



# MICROCHIP 2019 MASTERS

Berlin, Germany  
September 16 - 19

## European Conference Event Guide



SMART | CONNECTED | SECURE

[www.microchip.com/eumasters](http://www.microchip.com/eumasters)



**MICROCHIP**

# Microchip's European MASTERs Conference 2019

## 16 - 19 September - Berlin, Germany

Microchip invites you to sign up for our 2019 European MASTERs Conference and experience the premier technical training event for embedded control engineers. The U.S. MASTERs Conference is in its 23rd consecutive year & the Berlin MASTERs will celebrate its 5th consecutive year this September! MASTERs continues to give system design engineers at every level extensive product information, hands-on training and the opportunity for networking with Industry Experts to help you climb the learning curve and get your products to market faster.

### Classes

We run a selection of more than 85 classes that cover a broad range of topics, taught by Microchip's embedded systems engineers as well as selected industry experts. Come and learn from these experts and leave with everything you need to get up and running on your new design. We offer lecture, hands-on classes and additional material presented by some of our partners that covers a wide range of embedded control topics including new products and peripherals, C programming, firmware design, connectivity sessions on TCP/IP, USB, CAN and Bluetooth®, graphics and capacitive-touch interface development, intelligent power supplies, motor control, selecting op-amps for sensor applications using an RTOS and low-power system design.

### Our Experts On-Site

You will have an opportunity to meet with our experts from the different function groups to learn about our latest projects or discuss your own ideas. In addition, we will host an Experts Evening with more than 30 different expert groups. One-on-one expert Face Time can be requested during the registration for the event. You need to be specific on what you would like to discuss with us and we will assign time with a selected expert to address your request. If we can't meet your request on site, we will make arrangements to address this with a follow up call or visit.

### Pre-Conference Registration

You want more? The Pre-Conference will give you the opportunity to attend up to 3 additional classes before the main event starts. This will free up time for you to join the most interesting classes later in the week.

### Conference Registration

Pre-Conference Registration  
Monday 16<sup>th</sup> September 2019 from 10:30 – 13:00

Conference Registration  
Tuesday 17<sup>th</sup> September 2019 from 07:30 - 13:00

At registration you will receive your badge, which must be worn throughout the Conference during classes, meals and events.

### Experts Evening at European MASTERs

Our Experts Evening provides a great opportunity for conference attendees to meet with acknowledged experts in various technologies. The Spreespeicher Event Centre offers a superb location to informally network with specialists from within Microchip and our industry partners including design consultants, distributors and blue chip technology companies.



# Conference Agenda

## Pre-Conference

Monday, 16<sup>th</sup> September, 2019

<b>Registration</b>	10:30-13:00
Training Slot P1	12:00-13:30
Training Slot P2	14:00-15:30
Training Slot P3	16:00-17:30



## Conference

Tuesday, 17<sup>th</sup> September, 2019

<b>Registration</b>	07:30-13:00
Training Slot 1	09:00-10:30
Training Slot 2	11:00-12:30
<b>Lunch</b>	12:30-13:30
Training Slot 3	13:30-15:00
Training Slot 4	15:30-17:00
<b>Boat Cruise to Müggelsee</b>	17:00-18:00
<b>Dinner at Rübezahl, Müggelsee</b>	18:00-21:00
Arrive back at HTW	22:00

Wednesday, 18<sup>th</sup> September, 2019

Training Slot 5	09:00-10:30
Training Slot 6	11:00-12:30
<b>Lunch</b>	12:30-13:30
Training Slot 7	13:30-15:00
Training Slot 8	15:30-17:00
<b>Boat Cruise to Spreespeicher</b>	17:00-18:00
<b>Experts Evening, Spreespeicher</b>	18:00-21:00
Arrive back at HTW	22:00

Thursday, 19<sup>th</sup> September, 2019

Training Slot 9	09:00-10:30
Training Slot 10	11:00-12:30
<b>Lunch</b>	12:30-13:30
Training Slot 11	13:30-15:00
Training Slot 12	15:30-17:00



# Conference Details

## Lunch and Dinner with an Expert

In addition one-to-one expert Face Time can be requested during the registration for the event. You will need to be specific on what you would like to discuss with us and we will assign time with a selected expert to address your request. These meetings will be arranged as a working lunch or working dinner.

