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 cours R1 - ARM7/9 implementationdetails the operation of this core.
- The following courses could be of interest:
  - USB Full Speed High Speed and USB On-The-Go, reference cours IP2 - USB 2.0
  - Ethernet and switching, reference cours N1 - Ethernet and switching
  - CAN bus, reference cours IA1 - CAN bus

Environnement du cours

- Cours théorique
  - Support de cours imprimé et au format PDF (en anglais).
  - Le formateur répond aux questions des stagiaires en direct pendant la formation et fournit une assistance technique et pédagogique.
- Au début de chaque demi-journée une période est réservée à une interaction avec les stagiaires pour s'assurer que le cours répond à leurs attentes et l'adapter si nécessaire

Audience visée

- Tout ingénieur ou technicien en systèmes embarqués possédant les prérequis ci-dessus.

Modalités d'évaluation

- Les prérequis indiqués ci-dessus sont évalués avant la formation par l'encadrement technique du stagiaire dans son entreprise, ou par le stagiaire lui-même dans le cas exceptionnel d'un stagiaire individuel.

- Les progrès des stagiaires sont évalués par des quizz proposés en fin des sections pour vérifier que les stagiaires ont assimilé les points présentés
- En fin de formation, une attestation et un certificat attestant que le stagiaire a suivi le cours avec succès.
  - En cas de problème dû à un manque de prérequis de la part du stagiaire, constaté lors de la formation, une formation différente ou complémentaire lui est proposée, en général pour conforter ses prérequis, en accord avec son responsable en entreprise le cas échéant.

Plan

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

Renseignements pratiques

Renseignements : 4 jours