# Storage information portable system based on ASIC applicable in the treatment of Diabetes

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***Summary / Abstract.***

In this paper we present a high autonomy, light, small size, and high data storage capacity electronic log-book related to a Decision Support System (DSS) for children affected by Insulin-Dependent Diabetes Mellitus (IDDM) treatment and control.

## 1. Introduction.

Diabetes mellitus is one of the major non-communicable chronic diseases in Western society. It affects 3 % of the population of Europe and approximately one hundred million people worlwide.

It is a life long condition characterised by raised blood glucose levels (hyperglycaemia) due to under production or reduced action of the hormone insulin. Insulin-dependent diabetic patients have no endogenous pancreatic insulin secretion and are dependent ton insulin injections to reduce and thereby control their blood glucose levels.

Planning management control actions requires substantial amounts of information to be processed and is inherently associated with uncertainty and cost-benefit considerations. This represents a challenging situation that has increased interest in the application of information technology (IT) and computer-based decision support tools to assist in the delivery of high quality diabetes care.

The routine management of insulin-dependent patients requires them to regularly monitor the status of their glycaemic control using home blood (or urine) glucose monitoring equipment. Blood glucose and urine glucose values are commonly manually recorded by patients with a pen and paper in log-books, as well as insulin therapy, patient's diet, exercise intensity, urine acetone value, observations, and the hour of the data taking. The cumplimentation degree of these manual transcriptions is usually very poor and, then, there are not useful for medical treatments.

In the Medical Informatics Laboratory, the Decision Support Systems Group (DSSG) is designing a Decision Support System (DSS) for the IDDM treatment and control, "Diabetes-I" able to register 20-30 data/day. The IC Design group collaborates in this project and in this paper they present an ASIC designed for this system as an easy and friendly electronic data acquisition module.

At present there are some commercial products in the market designed by investigation groups and pharmaceuticals big industries. But, on one hand, first systems are designed for very particular systems. On the other hand the industries design high quality data acquisition systems but the data structure and codification are not normally useful for the doctor–patient communication needs requested in this project. As a consequence these products are not adequate for the particular DS System.

The number of patients is not very high, and, then the estimated market for these systems is not very large. However its social interest is important. A deficient diabetes treatment causes serious diseases: renal sickness , circulatory problems,...

In addition, the product presented in this paper is part of a global Decision Support System (DSS)

that is being successfully implanted, and so its feasibility is very high.

## 2. An electronic data log- book. A first prototype.

As it has been pointed out above, the IC Design Group is working in the DSS project and it was asked to design an electronic data log-book in order to improve the data collection. In addition this electronic module had to be light, small, user friendly and had to have a high autonomy and high data storage capacity. These characteristics should allowed the user to store in a comfortable and efficient way all the data required for his disease treatment and also the transfer of this information to a personal computer, PC, for its later processing.
First, this group proposed a design based on 87C51 microprocessor. This module allowed the data transfer to a PC personal computer. The functional specifications of this were:

- The portable device had its own identifier.
- There was a personal identifier for each patient.
- It was able to store more than four months data.
- It admits only integer values of a specific range.
- All required data must be entered.
- The data were transmitted to the doctor's computer and these one takes care of the patient.

***Data Specifications:***

| Obl | Data | Rank |
|---|---|---|
| X | Day | 1 - 31 |
| X | Hour | 0 - 23 |
| X | Minute | 0 - 59 |
| X | Moment | 1 – 8 |
| X | Glycaemia | 0 – 999 |
| | Glucose in urine | 0 – 5 |
| | Acetone in urine | 0 – 5 |
| | Fast insulin | 0 – 99 |
| | Intermediate insulin | 0 – 99 |
| | Slow insulin | 0 – 99 |
| | Intensity exercise | 0 – 10 |
| | Nutritional diet | 0 – 99 |
| | Observations | 0 - 99 |

Fig 1.

***Technical characteristics:***

- 87C51 Microprocessor.
- 8Kb data RAM.
- 7 segments 3 displays.
- Telephone type keyboard and pulse.
- PC series port connection.
- LEDs to enter data.
- Rechargeable supply batteries.
- Batteries charger connection.

***Data compression:***

Before memory storing, the data are compressed. The particular process used get a 28% memory reduction, and it consists of keeping only the significant data bits according to the maximum value of their range. This method reduces the amount of required memory from 14 bytes to 10 bytes for the 13 data. Then each data scan can store more than 800 data into the available 8Kb memory.

***Tests results.***

The prototype designed accomplished all these functional, technical and data specifications, but it had high power consumption due to the components used. Therefore, the number of rechargeable batteries had to be increased to obtain a enough autonomy. This results in a increase of the size and weight of the system. As a consequence this system could not be suitable for children.