## Development Tools Store

Microchip offers a wide selection of the most popular development tools at discounted prices for MASTERS attendees during the Conference. Using this discount at MASTERS to purchase your tools could help offset your cost for the conference. Orders will be processed through our microchipDIRECT site at [www.microchipdirect.com](http://www.microchipdirect.com).

## Microchip On-site Office

Have questions about registration, schedules, evening events or classroom locations? Whatever you can't find on our website can be answered by our friendly team in the Microchip on-site office. Our team is waiting to help you make the most of your MASTERS Conference experience. We're here to help!

## Conference Certificates

Certificates will be handed over during Registration if you have filled in a valid schedule for the conference.

## Internet Access

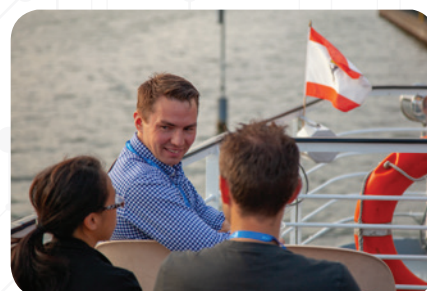
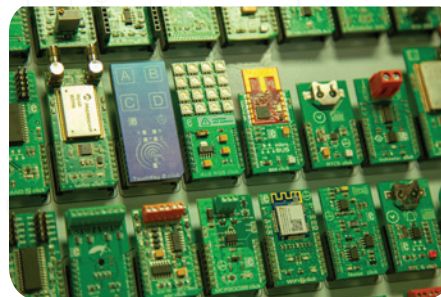
Conference Attendees will have the ability to check email on site with a free wireless access code. The code will be handed over during registration.

## Meals Included in the Conference Fee

- Lunch on 17<sup>th</sup>, 18<sup>th</sup>, 19<sup>th</sup> September 2019
- Rübezahl Cruise and Dinner
- Experts Evening and Dinner at Spreespeicher
- Coffee and Refreshments offered during the breaks

## Dress Code

Dress code for all classes and events is business casual.





# Location

## HTW - University of Applied Sciences - Berlin, Germany

### Location

This event will be held at HTW Berlin, University of Applied Sciences at their Wilhelminenhof Campus.

With a student body of more than 13,000, the Hochschule für Technik und Wirtschaft (HTW) Berlin is the largest University of Applied Sciences in the City. With around 70 Bachelor's and Master's courses in Engineering, Economics, Information Technology, Culture and Design the study programme offers a wide range. The compact studies of applied sciences leads towards professional practice. Degree courses can be supplemented by instruction in foreign languages and key skills. University rankings have consistently established HTW as one of the leading providers of a modern and professional education.

<http://www.htw-berlin/de/en>



Hochschule für Technik  
und Wirtschaft Berlin

University of Applied Sciences



### About HTW Berlin

The Hochschule für Technik und Wirtschaft HTW is located in one of the most important industrial quarters of Berlin.

This district was one of Berlin's first industrial centers, the site of the former cable factory of the Kabelwerk Oberspree. There, the workers manufactured cables, assembled cars and designed transmitters. They were decisive in giving the city its reputation as an electric city.

At the end of the 19th century AEG, the Allgemeine Elektrizitäts Gesellschaft or literally the General Electricity Company, one of the first companies in the electrical industry, took over the complex and within just a few decades would play a decisive role in advancing the electrification of society.

