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ARM-7 Development Board

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Abstract— The ARM-7 development board using NXP's LPC2148 is developed with two applications. The board features various interfaces available on-board to unleash the power of LPC2148 and ARM-7 architecture. It has been designed to help professionals, students and amateurs to explore the capabilities of LPC2148 microcontroller and practice application development for various interfaces with minimal hardware configuration. The ARM memory interface has been designed to allow the performance potential to be realized without incurring high costs in the memory system. Speed-critical control signals are pipelined to allow system control functions to be implemented in standard low-power logic, and these control signals facilitate the exploitation of the fast local access modes offered by industry standard dynamic RAMs. The board has been developed with two applications namely; keypad interface and the LCD interface.

Keywords— ARM-7, LPC 2148, LCD, 4*4 Matrix Keypad.

I. Introduction

LPC2148 microcontroller is based on a 32/16 bit ARM7TDMI-S CPU with real-time emulation and embedded trace support. It combines the microcontroller with embedded high speed flash memory of 512 kB. A 128-bit wide memory interface and unique accelerator architecture enables 32-bit code execution at the maximum clock rate. For applications where size of the code is critical, the alternative 16-bit Thumb mode reduces code by more than 30 % with minimal performance penalty. Their tiny size and low power consumption makes LPC2148 an ideal for applications where miniaturization is a key requirement, such as access control and point-of-sale. The serial communications interfaces ranging from a USB 2.0 Full Speed device, multiple UARTS, SPI, SSP to I2Cs and on-chip SRAM of 40 kB, makes the device very well suited for communication gateways and protocol converters, soft modems, voice recognition and low end imaging, providing both large buffer size and high processing power. More than one 32-bit timers, single or dual 10-bit ADC(s), 10-bit DAC, PWM channels and 45 fast GPIO lines with up to nine edge or level sensitive external interrupt pins make these microcontrollers particularly suitable for industrial control and medical systems. LPC2148 consists of an ARM-7 TDMI-S CPU with emulation support, the ARM-7 local bus for interface to on chip memory controllers, the AMBA Advanced High Performance Bus (AHPB) for interface to the interrupt controller and the VLSI peripheral bus for connection to the on-chip peripheral functions.

II. History

The history of the ARM processor family is closely related to that of the British personal computer industry, and reflects differences between the development of the British and American computer industries. A number of different manufacturers achieved prominence in this quickly emerging market. In 1985, Acorn Computer Group, one of the leading names in the British personal computer market, manufactured the first commercial RISC microprocessor. Other significant manufacturers were Sinclair, another Cambridge start-up, and to a lesser extent the American companies Apple, Commodore and Tandy, along with a host of smaller British developers producing a wide range of machines targeted at the booming home computer market.

In 1991, the first RISC microprocessor, which can be embedded, ARM6 was invented. From the year 1992 onwards, various companies such as Sharp, Samsung started using ARM processor while in the year 1993 ARM7 the first multimedia processor was developed. In the year 1995, Thumb instruction set was introduced in ARM family. From the year 1996-2000 companies such as Alcatel, Philips, Sony, started using ARM, while in 1999 ARM cooperated with Erickson for the development of Bluetooth. From 2000-2002 ARM's share of the 32 – bit embedded RISC microprocessor market was 80% [7].

III. Objective and Specification

A. Objective of the system

The objective of the system is to develop a development board using LPC2148 interfaced with LCD and keypad.

