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ARM DEVELOPMENT KIT FOR DATA COMMUNICATION

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Abstract: *The paper deals with the project whose aim was to create new development kit with 32-bit ARM microprocessor. Kit is intended as a learning tool as well as a development platform to design simple or highly complex applications. The biggest advantage of presented kit is the ability to use any microprocessor pin because all input/output pins of microprocessor and pins of AD/DA converters are carried out into two stacking pin connectors, though which our kit can be connected for example to a universal PCB. This development kit offers great level of flexibility - by using of jumpers we can switch operating modes of microprocessor, connect/disconnect the real-time clock, peripherals, etc.*

Keywords: *32-bit, ARM, Cortex-M3, Data Communication, Development Kit, LPC17xx, Microprocessor.*

1. INTRODUCTION

In the last few years the development of electronics has been greatly increased. Mainly using of microprocessor technology, micro-electro-mechanical systems, smart sensors, signal processing, nanotechnology, and special integrated circuits have come into prominence.

Electronics are now appearing in various fields of human activities. Electronic systems can be found in homes, in the automotive industry, engineering, agriculture, health and electronics had to undoubtedly penetrate into the most advanced military applications.

Nowadays, microprocessors (processors, microcontrollers, CPU, etc.) are part of almost every non-trivial electrical equipment from the radios, through kitchen appliances and mobile phones to a central units in passenger cars. Microprocessors themselves have almost no value, perhaps only the cost. The value comes up in the conjunction with a program that breathes life into them.

It used to be usual that at previous microprocessor series each manufacturer had a different type of core which caused a problem when the developer or programmer had to change the manufacturer of used microprocessor. Such change means that the programmer must learn to think in terms of the new core literally from the beginning and start writing programs that are optimal for that new core. Many problems occur when the original programs are written in assembly language. In this case, there is usually no other way than to manually rewrite the most important parts of the programs. If programs were established for many years, this problem is usually key issue which significantly affects the choice of a new microprocessor.

One of the first microprocessor which overcame this drawback was legendary 8-bit 8051 from Intel. It achieved great popularity and due to the promotion by manufacturers it

is still in use. It has been produced by a number of leading international manufacturers such as Philips, Siemens and Dallas Semiconductor. All these manufacturers have different processors with different parameters, peripherals and performance, but they have compatible core. It means that programs written for one processor can be also simply used for the processors from other vendors. However, this core is already obsolete.

High demands on numerical performance led primarily to an increase in clock frequency. Increasing of frequency above 100 MHz brings substantial price increases, and therefore the manufacturers were looking for better ways to significantly improve performance. One way to increase processor performance is to increase the word size with which microprocessors work. Therefore they put on the market 16-bit microprocessors and then 32-bit microprocessors.

At first it looked like at all other microprocessor series where each manufacturer has a different type of core. It was a matter of time until someone brings a unifying element into the field. And that company was ACORN with its core marked ARM7TDMI. Due to the appropriate licensing policy this company has made significant expansion of its core, which can be used by many microprocessor manufacturers around the world such as NXP, ST Microelectronics and Atmel.

ACORN is not a company producing microprocessors. The company is focused on the development of types of cores, and it then offers them to other manufacturers, which according to their needs to the core add additional peripherals, improvements etc. and produce them. Especially for smaller manufacturers it is vitally important because they cannot dictate terms and force using of own processor core, which cannot be used for standard written source codes. The company developed the core marked ARM (Advanced RISC Machines). According to the computing power, consumption and the other parameters ACORN designed several ARM cores (Sadasivan, 2006).

2. NEW DEVELOPMENT KIT - ARGUMENTS AND REQUIREMENTS

2.1 Arguments about new development kit. Today's microprocessors have a JTAG interface, which, among other things, allows us to "control" the microprocessor so it is a possible way to debug software on a microprocessor without expensive hardware emulator. However, the interface itself may not be enough for novice users; so many manufacturers directly offer development boards for familiarization with their microprocessors. These development boards do not usually have any free pins of microprocessor, so their usage for learning purposes or development of new devices is very limited. Presented development kit removes this defect, along with other improvements and modifications.

With this kit a novice user has a chance to start immediately familiarizing with the microprocessor instruction set and style as well as writing programs. User does not have to create any testing board with microprocessor and detect whether the first draft of his construction with a new microprocessor works correctly or not. On the other hand, for the advanced user this development kit represents a powerful tool for the development of highly complex devices and applications.

2.2 General requirements for new development kit. The aim is to offer a universal kit which would be suitable for teaching purposes and familiarization with the features of microprocessors, as well as for the development of more demanding applications, such as using RTOS (Real-Time Operating System) and other advanced features.

The development kit should contain the most modern communication and other elements, or it should be prepared for their additional installation and usage at least. Also a stabilized DC voltage source should be a part of the designed board. Of course, it is necessary that the board must be equipped with several communication buses like I^2C, SPI, CAN, UART, Ethernet, CAN, RS-232, RS-485, USB, audio in/out etc. Some

configurable buttons, LEDs or even a slot for SD card etc. could be placed on the top of the board. The board should also include several configuration pins through which we can choose different wiring configurations, switch operating modes of microprocessor or connect/disconnect the real-time clock, peripherals and so on. It is also appropriate to connect various sensors (temperature, pressure, etc.). JTAG (TRACE) interface should be used as a programming and debugging interface.