Every day, thousands of workers arrived by tram and flocked into the tightly packed factories that were clad in yellow clinker stone and lined Wilhelminenhofstrasse. Now in the 21st century this area has been through a period of regeneration and today, mostly you will find students disembarking from the trams, heading for the yellow-bricked buildings on the University Campus.

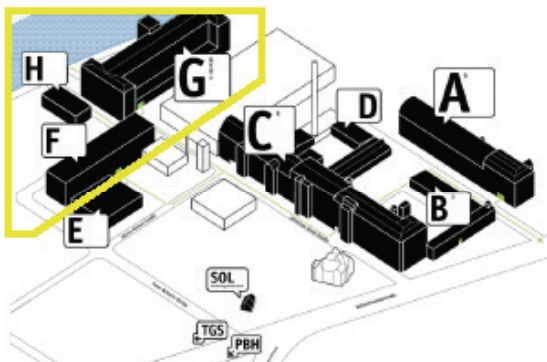
### Rübezahl at Müggelsee

Located at the nearby Müggelsee within a conservation area, the Rübezahl is a lovely beer garden and event location. We will have a barbeque and the relaxed atmosphere encourages networking.

### Spreespeicher Berlin

The noble oak flooring together with the existing old brickwork of the former granary creates an uniquely industrial charm. The beautiful loft windows lead to an exclusive sun deck and offer a magnificent view of the Spree. Several rooms will be connected through moving glass panels hosting our Experts Evening combining an Exhibition with a Dinner.

Microchip MASTERS will be located in buildings F, G & H



# Travel & Accommodation

## Accommodation

Overnight Accommodation is NOT INCLUDED in the Conference Fee.

You will find a wide range of hotels nearby if you use one of the common booking systems:

[www.hrs.com](http://www.hrs.com)

[www.hotels.com](http://www.hotels.com)

[www.booking.com](http://www.booking.com)

Enter Berlin Köpenick or Koepenick as the travel destination.



## Airport Information

Berlin Tegel is 25km away from the Conference

<http://www.berlin-airport.de/en/travellers-txl/index.php>

Berlin Schoenefeld is 13km away from the Conference

<http://www.berlin-airport.de/en/travellers-sxf/index.php>

## Public Transportation

Tramway Stop Rathenastr./ HTW

Lines 21, 27, 63, 67, M17

<http://www.bvg.de/en>



## Taxi or Car

Wilhelminenhofstraße 75A, 12459 Berlin

Navigation: Ernst Ziesel Straße, Berlin



# -What's included at European MASTERS...

## Conference Fees

### Early Bird Special - Register before 28 June 2019

€ 441 (excluding VAT) - Conference only  
€ 495 (excluding VAT) - Conference and Pre-Conference

### Regular Price- Register after 28 June 2019

€ 490 (excluding VAT) - Conference only  
€ 550 (excluding VAT) - Conference and Pre-Conference

## Discounts Available

### Early Bird Discount

Register by 28 June 2019  
10% off regular price

### Additional Fees

There will be a EUR 25 (excluding VAT charge for payment via Purchase Order)

### Design Partner Discount

Design Partner Program number (DP#) needed!  
Minimum 25% off regular price  
Final cost varies by status

### Academic Discount

Academic Discount Number (AP#) needed!  
25% off regular price

### Group Discount

Must be from the same company  
Discount varies. Contact EUMASTERS@microchip.com

## Waiver

Microchip reserves the right to refuse registration or entry to anyone for any reason.



## Special Events

### Boat Trip to Müggelsee and a dinner at the Rübzahl

Enjoy a boat trip to the nearby Müggelsee and a dinner at the Rübzahl Restaurant with it's nice waterfront terrace.

### Experts Evening

Boat trip towards the center of Berlin. We will arrive at the Spreespeicher nearby the East Side Gallery just next to the Oberbaumbrücke and host an evening combining Experts from Microchip plus selected industry partners. This will be an Exhibition plus Buffet Dinner and will give you plenty of opportunities to communicate with us.