B. Specification of the system

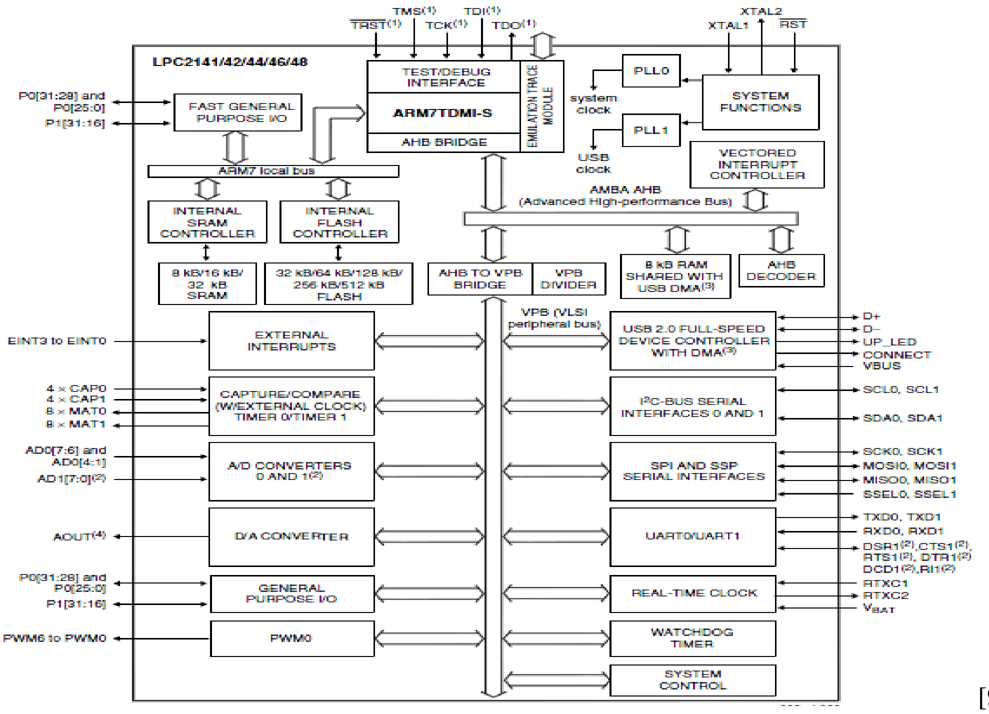
The development board is prepared using copper clad Printed Circuit Board (PCB). The power supply to this board is designed in such a way that if the desired voltage is applied to the I.C. then the LED will glow. The 64 pin I.C., which consists of two ports P0 and P1, the port P0 is interfaced with 16*2 LCD with pins P0.11 to P0.22 actually being used for interfacing. The two serial communication ports, UART0 and UART1, are connected to MAX 3232, the voltage converter I.C., is used for DB9 connectors. These two DB9 connectors are connected to main ARM I.C. at port P0. Out of these two connectors UART0 should be connected to computer while burning the program to the ARM I.C.

This board is having 5 external connectors; one port will be connected externally to 4*1 keypad while other is provided for 4*4 keypad. But, for this project, the later port will be used for 4*4 keypad. One connector is for giving input to ADC and one is for external interrupt. The last connector is for connecting I/O lines externally. The LEDs can be connected to this one or it can be reserved for future usage. All of these are connected to port P0 but, keypad which is connected to port P1.The board will be given 12V dc power supply, but due to LM7805 it will be down converted to 5V and will be further down converted to 3.3V using LM317. There are two potentiometers out of which one is for setting output of LM317 to 3.3V and second is for adjusting contrast of LCD. The ARM-7 integrated circuit, i.e. LPC 2148, is having two clocks one of frequency 12MHz and other of 32.768 KHz. It also has digital ground and analog ground separately. A reset switch is connected to the I.C. and also a switch for switching from programming mode to running mode and vice versa. There is also one external connector for test/debug interface connected to JTAG. One I.C is Atmel L911 which is EEPROM I.C and is kept for future usage.

IV. DESIGN OF THE SYSTEM

Hardware Design

Internal Block Diagram of LPC214x



[9]

Fig 1: Internal block diagram of LPC 214x

Above block diagram shows general internal structure of LPC214x where 'x' any number from 1, 2, 4 or 8. This block diagram has two ports viz. port P0 and P1 of 32- bits each. These pins are general purpose input/output (GPIO) pins connected to fast general purpose I/O block. Fast general purpose ARM-7 local bus which is connected to 32 kb SRAM and 512 kb Flash memory through SRAM and Flash controller. ARM-7 local bus is also test/debug interface block. The clocks are connected to the I.C. via XTAL1 and XTAL2 pins. These blocks are connected to system function block which also has system clock and USB clock. Advanced high performance bus is connected to vectored interrupt block. This block manages the interrupt services to this the integrated circuit.