## 3. An improved data log-book module.

Taking into account the technical problems of this first prototype and in order to solve them, the group decided to design a new module based on an ASIC. This IC could accomplish the required small size and low consumption characteristics. In addition the entering data and the previously stored data are displayed in a 20 characters 4 rows LCD display (fig.2).

Also, this new design can be programmed in the same way as the first prototype described.

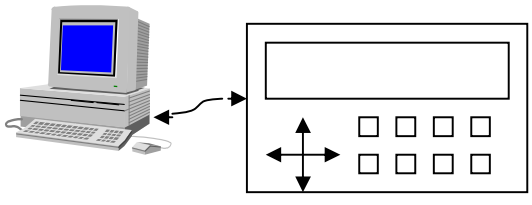


Fig 2.

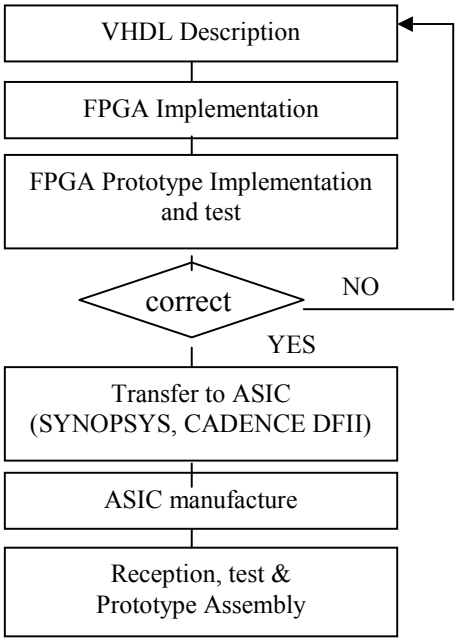
**System's description.**

The new module has been designed by using three basic components (Fig 3.):

-A Display LCD (DMC 20481)
-20 characters x 4 rows
-Controller LSI HD44780
-A Numeric keypad + functions
-The ASIC.


Fig 3.

To achieve this design the following process has been proposed:




A basic diagram is represented in figure 6.

Fig 4.

The functional description of the ASIC can be summarised as follows:
First, it stores in a ram memory the data transmitted from the PC (patient identification code, head of display, number and data range, etc) or from the keyboard (data entered by the patient). (Fig 2.)
The header of the display shows some characters that are helpful when the data are entered. This header is programmable and then this system could serve to other purposes. In addition , the stored data and those that are being entered are showed. (Fig 5.)

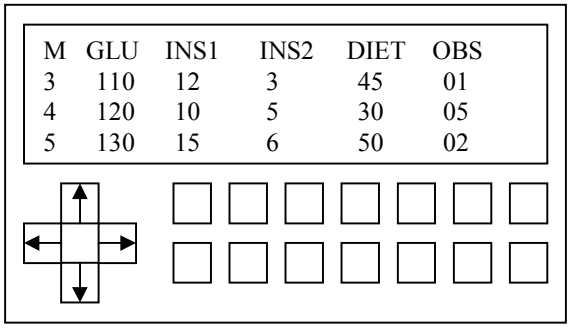



Fig 5.

Second, it transmits the stored data in the memory to the PC. The communication with the PC is made via series using the parallel port of the PC (two data lines and two control lines). (Fig 2.)