## What's Included

- Entry to the MASTERS Conference classes
- USB Flash drive with all class material including classes from the Worldwide MASTERS 2019 Conference
- Google Home Mini Unit to practice skills learned
- Computers and development tools on loan during the hands-on classes
- FREE internet during conference hours
- Significant discounts on all Microchip development tools when ordered during the conference days
- All lunches, refreshments and snacks during the conference days
- Boat trip and dinner on Tuesday night
- Experts evening boat trip and dinner on Wednesday night

## Photograph Disclaimer

Microchip may elect to take photographs of people and events during the MASTERS Conference. By attending this MASTERS Conference, you agree to permit Microchip to use your likeness in these photos in furtherance of its business. This release indicates that you agree that Microchip shall be the copyright owner of the photographs and may use and publish these photographs. Microchip is released from any and all claims and causes of action that you may have now or in the future based upon or in connection with the photographs and Microchip's use of the photographs in any manner. All rights granted to Microchip by you in this Release are irrevocable and perpetual. You waive all rights to any equitable relief in connection with this Release and the subject matter of this Release.



# Attractions & Sights in Berlin

Berlin is more than 775 years old and over the decades, all generations have left their monuments and landmarks in the city. The densest array of sights in Berlin lies east of the Brandenburg Gate, on either side of Unter den Linden.

## Brandenburg Gate

Brandenburg Gate is Berlin's most famous landmark. A symbol of Berlin and German division during the Cold War, it is now a national symbol of peace and unity.

## Reichstag

The Reichstag building with the famous glass dome is one of the most frequently visited sights in Berlin. It is the seat of the German parliament, the Bundestag.

## Alexanderplatz

Alexanderplatz is a central square and traffic junction in Berlin's Mitte district. One of the city's most visited squares; it is the site of many attractions and sights in Berlin.

## Berlin TV Tower

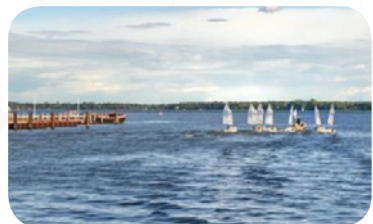
The TV Tower at Alexanderplatz is Berlin's most prominent landmark and the tallest building in Germany. Its steel sphere contains a visitor platform and a revolving restaurant.

## Eastside Gallery

The longest preserved piece of the Berlin Wall, standing between Ostbahnhof and Oberbaumbrücke, is known worldwide as the East Side Gallery. After the Wall fell, 118 artists from 21 countries redesigned 1.3 kilometers of the former border into the longest open-air gallery in the world. The East Side Gallery stands both as a symbol of joy over the end of Germany's division and as a historical reminder of the inhumanity of the GDR border regime. Today it is one of Berlin's most popular tourist attractions. Open 24 hours a day all year round.


## Müggelsee

The Müggelsee, also known as the Großer Müggelsee, is a lake in the eastern suburbs of Berlin, the capital city of Germany. Visitors can enjoy the beach, paddling, hiking and renting watercraft. You can also tour fishermen's town Rahnsdorf on the Southeast side or visit the 'Museum im Wasserwerk' on the North side of the lake.



For more details about all of the above and more please visit: <http://www.visitacity.com/en/berlin/activities/all-activities>

