Small Graphical Controller Unit

Department of Electronic and Electrotechnology Zilina University

Abstract: At the Department of Electronic and Electrotechnology zilina University, FPGA (Field Programmable Gate Array) and DSP (Digital Signal Processor) were implemented at design and realisation of the prototype with operating name the IGC (Intelligent Graphical Controller). The core of controller contains one signal processor ADSP-2181 and one CPLD XC 95108 (XILINX), which enable handle of demanding signal algorithm and real fast graphical presentation. This controller includes standard I/O communication ports and allows to control up to 512 external I/O. The part also includes real time generator, battery management and battery backup memory.

Keywords: Graphic displays, Computer systems, Design systems, Implementation, Signal processors

1. Introduction

In various area of instrument, industrial or medical electronic is typically occurs of demand miscellaneous abstract data information. Cost savings solution are available portable displays created at the display unit principle:

- LCD (Liquid Crystal Display),
- FED (Field Emision Display),
- EL (Electroluminescent).

The access of the display is dependent on applications, when we decide according to display capacity resolution, colour,contrast, brigtnes, viewing angle of vision, image stability, power consumption, response time, price atc. For small portable applications is possible to exploit the display device with the resolution from 1/8 VGA until VGA format (640x480 pixels).

For control of the display unit is applied an embdded microcomputer with built-in adapter, eventually an individual VGA adapter.

IGC, which is the subject of this contribution uses in the process of viewing the STN (Super Twisted Nematic) mono LCD flat panel with CFL (Cathode Fluorescent Lamp) 320 x 240 pixels. The advantage of this flat panel is, that has industry standard interface (4-bit parallel control). Each of 76800 pixels is individual addressable, by which a fidelity display of graphics and texts is achieved.

The control of the flat panel, unlike another known forms, is executed by the signal processor DSP 2181. The data, which are to be presented, are built in a memory space area of the signal microcomputer. The data transmission into LCD unit is realized by the fast internal IDMA (Internal Direct Memory Acces) channel. This resolution is advantageous in fast dynamic layouts of the screen entities. This choosing concept of the display unit control takes only 1 % machine time of used signal processor.

Further, the signal processor ensures the operating of the key set, serial interface, parallel interface, acoustic piezoelectric output and the communication with the RTC (Real Time Circuit).

2. The Architecture description of the IGC modulle

The core of the IGC creates the signal microcomputer DSP 2181 (Analog Devices). The key performance specifications of the procesor are follower :

- 25 ns instruction cycle time from 20 MHz crystal
- Single-cycle instruction execution
- ADSP-2100 family code compatible
- 80K Bytes of on-chip RAM, configured as:

  -16K words on-chip program memory RAM

  -16K words on-chip data memory RAM

- Independent ALU, Multiplier/Accumulator, and barrel shihter computational unit
- Programmable 16-bit interval timer with prescaler
- 16-bit Internal DMA port for high speed access to on-chip memory
- 4 Mbyte memory interface for program overlays and storage of data tables
- I/O memory interface with 2048 locations supports parallel peripherals

In the signal processor is added the external memory space. The memory space is composed from the following segments:

- ROM segment: 128 KB
- RAM backup segment: 512 KB
- RAM overlay segment: 3 x 32 KB

The input-output subsystem IGC uses the input-output parallel interface and the IDMA channel of processor. This subsystem is implemented into one CPLD (Complex Programmable Logic Device) circuit XC 95108 PLCC 84 by XILINX. The implementation (XACT) includes the following functional logic blocks:

- the parallel printer port CENTRONIX
- control of the key set
- control of the display unit
- the circuit of electronic key off of the IGC

The RTC circuit and acoustic piezoelectric output are connected directly to the individually programmable output IO pads of the signal processor.

3. The basic software of the IGC

For the IGC it has been created a basic input-output system called BIOS IZP (Basic Input Output System). An individual program elements of the BIOS IZP include functions, that enable a baseline input-output operations of an additional I/O driver. There are following I/O driver:

- display device driver
- key set driver
- serial interface driver
- parallel interface driver
- acoustical piezoceramic driver
- communication with real time circuit
- program actuating cut-off of IGC

The display device driver function executes calculation of co-ordinates point (X,Y) of display to the address memory cell in the signal processor (Fig. 1).

