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Driver for insole heated by Graphite Nanoribbons

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Abstract

Electronic device responsible for constraining the average power delivered to an insole composed of graphite nanoribbons. As the most wearables are power constrained, the main criterion guiding the system design comes down to minimization of power consumption, while retaining sufficient energy to heat the device properly.

Key words:

Graphite, wearable, heat control

Introduction

The use of gloves and shoes with internal heating is a common solution for workers in the refrigeration industry. Footwear and gloves with soles and heated linings are available to meet this demand. The heating is carried out by Joule effect by an electric current that crosses a network of metallic wires that permeate the insole or the fabric. However, so that the wires do not break easily, they must acquire a certain mechanical strength, which tightens the equipment and reduces the user's dexterity.

An alternative proposal makes use of a flexible material, but with high resistance to ruptures, composed of graphite nanoribbons. This proposal is currently being developed at the Semiconductor and Nanotechnology Components Center (CCSNano) of UNICAMP. This project is part of this proposal and focuses on the development of the electronics needed to control and power the heater to the graphite nanoribbons being developed.

The idea is to have a circuit capable of decreasing the power consumption required to maintain the insole heated and operating properly. One of the challenges is to accomplish it employing discrete and cheap components instead of expensive and complex ones. There is also a dimension and mounting restraint characteristics that should be performed to ensure users safety/comfort.

The device has a switch that changes between two different configurations. Each configuration will deliver a distinct amount of power to the graphite nanoribbons that is, two different temperature setpoints.

Results and Discussion

The PWM control caused a significant improvement in the current consume over time. However, care must be taken: the duty cycle must stay at a percentage that does not compromise the insole temperature.

In the construction of the circuit a triangular wave generator was used along with a voltage level comparator to achieve the desired duty cycle. The logical circuit responsible for the overall control consumes very low power in comparison to the power used to heat the graphite material. It is important to notice that the amplifier integrated circuit requires a minimum of 3V to operate and 3 NiMh batteries were used in series in the tests, which guarantee the minimum voltage for most of the time.

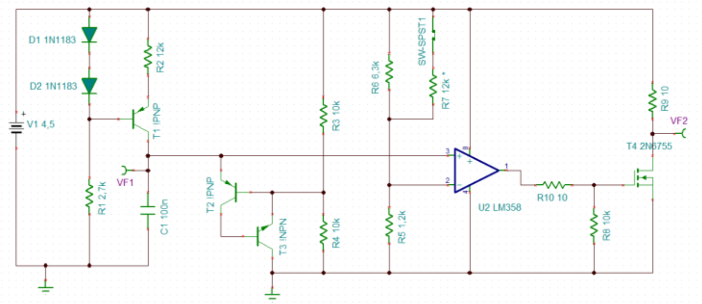

Figure 1. Circuit schematic of the nanoribbons driver.

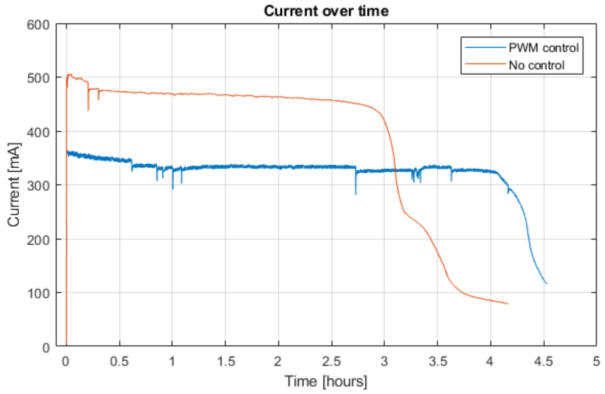

Figure 2. Different control modes and their currents curves.

Conclusions

The PWM control helps to save significant battery energy and, consequently, makes the batteries last longer. The duty cycle was carefully calibrated to ensure that the temperature levels were appropriate to satisfy the application requirements.

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