It has pins for external interrupts namely, EINT0 to EINT3. These four interrupt pins are there for interrupting the microcontroller and it works according to the priority of the interrupt received. Capture/compare block captures the input through CAP input pins and matches the output with MAT pins. This diagram shows two analog to digital convertor blocks with two input pins. Digital to analog convertor has output pin. It has 7 pulse width modulation output pins. This device supports USB2.0 and also has UART pins for serial interfacing. It also has SPI and I2C serial interfaces blocks which are helpful while serial communication [9].

A. Power Supply:

Starting with the power supply will make things simple for our first electronics project. Well the reason is quite obvious because all electronic circuits require a DC power supply to work. You really do plug in the wires of your electronic items in AC mains supply but they do have AC to DC converters to provide DC to the circuits. All this is done with a power supply in the right place.

This circuit has a small +5V power supply. The circuit will provide a regulated voltage to the external circuit which may also be required in any part of the external circuit or the whole external circuit. You can also use it to convert AC voltage to DC and then regulate it , for which you need a transformer to make the AC mains drop down to a safe value i.e. 12-15 volts and then use a rectifier to convert AC into DC. This circuit can give +5V output at about 150 mA current, but it can be increased to 1 A when good cooling is added to 7805 regulator chip. The circuit has overload and terminal protection. The capacitors must have enough high voltage rating to safely handle the input voltage feed to circuit [4].

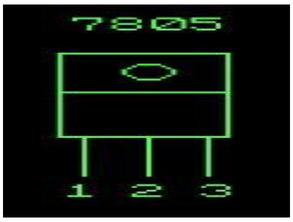
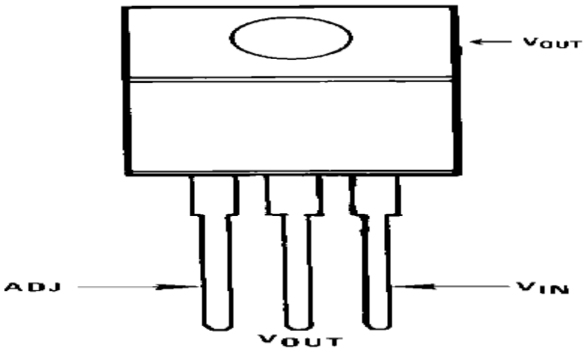


Fig 2**:** Pin diagram of I.C LM7805 [4]

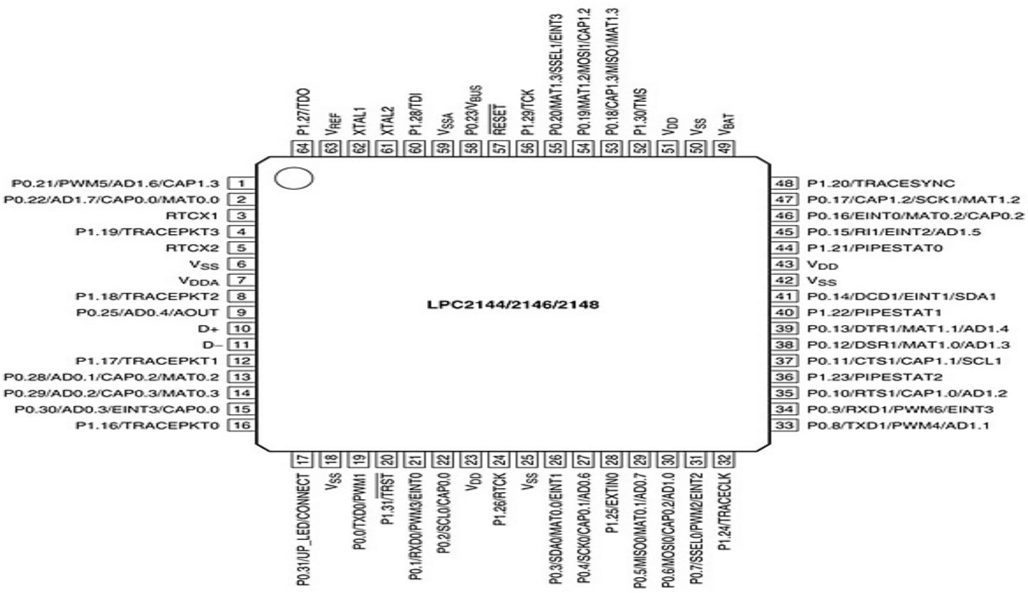
The LM317 I.C (shown in the next figure) is for down converting the output voltage of LM7805 to 3.3V which is required for the main ARM I.C. LPC2148 [3].



