# Universidade de Aveiro

## Dep. de Eletrónica Telecomunicações e Informática

## Reverse Engineering

## Project #3

### 1. Description

Consider the simplified scheme of a simulated thermal chamber with two cavities interconnected by perforated plates as shown in the following figure:

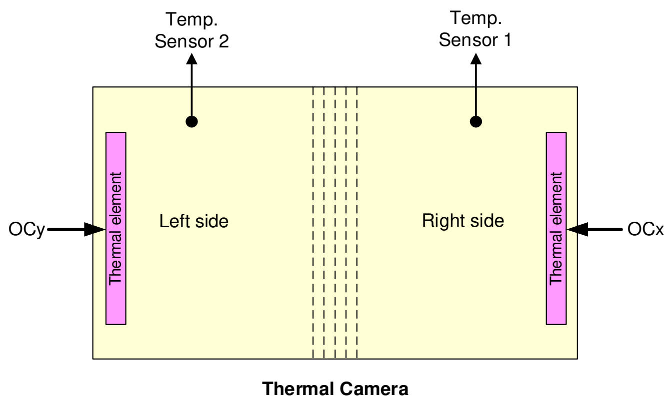


Figure 1: Simplified schematic of the thermal chamber.

This camera is connected to an embedded system, based on a PIC32MC745F512H microcontroller, through four key connections:

- Two control outputs designated as OC1 and OC2 through which the controller can increase or decrease the energy supplied to each side of the chamber and, in this way, increase or decrease the temperature.
- Two sensors that allow measuring the temperature in each of the two cavities of the thermal chamber.

The temperature in each of the chambers can be adjusted between 35ºC and 99ºC.

In Annex 1 it is possible to observe the relevant information for understanding the main elements of the controller, namely:

- A simplified version of the controller diagram with its main elements, both in terms of camera control and user interface.
- The identification of two complementary blocks used by the controller in its normal operating mode (an EEPROM memory and an RS232C port).
- Identification of the relevant components for this project, as well as the type of interconnection between them and the central microcontroller.
- An image of the embedded system board on which the controller is instantiated, with identification of the relevant elements for the project.
- The functional description, in the form of a table, of the controller's behavior in response to the position of the four available dip-switches.

**NOTE:** In this project, the thermal chamber does not physically exist, so the temperature sensors are in practice located in the controller circuit itself (as can be seen in Annex 1).

Since it is not easy to obtain significant temperature variations in these two sensors (variations greater than 3 or 4°C would imply the use of heating devices that could physically compromise or even damage the controller module), the installed software allows simulating the temperature variation measured, through the interconnection from the controller to a host PC via an RS232/USB converter (which simultaneously powers the controller board).

For that, in a text terminal connected to the /dev/ttyUSB0 port (confirm in each case), the user can use six keys to control the offset (in °C) measured by each of the temperature sensors.

- Keys '**1**', '**Q**' and '**A**' allow the user to increase/decrease and reset the temperature offset of temperature sensor 1 (this offset will never be lower than a value given by ($T_{sens1}$+$T_{offset}$ ) < 35°C or higher to a value such that ($T_{sens1}$+$T_{offset}$ ) > 99°C.
- Keys '**2**', '**W**' and '**S**' allow the user to increase/decrease and reset the temperature offset of temperature sensor 2 (this offset will never be lower than a value given by ($T_{sens2}$+$T_{offset}$ ) < 35°C or higher to a value such that ($T_{sens2}$+$T_{offset}$ ) > 99°C.

In normal operating mode, the controller will always respond (at the OCx and OCy control outputs) to the temperature value that results from the sum of these two terms ($T_{sens}$+$T_{offset}$).

In temperature setup mode, after selecting the desired temperature value, the INT1 switch must be pressed to store the new setpoint.

## 2. Objectives

The objectives of this project are to extract, using the techniques, knowledge, tools and technical information available online, as much information as possible on all elements related to the operation of the controller, as well as a functional description, as accurate as possible of the system.

In addition to consulting the manuals of the most relevant components to understand the main aspects of their operation, the report to be produced and delivered must contain, <u>among others</u>:

- The characterization of the process of obtaining the temperature(s) of the thermal chamber for temperature control purposes, namely, sampling rate (time interval between readings) of each of the sensors and method of calculating the temperature measurement used for control purposes.
- The clock signal frequency of I2C and SPI communications.
- The baudrate used in RS-232C communication, as well as the communication parameters.
- The information that is made available through the board's RS-232C port, as well as how to obtain it.
- The characterization and frequency of messages exchanged between the microcontroller and each of the peripheral devices.
- The identification (address) of the temperature sensor associated with each side of the thermal chamber (sensor1: right side, sensor2: left side).
- The association of the OC1 and OC2 outputs to the side to which they are connected in the thermal chamber.
- The definition of the control mode of the thermal element associated with each of the OC outputs, as well as the period of the signals produced at these outputs and the behavior of these same signals depending on the target temperature (setpoint) and the temperature measurement obtained.

- The purpose or purposes for which the EEPROM is used, as well as the addresses actually used for that purpose or those purposes.
- The purpose, from a user interface perspective, of the LEDs [7…0], during the controller's normal operating mode and during the temperature setpoint definition periods.

**NOTE:** All conclusions presented in the report must be duly justified, otherwise they cannot be considered for evaluation purposes.

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