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Chapter

1

Introduction

Part II of this book delivers to the reader the experience of µC/OS-III through the use of world-class tools and step-by-step instruction.

The book is packaged with the ARM/Keil MCB1700 evaluation board. The MCB1700 Evaluation Board is available in two different configurations:

- MCB1750 Evaluation board which contains an NXP LPC1758, Cortex-M3 based Microcontroller.

- MCB1760 Evaluation board which contains an NXP LPC1768, Cortex-M3 based Microcontroller.

There are also two revisions of the board: Rev. 1 and Rev 1.2. In revision 1.2 only minor changes have been made that have no influence on examples and applications. Here are the changes in detail:

- Different USB host connector. Because of a mistake in the layout of revision 1, it was necessary to use an upright version of USB host connector. Revision 1.2 has the intended angular version populated.

- Two 0 Ohm resistors R82 and R83 have been added to be able to disconnect the USB interface from pin P1.22 and P1.19 in case these pins are not used for USB host.

- About half of all holes of the port headers were too small by mistake.

To build the example code provided in Part II of this book, you will need to download the Keil Microcontroller Development Kit (MDK-ARM), which enables you to build applications up to 32 Kbytes in size (see Chapter 3, “Setup” on page 679). You can also download the award-winning µC/Probe from the Micriµm website to monitor and change application variables at run time (see Chapter 3, “Setup” on page 679).

The heart of the LPC1700 family is the ARM Cortex-M3 CPU, one of the most popular CPU cores on the market today. The Cortex-M3 runs the very efficient ARMv7 instruction set.

The LPC1758/68 runs at clock frequencies up to 100 MHz and contains such high-performance peripherals as a 10/100 Ethernet MAC, full-speed USB 2.0 (Host/Device/OTG), timers, UARTs, and more. The LPC1758/68 also features built-in flash memory of 512 Kbytes, and 64 Kbytes of high-speed static RAM.

1-1 THE KEIL MCB1700

Figure 1-1 shows a picture of the Keil MCB1700. Board features include:

- Low cost
- 100 MHz LPC1758/68 Cortex-M3 based microcontroller
- On-chip memory: 512KB flash memory, 64KB RAM
- 10/100 Ethernet connector
- Color QVGA TFT LCD
- SD/MMC card socket
- USB 2.0 full speed host/device/OTG
- Dual CAN Interfaces
- Dual RS-232C serial ports
- 5-position joystick and push-button
- Potentiometer for analog-to-digital converter (ADC) input
- 70 GPIO pins
- LEDs
- Debug interface connectors (20-pin JTAG, 10-pin Cortex debug, 20-pin Cortex debug + ETM trace)

The LPC1758/68 is capable of running a TCP/IP stack such as Micriμm's high-quality μC/TCP-IP. This allows applications to network with other devices, as well as access the Internet. Other application protocols allow applications to run a DHCP client (to obtain an IP address), FTP client/server, HTTP server (i.e., a web server), SMTP client (to send e-mails), POP3 client (to receive e-mails), and more. μC/TCP-IP can also be used as an interface to μC/Probe.

The LPC1758/68 is also capable of running USB stacks such as Micriμm's μC/USB-Device, and μC/USB-Host. The USB controller is a full-speed device, and can transfer data up to 12 Mbps. The MCB1700 can thus act as a USB device or a USB host. As a device, the evaluation board can act as a Human Interface Device (HID) or a Mass Storage Device (MSD), especially with the on-board SD card. In other words, the MCB1700 can appear as a disk drive to a PC. As a USB host, the MCB1700 interfaces to USB memory sticks, allowing for the storage and retrieval of data.

The included microSD connector allows applications to run a file system such as Micriμm's μC/FS to save and retrieve contents onto a Micro Secure Digital (microSD) card. The microSD card can be used to log data to a file, which can be read from a PC (assumes USB Device, MSD, or an FTP client or server). Note that the microSD card is not provided with the MCB1700 evaluation board.

The two RS-232C connectors allow an application to output information to a terminal (or a terminal emulator). One of the two RS-232C interfaces can also be used with μC/Probe.

Appendix E contains the complete schematics for the MCB1700.

