



## FK1 - Kinetis MCU Implementation

*This course covers all NXP MCUs belonging to the Kinetis families K10, K20, K30, K40 and K60*

### Objectives

- This course has 5 main objectives:
  - Describing the hardware implementation and highlighting the pitfalls
  - Describing the ARM Cortex-M4 core architecture
  - Becoming familiar with the IDE and low level programming
  - Describing the units which are interconnected to other modules, such as clocking, interrupt controller and DMA controller, because the boot program generally has to modify the setting of these units
  - Describing independent I/O modules and their drivers.
- Note that this course has been designed from the architecture of the most complex Kinetis device, the K60.
  - Consequently, a chapter has been designed by Acsys for each possible integrated IP.
  - So the customer can build its own course outlines from the topics described hereafter.
- Products and services offered by ACSYS:
  - ACSYS has developed FFTs (floating-point and fixed-point) optimized for ARM cores, based on SIMD instructions supported by the Cortex-M4.
  - Contact [formation@ac6-formation.com](mailto:formation@ac6-formation.com) to obtain informations about the performance of these FFTs.
  - ACSYS is able to assist the customer by providing consultancies. Typical expertises are done during board bringup, hardware schematics review, software debugging, performance tuning.
  - ACSYS has also an expertise in FreeRTOS or MQX porting and uIP /LWIP stack or Interniche stack integration.

This document is necessary to tailor the course to specific customer needs and to define the exact schedule.

### Prerequisites and related courses

- This course provides an overview of the Cortex-M4 core. Our course reference cours [RM3 - Cortex-M4 / Cortex-M4F implementation](#) details 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](#)
  - IEEE1588, reference cours [N2 - IEEE1588 - Precise Time Protocol](#)
  - CAN bus, reference cours [IA1 - CAN bus](#)

### Environnement du cours

- Cours théorique
  - Support de cours au format PDF (en anglais) et une version imprimée lors des sessions en présentiel
  - Cours dispensé via le système de visioconférence Teams (si à distance)
  - 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.

# Course Outline

## ARCHITECTURE OF KINETIS MCUS

- ARM core based architecture
- Description of K10, K20, K30, K40 and K60 SoC architecture
- Clarifying the internal data and instruction paths: AHB-lite interconnect, peripheral buses, AIPD bridges
- AMBA-to-IPS Re-use IP: ColdFire (AIPS) Controller
- Integrated memories
- SoC mapping

## THE ARM CORTEX-M4 CORE

- V7-M core family
- Core architecture
- Freescale on-chip instruction and data cache
- Thumb-2 instruction set
- Exception behavior
- Basic interrupt operation, micro-coded interrupt mechanism
- Memory Protection Unit

## V7-M DATA SIGNAL PROCESSING INSTRUCTIONS

- Multiply instructions
- Packing / unpacking instructions
- SIMD packed add/sub instructions
- SIMD combined add/sub instructions
- SIMD multiply and multiply accumulate instructions
- SIMD sum absolute difference instructions
- SIMD select instruction
- Saturation instructions
- Floating point unit
- Cortex Microcontroller Software Interface Standard (CMIS)

## BECOMING FAMILIAR WITH THE IDE

- Acsys covers 3 IDEs: CodeWarrior, IAR and GCC / Lauterbach
- Thus the customer has just to indicate which one he has chosen
  - Getting started with the IDE
  - Parameterizing the compiler / linker
  - Creating a project from scratch
  - C start program

## PROGRAMMING AND DEBUGGING

- Debug interface
- Programming

## RESET, POWER AND CLOCKING

- Reset
- Clocking
- Operation modes

## INTERNAL INTERCONNECT

- Crossbar switch
- Hardware Memory Protection Unit
- eDMA

## HARDWARE IMPLEMENTATION

- Power pins
- Pinout
- GPIO module

## INTEGRATED MEMORIES

- Flex memory, this module is not implemented in all Kinetis devices
- Internal SRAM

## MEMORY INTERFACE

- Each Kinetis family supports either a subset or all the following controllers
- FlexBus
- eSDHC
- NAND flash controller
- DRAM controller

## TIMERS

- Low Power Oscillator
- COP
- External Watchdog Monitor
- Periodic Interrupt Timer
- Low Power Timer
- Flex Timer
- Carrier Modulator Transmitter

## ANALOG MODULES

- 16-bit Analog-to-Digital Converter and Programmable Gain Amplifier
- 12-bit Digital-to-Analog Converter
- Voltage Reference VREF
- High-Speed Comparator HSCMP
- Programmable Delay Block PDB

## SECURITY AND INTEGRITY

- Hardware Cyclic Redundancy Check
- Memory-Mapped Cryptographic Acceleration Unit (MMCAU)
- Pseudo Random Number Generator
- Secure Real Time Clock
- DryIce and Tamper Detect
- Cryptographic Acceleration Unit

## CONNECTIVITY AND COMMUNICATION

- DSPI
- UART
- I2C

- CAN modules
- USB
- Fast ethernet with IEEE1588
- ISO7816 smartcard interface
- I2S audio interface

## **USER INTERFACES**

- Segment LCD controller
- Graphics LCD controller
- Capacitive touch sensing