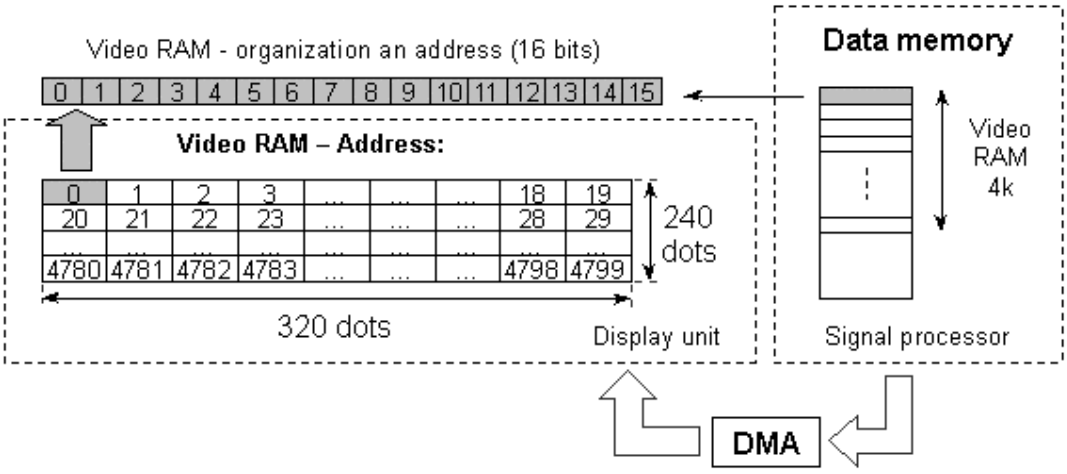

Fig. 1. A principle of the video display function design

The resolution of the display units is 320 * 240 pixels. All the address of video memory contains values of sixteen consecutive fluent pixels. The calculation of co-ordinate dot (X, Y), to set the reference bit in memory of signal processor is following:

VideoRAM_XY= VideoRAM+DIV(X/16)+Y*20;

Where:

VideoRAM_XY ….The address of data location (16 dot), where is a dot (X,Y)

VideoRAM .……Initial address video memory

DIV(X/16) .……The result integer divide

The adjustment of an appropriate bit (dot) at the existing address of data location VideoRAM:

Bit_XY = [VideoRAM_XY] or MOD(X/16);

Where:

[VideoRAM_XY] ... Value address video memory

MOD(X/16) .……Modulo after integer divided

This function is basis for further derivation of functions necessary for creating user define application, as well as:

- Function of a character representation
- Function of an image of lines
- Function of an image of rectangle
- Function of an image of rectangular area
- Function of an image of picture

The designate functions can be modified in a different displaying mode for example: and, xor.

In order to enable execute the display of character, it was necessary to build up a character map related to individual characters (Fig. 2). In design of the video display functions of character are included also the diacrtical marks.

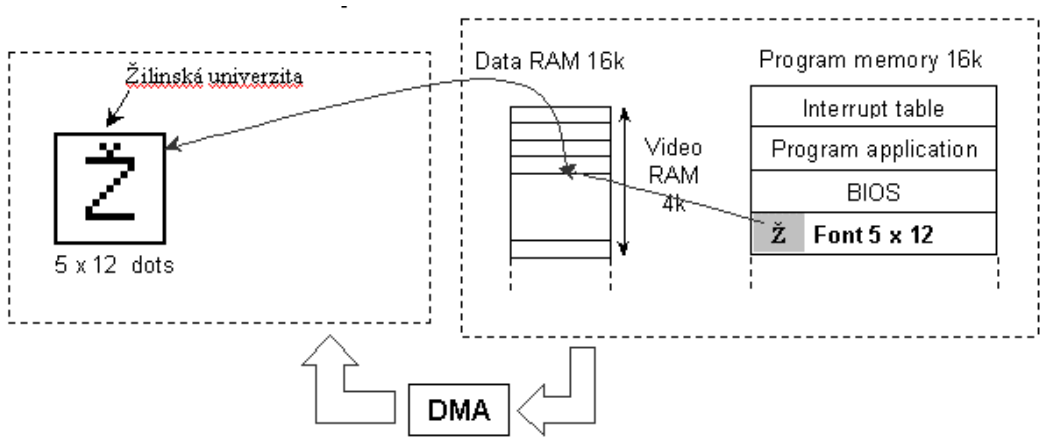

Fig. 2. A principle of characters display

The function of users definition picture display enables a dichromatic picture display, that is stored in the code memory of signal processor. The input data parameters of the function are:

The position of the left overhead corner (X1, Y1) and address program memory, which represent the origin of the users picture data (Fig. 3).

