is activated by Q1 which is logically controlled. The core is based on one ATTiny microcontroller, a very cheap ATMEL microcontroller (under 1 dollar per chip) [8].

The power for the chip and the other components is given by a special switching supply. It is also a small jumper (JP2 in Figure 3). This jumper will determine the logical behaviour of the Rx's on blackout or power cut situations. If this jumper is missed the control system will "forget" the initial state and all the time when is powered, it will start from light off situation. If the jumper is connected the circuit will memorize the last state and will start from that state (on or off).

Also the IC will be mounted on a socket. This will assure a very easily changing of the circuit in case the system falls. For reliability of the system this is an important issue.

3.3. The Control Box

Control box is placed in main distribution and can be seen in Figure 2. The aim is to interface the 4-wired system with the time controller or with the internet. This configuration allows a large scale of applications.

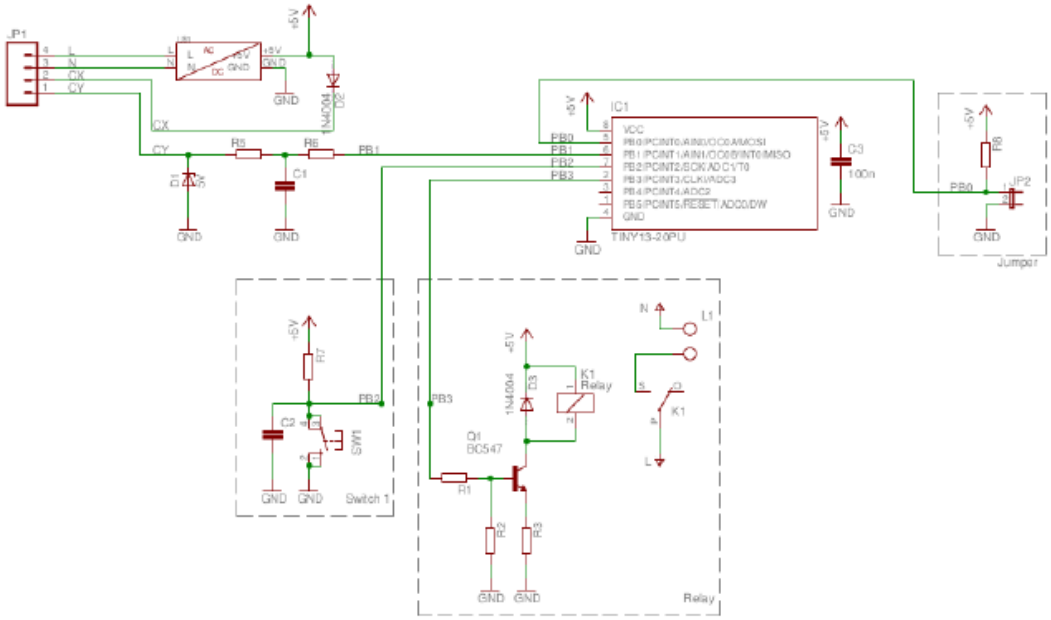

Fig. 3. *New distribution box schematic*

There are time switches already on the market and if the user needs a custom control it can be made using the actual standards.

Also is possible to split the control box in power section (and include it in main distribution like in Figure 2) and logical section (and place it on communication systems).

4. Conclusions

This 4-wires system is easily to be implemented, is cheap enough and allows modular development and also could be controlled by many devices with local control or remote control.

The implementation requires very few modifications in existing systems and also doesn't need very specialized manpower.

This proposed system prepares the old systems to the new impact of technology of Internet of Things and also keeps the cost as low as possible.

The green issue is related with this project because of the possibility of minimize the power used in house lightning due the control possibilities. This control can be made with a local controller based on a time machine or remote with an internet controller.

Also this project avoids using the wireless connection between modules in order to save power and money but the controller itself can be wireless connected to the internet.

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