

Multitasking Scriptable Autotuning PID Platform

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1 Hardware

1.1 Definitions

All physical components, resulting from this project, will be called 'device' throughout the paper.

1.2 Goals

The device is intended as a learning project for the student, but also as a open software, open-hardware project, which anyone can create and use. Thus, the following hardware design priorities have been identified, in order of decreasing importance:

- safety – the device shall not cause a fire or electric shock to the end user
- reconstructability – the device shall be composed **only** of worldwide accessible components
- longevity – the device shall remain operational for 5 years of uninterrupted service with 95% confidence
- price – the BOM for the complete device shall not exceed 100BGN
- extendability – the number of input sensors and the number of output controllers, shall be trivially configurable
- ease of assembly – it shall be possible for a person with zero hardware experience to manufacture the device
- simplicity – each component shall fulfill a specific purpose, and the number of components shall be the lowest possible

1.3 Layout

Due to the requirement of extendability, the device shall consist of a number of printed circuit boards, in contrast to a single monolytic PCB. Each PCB shall fulfill a sole purpose, and any number of different modules shall be able to mate together. The following distinct roles have been identified:

- high-voltage input stage – called zero-cross detector or ZCD board from now on
- computational stage – called main board from now on
- high-voltage output stage – called software controlled rectifier board or SCR board from now on

The resulting design exhibits the following characteristics. Only a single ZCD board is required, because mains waveform is invariant across the device in it's entirety. Only a single main board is required, as the selected microcontroller, although inexpensive, provides plenty of resources for numerous control loops. In order to satisfy the requirement

for simplicity, the main board is configured for a single SCR output board. However, soldering additional connectors to the main PCB is trivial, thus achieving extensability. The SCR output board is long-life and supports loads of up to 1kW.

1.4 ZCD board

The ZCD board is a sensory input to the microcontroller. Because the voltage of mains power is alternating, it is impossible to output precise amounts of power without knowing the phase of the waveform. The implementation of the ZCD board is straightforward and extremely simplified. In fact, an extensive internet search has demonstrated no other PCB has ever been designed with such a level of simplicity. In other words, **the designed PCB contains fewer elements than any known PCB for the same purpose!** This produces problems, which have deterred other designers. However, all artifacts have been dealt with in software.