[3]

Fig 3: Pin Diagram of I.C.LM317

B. ARM7 Microcontroller (LPC2148)



[9]

Fig 4: Pin Diagram of LPC 2148

It has 16/32 bit ARM7 TDMI-S microcontroller in a tiny LQFP64 package and 32 kB of on chip static RAM and 512 kB of on chip flash program memory. 128 bit wide interface/ accelerator enable high speed 60 MHz operation and In-System Programming/In-Application Programming (ISP/IAP) via on chip boot loader software. Single flash sector or full chip erases in 400 ms and programming of 256 B happens in 1 ms. On-chip Real Monitor software and high speed tracing of instruction execution. Also, multiple serial interfaces including UART's, two fast I2C-bus (400 Kbit/s) and SPI. Further, up to 47 5 V tolerant general purpose I/O pins in tiny LQFP64 package. 60 MHz maximum CPU clock available from programmable on-chip PLL with settling time of 100 microseconds and On-chip integrated oscillator operates with external crystal in range of 1 MHz to 30 MHz and with external oscillator up to 50 MHz [9].

C. LCD

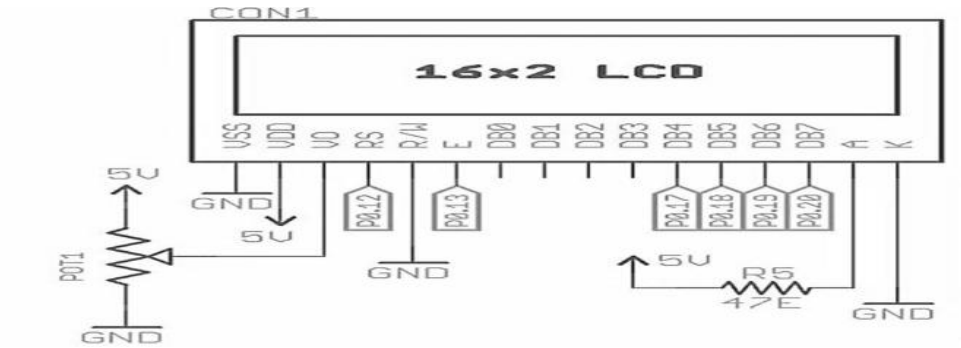


Fig 5: 16*2 LCD

When we use 16 by 2 LCD that means that it can display the two lines containing 16 characters each. The pixel matrix is of 7 by 5 pixels that are each character can be displayed using 7 columns of the pixels and 5 rows of the pixels.

To control the operation of LCD, three control signals are used. They are as follows:

1) Enable (EN):

This pin is used to enable the display to perform any operation with it, without this the LCD won't start.

2) R/W (Read/Write):

This signal indicates to LCD processor that the operations being performed is read operation or write operation. If it is '1' then it indicates the read operation and if it is '0' then it indicates the write operation.

