



## This course covers the Cortex-M3 ARM core

### Objectives

- This course is split into 3 important parts:
  - Cortex-M3 architecture
  - Cortex-M3 software implementation and debug
  - Cortex-M3 hardware implementation.
- Although the Cortex-M3 seems to a simple 32-bit core, it supports sophisticated mechanisms, such as exception pre-emption, internal bus matrix and debug units.
- Through a tutorial, the Cortex-M3 low level programming is explained, particularly the ARM linker parameterizing and some tricky assembly instructions.
- Note that attendees can replay these labs after the training.
- The course also details the hardware implementation and provides some guidelines to design a SoC based on Cortex-M3, taking benefit of concurrent AHB transactions
- An overview of the Coresight specification is provided prior to describing the debug related units.

*A more detailed course description is available on request at [training@ac6-training.com](mailto:training@ac6-training.com)*

### Prerequisites

- A basic understanding of microprocessors and microcontrollers.

### Course Environment

- Theoretical course
  - PDF course material (in English) supplemented by a printed version for face-to-face courses.
  - Online courses are dispensed using the Teams video-conferencing system.
  - 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.

### Evaluation modalities

- The prerequisites indicated above are assessed before the training by the technical supervision of the trainee in his company, or by the trainee himself in the exceptional case of an individual trainee.
- Trainee progress is assessed by quizzes offered at the end of various sections to verify that the trainees have assimilated the points presented
- At the end of the training, each trainee receives a certificate attesting that they have successfully completed the course.
  - In the event of a problem, discovered during the course, due to a lack of prerequisites by the trainee a different or additional training is offered to them, generally to reinforce their prerequisites, in agreement with their company manager if applicable.

## Plan

### ARM Cortex-M3 CORPORATE INTRODUCTION

- ARM architectural summary
- Meeting the challenge with profiles
- ARM instruction set evolution

### ARM Cortex-M3 INTRODUCTION

- ARM Cortex-M3 processor macrocell
- Programmer's model
- Program status registers
- Instruction pipeline
- Fixed memory map
- Memory Protection Unit
- Interrupt handling
- Power management

### ARM Cortex-M3 CORE

- Block diagram
- Datapath and pipeline
- Write buffer
- Bit-banding
- State, privilege and stacks
- Alignment and endianness
- System control block

### THUMB-2 INSTRUCTION SET

- General points on syntax
- Data processing instructions
- Branch and control flow instructions
- Memory access instructions
- Exception generating instructions
- If then conditional blocks
- Stack in operation
- Accessing special registers
- Tutorial: Becoming familiar with Keil IDE
  - How to design a new project
  - Parameterizing the IDE
  - Executing simple labs to understand the operation of assembly complex instructions, such as table branch and it

### INTERRUPTS

- Basic interrupt operation
- Interrupt entry / exit, timing diagrams
- Tail chaining
- Interrupt response, pre-emption
- NVIC registers
- Interrupt prioritization
- Interrupt implementation configurability, impact on core size

### EXCEPTIONS

- Exception behavior, exception return
- Non-maskable exceptions

- Privilege, modes and stacks
- Priority boosting
- Vector table

## **MEMORY TYPES**

- Device and normal memory ordering
- Memory type access restrictions
- Access order
- Memory barriers

## **MEMORY PROTECTION UNIT**

- Memory protection overview
- Fault status and address registers
- Region overview, memory type and access control, sub-regions
- Setting up the MPU

## **EMBEDDED SOFTWARE DEVELOPMENT WITH Cortex-M3**

- Embedded development process
- Application startup
- Placing code, data, stack and heap in the memory map, scatterloading
- Reset and initialisation
- Placing a minimal vector table
- Building and debugging your image
- Long branch veneers
- Tutorial: Becoming familiar with Keil IDE
  - Scatterloading
  - Retargeting the C library
  - Handling interrupts in C language
  - Using SVC

## **INVASIVE DEBUG**

- Coresight debug infrastructure
- Halt mode
- Monitor mode
- Debug event sources
- Flash patch and breakpoint features
- FPB remapping
- Data watchpoint and trace
- DWT registers
- ARM debug interface specification
- AHB-Access Port
- Possible DP implementations

## **NON-INVASIVE DEBUG**

- Basic ETM operation
- Instruction trace principles
- ITM packets
- DWT trace packets
- Time-stamping packets
- Instruction tracing
- TPIU components
- TPIU pinout
- Software interface

**C/C++ COMPILER HINTS AND TIPS FOR Cortex-M3**

- ARM compiler optimisations
- Mixing C/C++ and assembly
- Coding with ARM compiler
- Measuring stack usage
- Unaligned accesses
- Local and global data issues, alignment of structures
  - Tutorial: Implementing these optimizations by using ARM/Keil compiler

**AMBA3.0 INTERCONNECT SPECIFICATION**

- Purpose of this specification
- 2-bus organization
- Example of SoC based on AMBA specification

**AHB - ADVANCED HIGH PERFORMANCE BUS**

- Centralized address decoding
- Address gating logic
- Arbitration, bus parking
- Single-data transactions
- Address pipelining
- Sequential transfers
- AHB-lite specification

**APB - ADVANCED PERIPHERAL BUS**

- Second-level address decoding
- Operation of the AHB-to-APB bridge
- APB3.0 new features

**AHB CORTEX-M3 HARDWARE IMPLEMENTATION**

- Clocking and reset, power management
- Bus interfaces
- AMBA-3 compliance
- Unifying the code buses
- Branch Status signal
- Unaligned access management
- Connection to the TPIU

**Renseignements pratiques**

**Inquiry : 4 days**