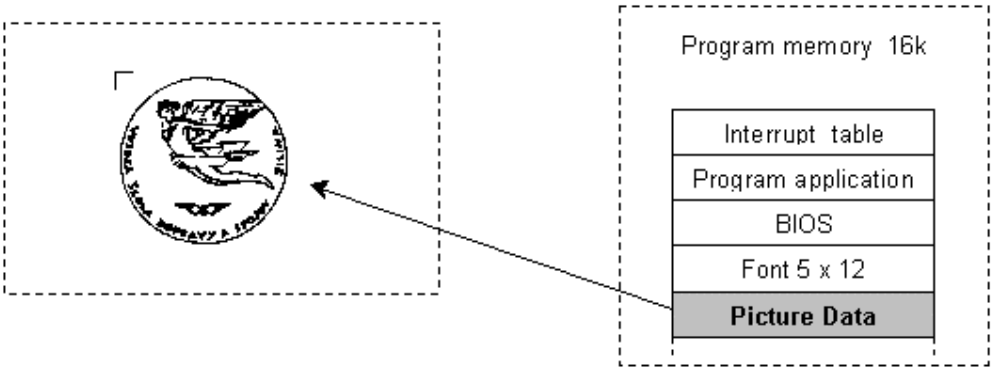

Fig. 3. The display of the picture by user definition

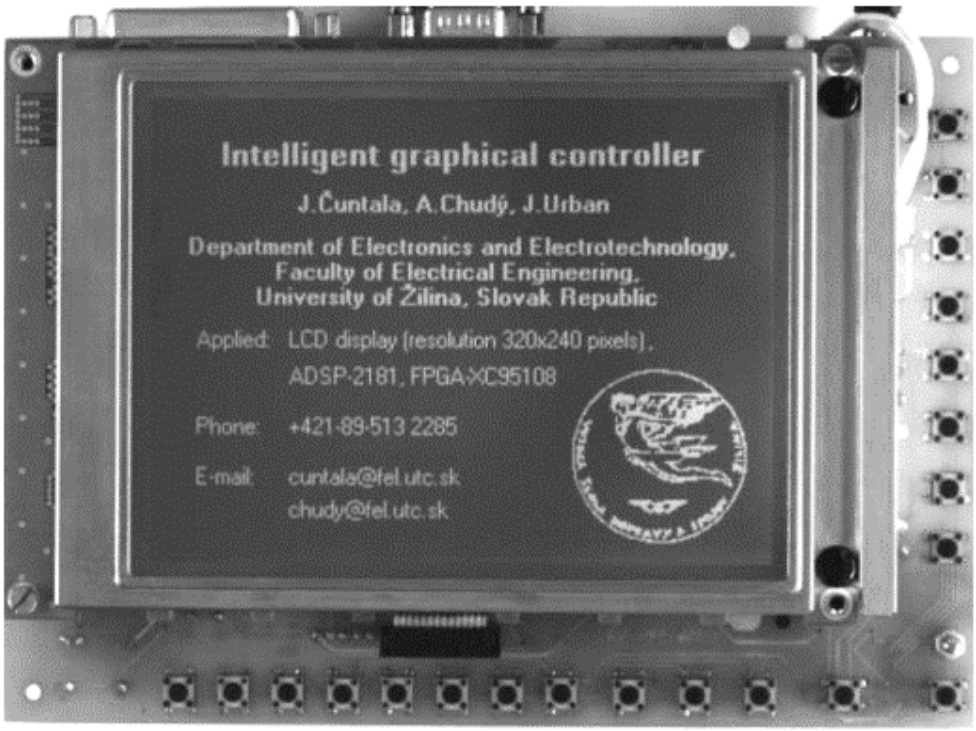

Fig. 4. IGC - view from front panel

4. Features of IGC

Dimensions/mass:
W 190mm, D 130mm and H 40mm / max 600 g includes battery

Power supply:
7 - 16 V DC or 6 x NiMH 1200 mAh AA

Power consumption:
500 mA, 800 mA with charge

Battery operating time:
min. 2h continuous running without automatic power off

Power off:
manually or automatic by setting 2 - 40 min

Charging time:
max. 3h, automatic off charge, checking battery status

Graphics: 320 x 240 pixel

Viewing area: 120 x 90 mm

Serial port: 1200 - 38400 Bd, RS232

Parallel port: Centronics

RAM: 80 Kbytes on chip ADSP2181

Backed up RAM: 128 Kbytes or 512 Kbytes

Internal EEPROM: 32 Byte

Expander port:
Data 16 bit, Address 8 bit, Throughput 33 Mbytes/s, IRQ 3, SPI 1 - 6 MBd, General IO – 7

Others:
Real time generator, 128kB program EPROM, Keyboard around the display (20 keys), Tone generator