3) RS (Register Select):

There are 2 types of registers as command register & data register. To select one of these registers, RS signal is used. If it is '0' then command register will be get selected and when it is '1' the data register will be selected.

D. RS232

Serial Port

The microcontroller LPC2148 has an inbuilt UART which carries out the serial communication operation. The serial communication is done in the asynchronous mode. A serial port, like other PC ports, is a physical interface to establish data transfer between computer and an external hardware or device. This transfer, through serial port, takes place bit by bit.

IBM introduced the DB-9 RS-232 version of serial I/O standard, which is most widely used in PCs and several devices. In RS232, high and low bits are represented by flowing voltage ranges:

Bit	**Voltage Range (in V)**	
0	+3	+25
1	-25	-3

The range -3V to +3V is undefined. The TTL standards came a long time after the RS232 standard was set. Due to this reason RS232 voltage levels are not compatible with TTL logic. Therefore, while connecting an RS232 to microcontroller system, a voltage converter is required. This converter converts the microcontroller output level to the RS232 voltage levels, and vice versa. IC MAX232, also known as line driver, is very commonly used for this purpose [5].

E. KEYPAD

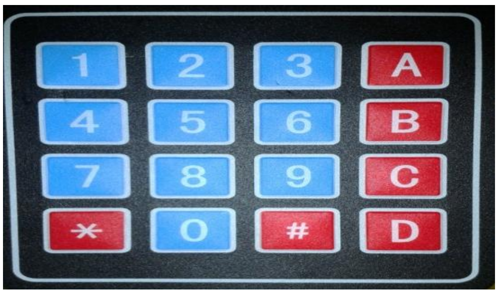


*Fig 6: 4*4 Keypad*

A connector to interface a 4*4 keypad is provided at the bottom edge of the ARM-7 development board. A total of the 8 lines are required to interface a 4*4 keypad to a microcontroller. Four of the lines are required to input pins and the other four to the output pins of the microcontroller. In this case the keypad is connected to port pins P1.16 to P1.23.

These lines when defined as input are internally connected to a strong pull-up of 60k to 300k. Therefore the need to connect external pull-ups to the input lines to define a logic "HIGH" state on "no key press" is not necessary. The figure above shows the schematic of the 4*4 keypad interface.

Test and Experiment results

The project is of development board of ARM7 using LPC2148. We have interfaced LED, LCD, and keypad. On interfacing LEDs with the I.C they blink as per the designed program. Here, we have designed the program in such a way that the LEDs will blink all together after few seconds. In case of LCD, the interfacing is done through the port P0 at pins P0.11 to P0.22. But on the development board we have designed an alternative this keypad used, viz., 4*1 keypad. ARM-7 development board provides a connector to interface a character LCD of 16 columns and 2 rows. Each character is made up of 5*7 pixels. The data lines and the control lines are connected to port P1 as stated above. The potentiometer is provided to manually control the contrast of the LCD. Keypad interfacing, we have interfaced keypad to port P1 at pins P1.18 to P1.25. We can design such a program that if we press any key on the keypad then it will be displayed on the LCD. We are using 4*4 keypad.

V. CONCLUSION AND FUTURE SCOPE

A. Conclusion

Advanced RISC Machine (ARM) is an advanced version of microcontroller which is developing day by day. The advanced versions of ARM are developing at very fast rate. We are using ARM7 which is having USB but ARM Cortex processors are already been developed which consists of advanced specifications and also costs more.

From this paper we have covered the background of ARM, the developments in ARM, specifications of ARM, advantages and disadvantages of ARM.

B. Future scope

This development board can be used for applications based on touch screen interfacing. Since this I.C. also supports USB, we can interface a USB port and use it for USB based applications. I2C protocol is used to communicate with the EEPROM. This board can be used to design different types of sensors like temperature sensor, distance sensor. A connector to add wireless ZIGBEE communication to the design. Also a provision to add motion detection sensor to the design is possible on ARM-7 development board. We can interface thermal printer, biometric identifier, GSM module and RFID.

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