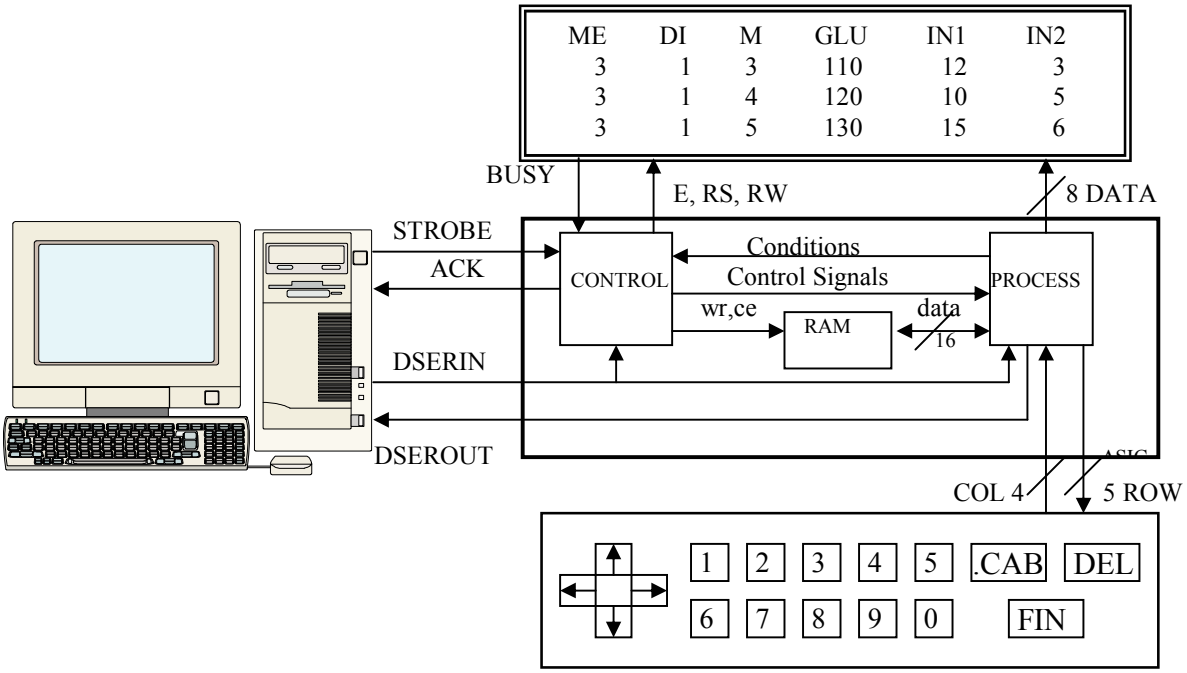


Fig 6.

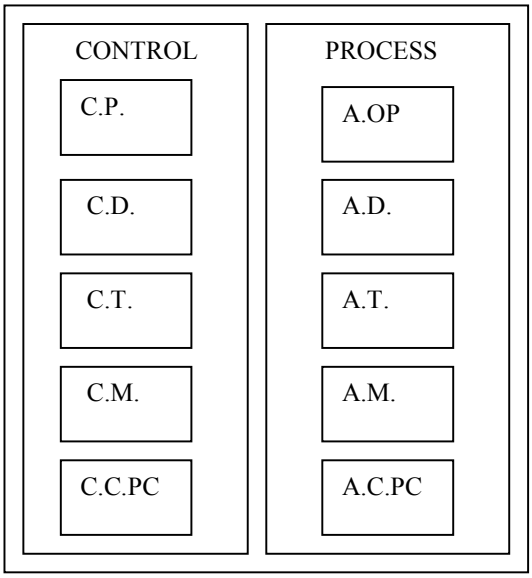



Fig 7.

Figure 7 shows the modules included in the control unit and the process unit.

In the control block there are some different machines:

CP main controller which controls the others.

CD implements the instructions of the display.

CT scan the keyboard, detects the pressed key and controls data introduction.

CM controls the read/write memory processes.

CCPC maintains the communication of the device with the PC.

In the process unit there are five sub-blocks:

A.M. includes the necessary elements for the data compression and data storage in a ram memory and also includes this memory.

AT includes the needed elements to gather up the data introduced by the keyboard.

AD includes the needed elements to transmit to the display the shown data.

AOP combinational circuitry for numeric data processing (to convert the pressed keys into hole numbers and to test errors of data range)

ACPC permits the PC/device communication in a read/write process.

## Conclusions

In Diabetes research and decision support systems development it is very important to have a complete database with the patient's information for a multidisciplinary study (Data analysis techniques, expert systems). Whether personal computers are nowadays more and more common at home, not all the patients can use them with this purpose, some times because of economic reasons and also because their knowledge in computer science is not high enough. The use of frendly portable devices can help the introduction of patient's data in the database. The improvement of the technical characteristics of these devices (size, weight, interface, etc.) can make their use more common and as a consequence the quality and quantity of data could be improved.
In this way in this paper a a high autonomy, light, small size, and high data storage capacity electronic log-book is presented.

## Present situation and perspectives

At this moment the prototype design at FPGA level is finished. The occupation level of the FLEX10k50GC403-4 used for this prototype is:

| | | |
|---|---|---|
| Dedicated inputs pins used : | 4/6 | (66%) |
| I/O pins used: | 60/304 | (19%) |
| Logic cells used: | 819/2880 | (28%) |
| Embedded cells used: | 64/80 | (80%) |
| EABs used: | 8/10 | (80%) |

Which means approximately a number of 10,000 equivalent gates.

At this moment, once the FPGA prototype evaluation is finished, we are working on the ASIC design and we think it should be sent to fabrication on the 5$^{th}$ of October Alcatel-Mietec's CMOS 0.7μm RUN. If there is no problem, at the

DCIS'98 we will have available concrete ASIC results such as gates number, Chip's area and at least a consume estimation.

## Acknowledgements

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