3. New DEVELOPMENT KIT - DESCRIPTION

3.1 Used microprocessor and its architecture. The designed development kit uses 32-bit ARM processor from Cortex-M3 series, namely LPC1766 from the manufacturer NXP Semiconductors. Cortex-M3 processor was developed as a modern replacement of the older type ARM7TDMI. Cortex processor family is built on the ARMv7 architecture and it represents one of the most powerful series of processors for embedded systems. Probably the most popular representative of the Cortex architecture is Cortex-M3. It is suitable as a core for high-performance 32-bit microprocessors. To compare with older ARM7TDMI architecture it provides significantly higher performance (1.25 DMIPS/MHz), a simpler programming model and a smaller consumption due to the deployment of new technologies, signal processing and power management (NXP, 2010).

As was written, NXP LPC17xx family of microprocessors is built on a 32-bit ARM Cortex-M3 core. These microprocessors are able to operate at maximum frequency 100 MHz and have two wait states. The core works with three levels of the pipeline. For the program is available up to 256 kB flash memory. There is a large number of peripherals such as 100 Mbit Ethernet, JTAG, USART, SPI, I^2C, USB Full Speed, CAN, RS-232, RS-485, RTC, 12-bit A/D and 10-bit D/A converters, four 32-bit counter/timer, the unit generating PWM and up to 100 general input/output pins with the possibility of generating interruption from 70 of them (Olimex, 2009).

3.2 Description of the development kit. The basic building block of the presented development kit is microprocessor NXP LPC1766. This powerful microprocessor supports various communication interfaces (mentioned in the previous chapter) which are incorporated into the board with appropriated supporting elements. On the board are also available pins for audio output, LCD display, power supply and so on. This enables multiple use of the development kit in a wide range of applications.

As mentioned before, microprocessor directly integrates on the chip a complete communication blocks and also programming/debugging interface ISP or JTAG (TRACE). All these interfaces are available either directly through the appropriate connector, pin connectors carried out on top of the board (see Fig. 1) or through two stacking pin connectors located on the bottom of the board (see Fig. 2). In addition, the board is also equipped with onboard level converter and basic communication UART interface pins are available as a RS-232 port connector D-Sub 9F (female type of connector allowing direct connection with either a PC or even USB/RS232 converter without the usage of crossover cables). The other special incorporated connectors serve for Ethernet,

USB communication and for SD/MMC card (see Fig. 1).

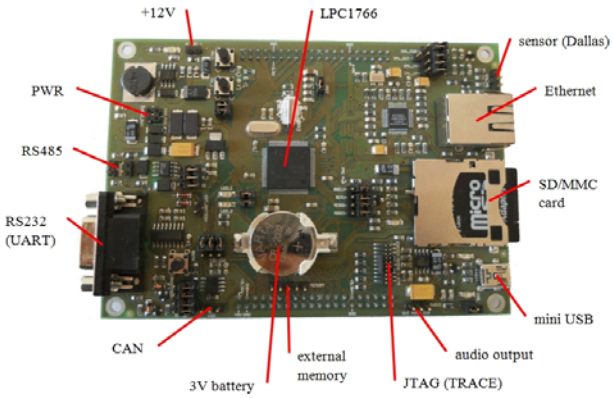

Fig. 1. Blocks of the development kit (top side)

Some signals of other communication interfaces are also available on configuration jumpers. By their removal/involvement is possible to ensure disconnection/connection or the user configuration of these communication interfaces. It means that almost every input/output pins of microprocessor are easily available, so the integrated functions can be used outside of the development kit board, which represents the biggest advantage of presented development kit and it fulfills all the requirements.

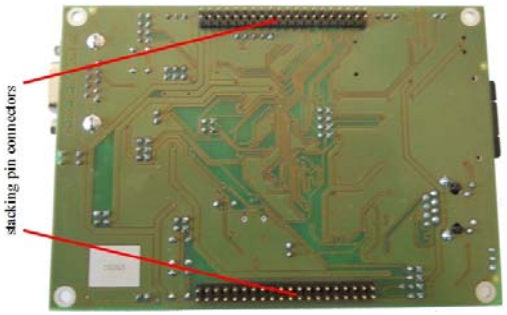

Fig. 2. Stacking pin connectors of the development kit (bottom side)

4. CONCLUSIONS & ACKNOWLEDGMENT

The development kit was primary designed as a tool to become familiar with the issue of 32-bit ARM microprocessors. Kit enables development of software and hardware for a subset of the Cortex-M3 microprocessor architecture. It can be used both for teaching and demonstration of the capabilities of microprocessor as well as for the design of simple or highly complex applications. The biggest advantage of presented board is the ability to use every pin of CPU, because all input/output pins and pins of AD/DA converters are carried out into two stacking pin connectors. This kit can be easily connected to a universal PCB. To start a new application is only needed to connect the supply voltage (through mini USB connector - directly from a computer or an external voltage supply), JTAG programmer and a development environment.

With this kit users can start to develop embedded systems for a wide range of applications taking advantage of the support from numerous communities associated with ARM microprocessors.

This paper was prepared as a part of the research project at the Department of Communication and Information Systems at the University of Defence and in cooperation with the company MESIT pristroje spol. s r.o. In addition, the project also includes the design and construction of a suitable JTAG programmer, including the reduction to the TRACE interface. Further, the complete product documentation for all parts of this project was created and prototypes were made. The software support for each peripheral of the development kit was also created, including practical examples.

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