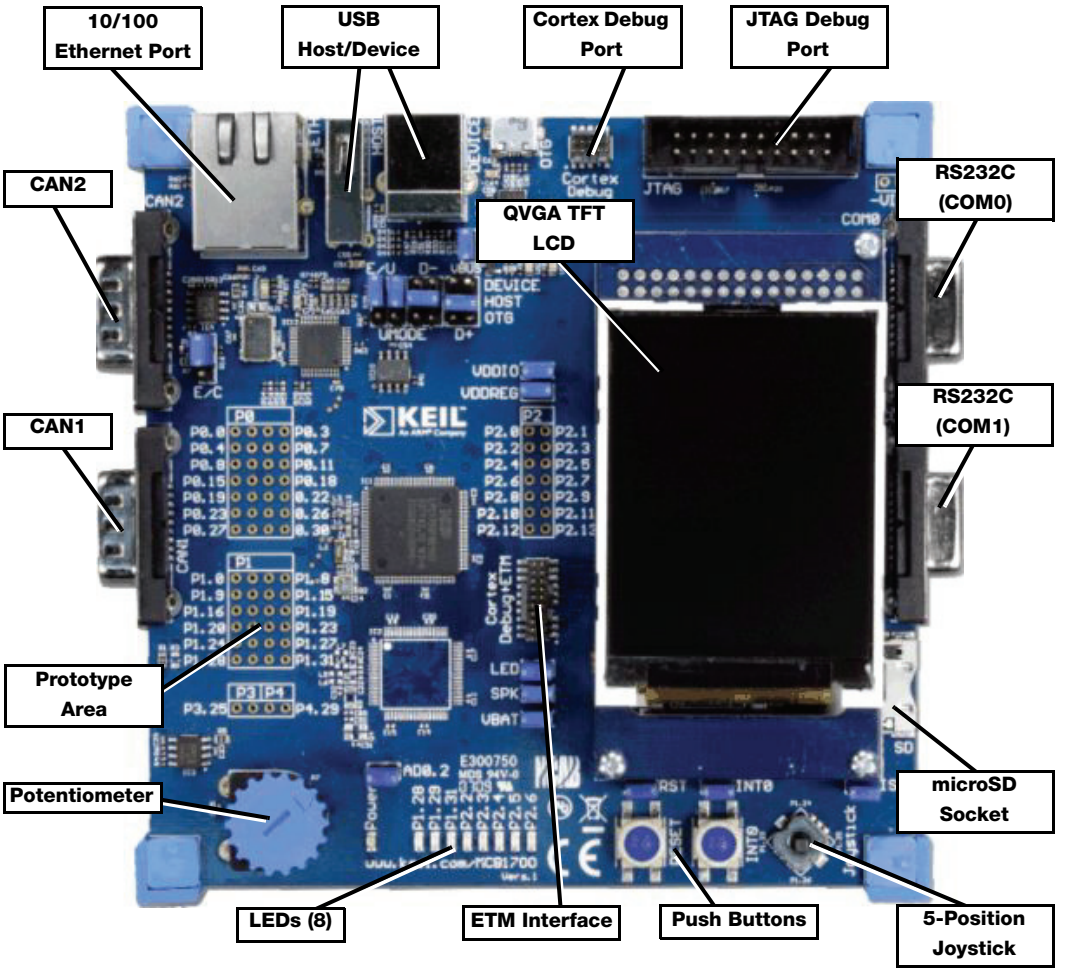

Figure 1-1 **Keil MCB1700 Evaluation Board**

1-2 PART II CHAPTER CONTENTS

Chapter 1, The ARM Cortex-M3 and the LPC1768. This chapter provides a brief introduction to the ARM Cortex-M3 CPU and its implementation in the LPC1768.

Chapter 2, Setup. The chapter explains how to set up the test environment to run µC/OS-III examples. The chapter describes how to download the 32K version of the Keil MDK-ARM tool chain, how to obtain example code that accompanies the book, and how to connect the MCB1700 evaluation board to a PC.

Chapter 3, DMA-Based LED Blinking. This chapter explains how to get µC/OS-III up and running. This first example will perform a modified version of the classical 'blink a light' test. After 10 seconds the application sets the CPU in sleep mode. The LPC1768's sleep mode halts the clock to the CPU's core and powers down the on-chip flash memory but the peripheral clocks and the SRAM memory module remain powered.

DMA is used to transfer data that is located in SRAM to the LEDs (which are connected to GPIOs on the MCB1700 evaluation board) while the CPU is in sleep mode. Since the CPU is in sleep mode, DMA requests are made by Timer 0 at a rate of 1Hz. An external interrupt ('INT0' push button) brings the CPU back to normal mode and the execution is resumed.

Chapter 4, LCD Display. This chapter describes how to create a simple Graphical User Interface (GUI) to be used in a multitask environment.

Chapter 5, Ringtone Player. In this chapter we implement a Ringtone Player using the MCB1700's speaker and the LPC17xx's digital-to-analog converter (DAC). The ringtones are stored onto the LPC17xx's on-chip flash memory in a Ring Tone Text Transfer Language Format (RTTTL). A simple user interface is created to allow the user to select and play a specific ringtone from a playlist.

The example requires a tone generator that creates a sine wave to be output to the DAC. The audio is sampled at 44,100 Hz and, instead of using a timer to generate an interrupt every 22.67 µs, the LPC17xx's DMA is used to eliminate the overhead of an interrupt.

The example also shows how audio quality is reduced when the application's task priorities are not properly assigned.

Chapter 6, Playing Audio Wave Files. This chapter describes the implementation of a simple media player. The media player will play files in WaveForm Audio file format (WAVE) from a microSD card. The audio will be played through the LPC17xx DAC and the MCB1700's speaker.

Files can be uploaded into the microSD card using the Trivial File Transfer Protocol (TFTP) through an Ethernet connection. Note that the microSD card is not provided with the MCB1700 evaluation board and you will thus need to acquire such a card from your favorite computer part supplier.

Appendix A, µC/OS-III Port for the Cortex-M3. This appendix explains how µC/OS-III was adapted to the Cortex-M3 CPU. The Cortex-M3 contains interesting features specifically designed for real-time kernels, and µC/OS-III makes good use of these.

Appendix B, µC/CPU Port to the Cortex-M3. This appendix describes how µC/CPU was adapted to the Cortex-M3 processors.

Appendix C, µC/Probe. This appendix provides a brief description of Micriμm's award-winning µC/Probe, which easily allows users to display and change target variables at run time.

Appendix D, Debugging with ARM CoreSight Technology on Cortex-M3 Processors. This appendix describes the debug components in the ARM CoreSight as implemented in the NXP LPC1768.

Appendix E, MCB1700 Schematics. This appendix provides the full schematics for the Keil MCB1700 evaluation board.

Appendix F, Bibliography.

Appendix G, Licensing µC/OS-III.

1-3 ACKNOWLEDGEMENTS

I would like to thank Mr. Bob Boys from ARM/Keil for his support and help on this project. His knowledge and insight of the Cortex-M3 architecture and the Keil tools have proved to be invaluable.

Thank you to Mr. Kenneth Dwyer and the fine folks at NXP for their help and for working with Micriμm to make this book a reality.

Finally, thank you to my great team at Micriμm for the help and support they provided for this project.