# 2019 MASTERS Conference Class List

Class	Title	Abstract	Hours	Tech Level	Type	Prerequisites
Products And Peripherals						
23001 PNP1	The Latest MCUs, MPUs, Analog and Timing Products from Microchip: 12 Months Ahead	This class provides an overview of Microchip's latest and future PIC® and AVR® MCUs, SAM MCUs and MPUs, as well as analog and timing products. Attendees will receive an introduction to new features, new technologies, and what new products they can expect from Microchip in the next 12 months.	1.5	1	Updated	
23002 PNP2	The Latest Ethernet, USB, Secure Elements, Wireless, and PoE Products from Microchip: 12 Months Ahead	This class provides an overview of Microchip's latest and future connectivity products for Ethernet, USB, Secure Elements, Wireless, and Power over Ethernet products. Attendees will receive an introduction to new features, new technologies, and what new products they can expect from Microchip in the next 12 months.	1.5	1	Updated	
23003 PNP3	No Experience? No Problem! Getting Started with PIC® and AVR® MCUs	Do you want to see how easy it is to create a PIC® or AVR® MCU project even though you have no experience? Even if you have little or no embedded programming experience this hands-on class will show you how to use Microchip's Code Configurator (MCC) to quickly create projects on either the PIC or AVR MCU platform without writing any code! We will start with a blank MPLAB® X project and walk you through the steps of quickly creating projects using both architectures so you can easily see what the differences are. Labs will cover several examples including the use of Core Independent Peripherals (CIPs) which are fundamental building blocks for complex solutions. This class is an excellent primer for more advanced classes using MCC or CIPs.	1.5	1	New	Minimal understanding of embedded C.
						
23004 PNP4	Create Unique Digital and Analog Functionality by Interconnecting Core Independent Peripherals (CIPs)	This class will show how to create a FSK demodulator, high-resolution PWM, WS2812B RGB LED protocol, ultrasonic range detector, metal detector, AC Sine direct drive and switch-mode power supply by interconnecting multiple Core Independent Peripherals (CIPs). Examples will be shown using PIC® and SAM MCUs. The CIP interconnections and circuit wave-forms will be presented along with live demonstrations of several of these designs. Exposure to these real-world examples will help you to apply CIPs in your project to reduce component count and improve system performance by replacing firmware overhead with CIP hardware.	1.5	2	Updated	Basic C knowledge. Some experience using microcontrollers to build complex systems.
23005 PNP5	NVRAM and EEPROM Selection and Design	For the users of microcontrollers, there is an impressive range of features and memory sizes available. But, for those times when the data storage requirements aren't cost effective for an MCU's internal storage or require better endurance, there is a wide selection of external memories that can quickly and easily fit the need. This class is an overview of external non-volatile memories. We will discuss the different types, how they operate and why some can wear out, and discuss some of the tradeoffs between the various types in applications where they fit best.	1.5	1	New	

### Tech Levels

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- 5: Advanced – attendees should already have expertise in the topic before attending



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Class	Title	Abstract	Hours	Tech Level	Type	Prerequisites
Products And Peripherals continued						
23006 PNP6	dsPIC® DSC Dual Core Application Development Tips and Tricks	This class will introduce the new dsPIC33C Dual CPU (Master-Slave) architecture. We will discuss the MasterCore-Slave CPU operation and the mailbox peripheral Master-Slave-Interface (MSI) which is used to communicate between the master and the slave cores. We will also discuss the new peripherals designed on the dsPIC33C families, such as protocol UART, high-resolution PWM with fine edge placement and CAN-FD, flexible oscillator, etc. We will discuss the advantages of dual CPUs, and how it is useful in applications such as motor control, digital power supplies, etc. Finally, we will discuss how to create master and slave projects and how to debug/program two projects in a dual core environment using MPLAB® X IDE.	1.5	1	New	
23007 PNP7	Timing and Frequency Applications, Specifications and Solutions	Microchip has the world's broadest portfolio of timing and frequency devices: from large atomic clocks that provide the world's time via GNSS, to miniature crystal and MEMS oscillators used within smart-sensors to remotely connect and synchronize any type of device. Choosing the right solution can be overwhelming, especially for newly emerging applications. This lecture will discuss the key specifications and what they mean to help engineers choose the right solution. Furthermore, this lecture will discuss several applications and their frequency/timing requirements: autonomous vehicles, smart connected devices, seismic exploration, phased array radars, satellite communications modems, and 5G communication networks. After attending this class, you will be able to choose the best clock solution for your product, reducing time-to-market and achieving reliability, performance and cost-effectiveness.	1.5	1	New	
23008 FPGA1	Getting Started with Microchip FPGAs	This class introduces Microchip's IGLOO2 and SmartFusion2 low-density FPGA families, and the PolarFire® mid-range density FPGA family and target applications. The presentation will include the architectural details of each family, available IP blocks including microprocessor cores, development tools and the design ecosystem to implement designs. Following the lecture, the instructor will demonstrate the FPGA design flow using the Microchip Libero® SoC toolset.	1.5	1	New	

