ARM Embedded Development Using Oberon-07

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Overview

- Background
- ARM Microcontrollers
- Embedded Software
- Astrobe Aim
- Why NXP LPC2000 Microcontrollers?
- Why Oberon-07?
- Astrobe Features

Background

- Application Programming:
 - Pascal on mainframes, minis, PCs and PDAs
 - C, Modula-2 and Oberon-2 on PCs
 - Borland Delphi on Windows
 - Component Pascal and C# on .NET
- Electronics Magazine Projects:
 - Shortwave radio
 - Digital clock and FM tuner
 - Single board computer and VDU
 - ARM development board

ARM7 Microcontrollers

- 32-bit RISC Architecture
- Low power consumption
- 170+ silicon licensees
- I0 Billion + Units Shipped
- Suitable for programming with a high-level language instead of assembler

Embedded Software

- A cross-compiled, statically linked, single executable
- All program code and data storage is on-chip
- Real time operation
- No operating system
- Peripherals are either on-chip or controlled via RS232, SPI or I2C interfaces

Typical Applications

Data loggers

- Sensors: Temperature, pressure, compass, GPS etc.
- Data storage on EEPROM (I2C) or SD CARD (SPI)
- Motion detectors and level meters
 - ADC Accelerometers
- Control panels
 - Keypad, pushbuttons or joysticks for input (GPIO)
 - Text or graphic output (SPI) to LCD display
- Robotics and vehicles
 - Motor control

Available Development Tools

- Integrated but expensive professional systems (\$5000+)
- DIY 'toolchains' cheap or free but complex to install and configure
- Most only support the C language
- Complexity:
 - A wide variety of microcontrollers from different manufacturers are supported.
 - Large range of compiler and linker options

Astrobe Aim

- An embedded development system that is:
 - Completely integrated
 - Easily installed and configured
 - Affordable for individuals
 - Usable by electronic engineers with little or no programming experience
 - Usable by computer programmers with little or no electronic hardware experience
- Simplification was achieved by:
 - Targeting a single family of microcontrollers
 - Using the Oberon-07 language

Why NXP LPC2000?

- Wide range of low-cost development boards from several manufacturers:
 - Coridium Corp
 - Elektor
 - Embedded Artists
 - MikroElektronica
 - Olimex
 - ThaiEasyElec
- Elektor Magazine articles
- Very active user group (Yahoo)

LPC2000 Features

- 8KB 512KB Flash ROM (program code)
- 2KB 64KB RAM (globals, heap and stack)
- 60 72 Mhz clock, 32 160 pin packages
- Resident Bootloader for programming via UART
- Memory Accelerator Module (MAM) for executing code from ROM
- Vectored Interrupt Controller (VIC)
- 24 devices supported
 - Range of peripherals supported
 - 7 sub-families memory size

NXP LPC2148



- 60 MHz 32-bit Processor
- 512KB Flash and 40KB RAM
- 12 Mbps USB 2.0
- VIC, 2 x 10-bit A/D, 10-bit D/A
- 2 x I²C
- 2 x UART
- SPI & SSP
- 45 Fast IO Pins, 6-output PWM
- 2 * 32-bit and Watchdog Timers
- Real Time Clock
- Power: 3.3v, 20-120 mA
- Price: \$15

Development Boards - 1







LPC2148 Quickstart and Prototype Board

Development Boards - 2







LPC2103 EDU and Experiment Board

Development Boards - 3



LPC2138 EDU Board



Oberon-07 Reliability - 1

Module Interfaces verified at compile and link time





Oberon-07 Reliability - 2

Efficient runtime error trapping

- Array bounds checking, invalid CASE value, integer division by zero, string overflow etc.
- Eliminates spurious secondary errors
- MISRA 2004 comparison
 - 122 required rules, 20 advisory rules when programming in C
 - More than 70% of the rules are not required when programming in Oberon-07. They are either already enforced by the language or are not applicable.

Oberon-07 SYSTEM Functions

- PUT*(CONST address: INTEGER; CONST x: <any basic type>)
 PUT stores the value of x into the word at memory address addr.
- GET*(CONST address: INTEGER; VAR v: <any basic type>)
 GET stores the value of the word at memory address addr into variable v.
- BIT*(CONST address, bitNo: INTEGER): BOOLEAN

BIT returns TRUE if the specified bit number of the contents of the given address is equal to 1, otherwise FALSE.

ADR*(CONST variableName: <any type>): INTEGER

ADR returns the absolute address of the given variable.

SIZE*(CONST typeName: <any type>): INTEGER

SIZE returns the number of bytes used by a variable of the given type.



Oberon-07 SYSTEM Examples

- SYSTEM.GET (LPC.IODIR, direction);
- SYSTEM.PUT (LPC.T1MR0, 100000);
- SYSTEM.PUT (LPC.IOSET, {13});
- SYSTEM.PUT (LPC.VICVectAddr0, SYSTEM.ADR(TimerHandler));
- rSize := SYSTEM.SIZE(recType);

PROCEDURE PutCh*(CONST ch: CHAR); BEGIN REPEAT UNTIL SYSTEM.BIT(LPC.U0LSR, 5); SYSTEM.PUT(LPC.U0THR, ch) END PutCh;

Oberon-07 SET Constants

set



HEX Value	SET CONST
0	{ }
1	{0}
0A0AH	{1, 3, 9, 11}
0FF0A0AH	{1, 3, 9, 11, 1623}
OFFFFFFFH	{031}

Oberon-07 SET Example

Assigning a value to the IOSET register produces highs on each pin corresponding to a bit which is set to 1.

If you have LEDs connected to pins P0.13, P0.14 and P0.15 you can light them the traditional way using hexadecimal notation:

SYSTEM.PUT (LPC.IOSET, OE000H)

Using Oberon-07's SET constant you can simply say:

SYSTEM.PUT (LPC.IOSET, { 13..15 })



Astrobe IDE Features

- A multi-file, split-screen, syntax-aware programmer's editor
- Automatic cross-reference of procedures and imports
- Oberon-07 ARM native code compiler
- Compile-error location
- LPC2000 startup code
- LPC2000-specific library modules
- General library modules
- Linker and Builder
- Flash program loader & terminal emulator
- Runtime error reporting



Reference Links

ARM

- www.arm.com
- Astrobe
 - www.astrobe.com
- Embedded Artists
 - www.embeddedartists.com
- MISRA
 - www.misra.org.uk
- NXP Semiconductors
 - ics.nxp.com/microcontrollers
- Oberon-07
 - www.inf.ethz.ch/personal/wirth/Articles/Oberon.html

Questions





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