Introduction to Microcontroller World
XMC™ Microcontrollers
March 2016
# Agenda

<p>| | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>What is a Microcontroller</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>CPU</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Co Processor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>On Chip Memories</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Communication Peripherals</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Analog Peripherals</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Timers with pulse width modulation capability</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Agenda

1. What is a Microcontroller
2. CPU
3. Co Processor
4. On Chip Memories
5. Communication Peripherals
6. Analog Peripherals
7. Timers with pulse width modulation capability
What is a Microcontroller?

**Processor + Peripherals**

- **Microcontroller**
  - CPU: ARM® Cortex®
  - Memory: (Flash / RAM)

**Connectivity**
- Connect your module to the external world (IOT)
  - USB
  - Ethernet
  - SDIO/Memory Interface
  - SPI, UART, I2C
  - Ethernet
  - CAN

**Drivers**
- Gate Drivers
- MOSFETS
- IGBT's

**Sensors**
- Temperature, Pressure, Acceleration,...
  - DAC
  - ΔΣ-Demodulator
  - ADC
  - Comparators
  - Position Interface

**Feedback Loops**
- Hall Sensors
- Encoders
- Current Measurement
## Agenda

1. **What is a Microcontroller**
2. **CPU**
3. **Co Processor**
4. **On Chip Memories**
5. **Communication Peripherals**
6. **Analog Peripherals**
7. **Timers with pulse width modulation capability**
What is the role of CPU in a Microcontroller?

- CPU stands for Centre Processing Unit which is the brain of the overall Microcontroller system.
- The CPU will execute instruction sets (software) from the memory (Flash/RAM) and command other peripherals for specific tasks or process incoming data.
- For embedded system of this generation CPUs are considered to be 32-bit. This means that the related instruction sets, address and data bus are accessed in 32-bit format.
- There are various CPU processing speed to cater for different needs and the CPU speed is specified in MHz frequency.
- The CPU needs to be driven by an external or internal oscillator also known as the clock source.
## Agenda

1. What is a Microcontroller
2. CPU
3. Co Processor
4. On Chip Memories
5. Communication Peripherals
6. Analog Peripherals
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Co Processor

What is the role of the Co Processor?

› The Co Processor is a computer processor used to supplement the functions of the primary processor (the CPU).

› Operations performed by the Co Processor may be floating point arithmetic, graphics, signal processing, string processing, encryption or I/O Interfacing with peripheral devices.

› This has the advantage of off loading the CPU to perform time critical task.

› Low end microcontroller does not come with Co Processor, hence complex software algorithm needs to be implemented which makes the overall system less efficient.

Infineon XMC4000
The XMC4000 ARM® Cortex® M4 has got a built in Digital Signal Processor (DSP) or Multiply Accumulate (MAC) to take care of complex arithmetic calculation.

Microcontroller

CPU
ARM® Cortex®

Co-Processor

Math

Tasks

Memory
(Flash / RAM)

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3. Co Processor
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On chip Memories

What is Flash memory?
› Flash is used for the storage of software or commonly known as the firmware in an embedded system.
› Hence firmware can be updated into the flash memory with a newer version by the process of electrically erasing and reprogramming the flash.
› Flash memory space range from 64 KB to 2 MB for Infineon XMC™ Microcontrollers.

What is RAM?
› RAM stands for Random Access Memory
› RAM is used as temporary storage of data variables. Unlike flash which contains mostly static instructions or data, RAM data can be frequently changing.
› Example, the below RAM data “Counter” is doing an incrementing operation. And its updated with a different value each time it is incremented.

```
Counter++;
```
<table>
<thead>
<tr>
<th></th>
<th>Agenda</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<tr>
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</tr>
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</tr>
</tbody>
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Communication Peripherals

Why MCU needs communication?

› The MCU needs to interact with other external device just like human beings who need to speak different languages.

› Hence there are many different communication protocol (USB, CAN I2C etc.)

Types of Communication Protocol

› In modern communication, Ethernet and USB can be found in most high end microcontroller. (e.g. XMC4000)

› Standard communication protocol such as UART, SPI, I2C or EBU can be found in most general microcontroller.

› For Automation purposes, CAN bus is usually used.

› Lately Ethernet is used in Automation for better performance, therefore EtherCAT® (Ethernet for Control Automation Technology) is introduced in Infineon XMC4800.
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</tr>
<tr>
<td>7</td>
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</tr>
</tbody>
</table>
Analog Peripherals

What are the Analog Peripherals?

› The Analog Peripherals refers to the Analog to Digital Converter (ADC), Digital to Analog Converter (DAC) and Comparator.

Analog to Digital Converter (ADC)

› ADC is used to convert analog voltage level to digital data. Such that this data can be used by the software to determine the next course of action.

› Usually sensors (e.g. temperature sensor) can be connected to a ADC channel as a close loop feedback system.

Digital to Analog Converter

› The DAC is function that convert digital data into an analog signal usually a specific voltage level.

Comparator

› The comparator is used to compare 2 analog voltage input. The result is an output voltage level high or low.
Agenda

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Timers with pulse width modulation capability

**Note:**
PWM stands for **Pulse Width Modulation**, it is a modulation technique used to encode a message into a pulsing signal.

**What is the purpose of the PWM timer?**
- The timer can be figured to output square waveforms with defined period and duty cycle, allowing for use in motor control applications, for example.
- It is also able to measure a PWM Frequency/Period and Duty cycle base on the rising and falling edge of the waveform.

**What is a Position Interface?**
- Position interface is used to interface with a rotary Encoder to understand precisely the angular position or motion example of a motor.
# Support material

## Collaterals and Brochures
- Product Briefs
- Selection Guides
- Application Brochures
- Presentations
- Press Releases, Ads
- [www.infineon.com/XMC](http://www.infineon.com/XMC)

## Technical Material
- Application Notes
- Technical Articles
- Simulation Models
- Datasheets, MCDS Files
- PCB Design Data
- [www.infineon.com/XMC](http://www.infineon.com/XMC)
- Kits and Boards
- DAVE™
- Software and Tool Ecosystem

## Videos
- Technical Videos
- Product Information Videos
- [Infineon Media Center](http://Infineon Media Center)
- XMC Mediathek

## Contact
- Forums
- Product Support
- [Infineon Forums](http://Infineon Forums)
- Technical Assistance Center (TAC)
Glossary abbreviations

› ADC  Analog to Digital Converter
› DAC  Digital to Analog Converter
› PWM  Pulse Width Modulation
› CPU  Central Processing Unit
› RAM  Random Access Memory
› I/O  Input and Output Port
› UART Universal Asynchronous Receive and Transmit
› USB  Universal Serial Bus
› I2C  Inter-Integrated Circuit
› CAN  Controlled Area Network
Glossary abbreviations

› EtherCAT® Ethernet for Controlled Automation Technology
› SPI Serial Peripheral Interface
› IoT Internet of Things
Disclaimer

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