5. Conclusion

In this contribution a fundamental structural and procedural performance chart of the IGC is introduced. It is possible to employ the IGC in a different applications, where a signal processor is required . The expanding input-output port enables the IGC completing with additional different feature of the measuring equipment or the control applications. It is possible also to append the display with a touch sensitive screen. Perspective exploitation of IGC is in a laboratory measurement engineering and for a portable instrumentation. A view from the front panel and from the component side is in the Fig. 4, Fig. 5.

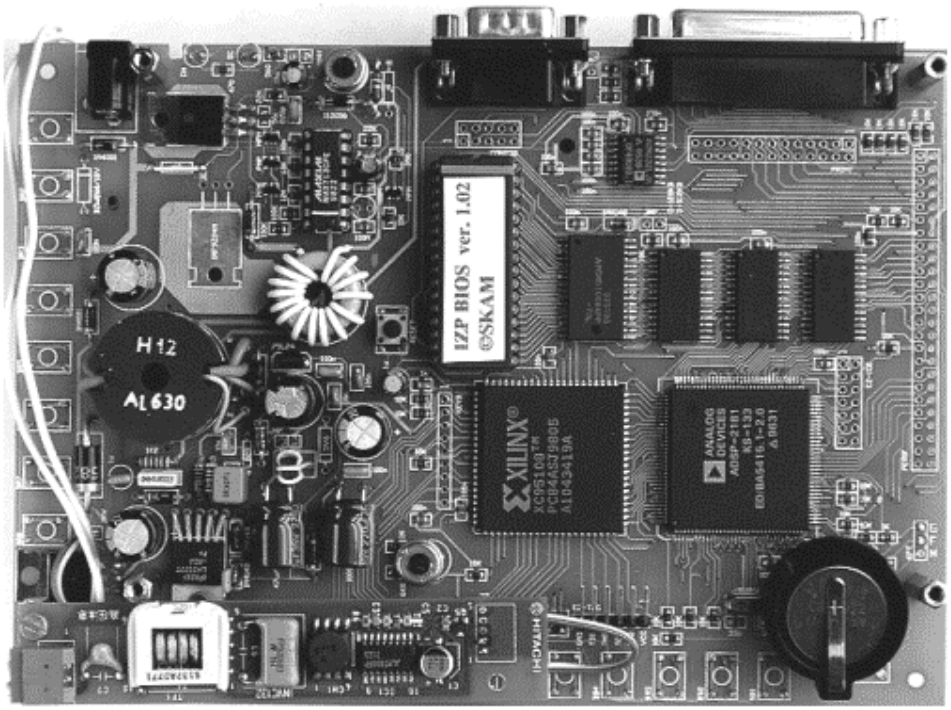

Fig. 5. IGC –view from component side

6. References

1. Analog Devices: Designers´ Reference Manual, DSP Microcomputer, ADSP-2181, 1998

2. XACT Development System Xilinx, The Programmable Logic Company, 2100 Logic Drive, San Jose, CA 95 124