AT2 - AT91SAM9 microcontroller implementation

This course covers AT91SAM9 ARM-based MCU family

Objectives

- The course details the hardware implementation of the AT91SAM9 MCUS.
- The ARM926EJ-S operation is detailed, particularly cache and MMU.
- The boot sequence and the clocking are explained.
- Practical labs on integrated peripherals are based on I/O functions provided by Atmel.
- The course provides examples of internal peripheral software drivers.
- Note that ACSYS does not sell emulation probes and IDEs. Consequently this course has not been designed to convince attendees to buy a particular IDE. The unique objective consists in providing sufficient knowledge to attendees so that they can successfully design a system based on AT91SAM9.
- This course has been delivered several times to companies developing embedded systems, such as medical equipments.
- Note that an additional day on Linux porting onto an AT91SAM9 board may be appended.

A lot of programming examples have been developed by ACSYS to explain the boot sequence, the vector table and the operation of embedded peripherals.

- They have been developed with 2 different IDEs : Keil and IAR.
- Consequently for on site course, it is up to the customer to select the IDE under which labs will be run.

A more detailed course description is available on request at training@ac6-training.com

Prerequisites and related courses

- This course provides an overview of the ARM926 core. Our course reference R1 - ARM7/9 implementationcourse details the operation of this core.
- The following courses could be of interest:
  - USB Full Speed High Speed and USB On-The-Go, reference IP2 - USB 2.0course
  - Ethernet and switching, reference N1 - Ethernet and switchingcourse
  - CAN bus, reference IA1 - CAN buscourse

Course Environment

- Theoretical course
  - PDF course material (in English) supplemented by a printed version.
  - The trainer answers trainees' questions during the training and provide technical and pedagogical assistance.
- At the start of each session the trainer will interact with the trainees to ensure the course fits their expectations and correct if needed

Target Audience

- Any embedded systems engineer or technician with the above prerequisites.

Course Outline

INTRODUCTION TO AT91SAM9 MCUs

Overview

- ARM core based architecture, AMBA buses
- Multi-layer AHB bus matrix
- The main three blocks : platform, core and input / output peripherals

THE PROCESSOR CORE

THE ARM926EJ-S CORE

- Operating modes : user, system, super, IRQ, FIQ, undef and abort
- ALU data path
- ARM vs Thumb instruction sets, interworking
- Access to memory-mapped locations, addressing modes
- Stack management
- Benefits of condition set capability in ARM state
- C-to-Assembly interface
- Exception mechanism, handler table
- MMU
- Cache operation
- JTAG interface
- Debug facilities

PLATFORM

INFRASTRUCTURE

- Power supplies, internal regulator
- Power-on sequence
- Clock generator, on-chip oscillator, PLL
- Reset controller
- Boot program
- Memory controller
- Internal high-speed flash
- External Bus Interface, SDRAM controller, NAND flash controller
- Power management controller
- Advanced interrupt controller
- External interrupt sources and fast interrupt source
- Parallel input / output controller
- Peripheral DMA controller

INTEGRATED I/Os

TIMERS

- Periodic Interval Timer
- Windowed Watchdog
- Real-time timer
- 3-channel timer / counter

ANALOG-TO-DIGITAL CONVERTER

- Successive Approximation Register 10-bit ADC
- Detail of the analog part, timings
- Conversion triggers

COMMUNICATION CONTROLLERS

- 2-wire interface
  - I2C protocol basics
  - Slave mode vs master mode
  - Transmit and receive sequences
- SPI
  - SPI protocol basics
  - Master / slave operation
  - Transfer sequence
- USART
  - Individual baud rate generators
  - RS485 support
  - Flow control
- Synchronous Serial Controller
  - Independent clock and frame sync signals for each receiver and transmitter
  - I2S analog interface support
  - Time Division Multiplexed support
- Ethernet MAC
  - Accessing PHY registers, auto-negotiation
  - Receive and Transmit buffer management, buffer descriptors
  - Incoming frame filtering
  - Error management
- USB device
  - Full speed operation
  - High Speed device port on AT91SAM9RL64
  - Connection of an external PHY using UTMI+
  - Endpoint configuration
- USB host
  - Overview of the OHCI specification
  - Clarifying the boundary between software and hardware
- Multimedia Card Interface (on demand)
  - MMC and SD card basics
  - Command / response protocol
  - Read sequence
  - Write sequence
- AC97 controller (Specific to AT91SAM9RL64, on demand)
  - Sound encoding
  - Connecting an external audio codec
  - Time slot assigner operation

IMAGE SENSOR INTERFACE

- Connecting an external image sensor
- CCIR656 specification
- Scaling, decimation
- Color space conversion
- FIFO and DMA transfer

LCD CONTROLLER

- Single and Dual scan color and monochrome passive STN LCD panels
- Single scan active TFT LCD panels
- Pixel encoding
- Supported resolution

TOUCH SCREEN ANALOG-TO-DIGITAL CONVERTER

- 6-channel ADC
- Multiple trigger sources
- Conversion sequencer