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Products And Peripherals continued						
23009 FPGA2	Using Microchip FPGAs in Low-Power Applications	Microchip PolarFire® FPGAs offer the industry's lowest-power FPGA fabric and 12.7G transceivers and the smallest footprint packaging at mid-range FPGA densities, enabling high-performance in small, power-constrained applications. This class will include an overview the PolarFire FPGA family and describe how to estimate and verify the power consumption of a design. Following the lecture, the instructor will demonstrate how to use the power estimation tools to estimate the power requirements of a low-power transceiver design using the Microchip power analysis tools, and measure the power on a Microchip development kit.	1.5	2	New	
Dev Tools						
23011 DEV1	Microchip Development Tools: Today and Tomorrow	This introductory-level course offers an overview of Microchip's development tool offerings, a quick review of integration roadmaps and new features in IDEs, compilers, starter kits, programmers, debuggers and other new products. Third party hardware and software tools will also be covered. Presented by Development Tools marketing , this is an interactive session, where attendee participation is crucial and mutually beneficial to both presenters and attendees.	1.5	1	Updated	
23012 DEV2	MPLAB® X IDE Essentials	This class covers getting started with MPLAB® X IDE for customers new to the MPLAB IDE ecosystem, which supports PIC®, AVR®, dsPIC®, and SAM devices. The entire project life cycle is covered: creation, editing and debugging. Demonstrations will be shown throughout the class and provided as projects that can be run as self-study after the class.	1.5	1	Updated	
23013 DEV3	MPLAB® X IDE Advanced Debugging and Features	This class covers advanced features and debugging within the MPLAB® X IDE ecosystem. We will show how complex break points, trace, code coverage, and the MPLAB® Data Visualizer can be used to more effectively debug your project and increase your productivity. Demonstrations will be shown throughout the class and provided as projects that can be run as self-study after the class.	1.5	2	New	Attendees for this class should have knowledge of basic debugging with MPLAB® X IDE.
23014 DEV4	MPLAB® Code Configurator (MCC) for Simplified Embedded Software Development	The MPLAB® Code Configurator (MCC) is a free plug-in of MPLAB® X IDE, which provides an easy setup and configuration experience for supported microcontrollers. In this class, you will learn to navigate and manage project settings with MCC, set up and configure peripherals including Core Independent Peripherals, and choose from a wide variety of software libraries. MCC will generate optimized driver code tailored to your requirements, which is automatically integrated into new or existing embedded projects. Learn how to leverage the power of MCC to quickly develop an embedded application and get your project off the ground in minimal time!	3	2	Updated	Attendees registering for this class should have a basic understanding of C, 8, 16 and 32-bit PIC® MCU development and the use of MPLAB® X IDE.









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Dev Tools continued						
23016 DEV6	MPLAB® Harmony v3 Fundamentals	MPLAB® Harmony v3 is an extension of the MPLAB IDE ecosystem that simplifies development of embedded firmware for Microchip 32-bit SAM and PIC32 microcontroller devices. It includes an easy to use Graphical User Interface (GUI) for selection, configuration, and generation of starter code, peripheral libraries, and extensive middleware. This class provides an introduction to MPLAB Harmony v3, an overview of what it is comprised, and an explanation of how it differs from MPLAB Harmony v2. Attendees will gain an understanding of key concepts, supported development models, and what resources are available for further learning. This class is recommended as a prerequisite to the MPLAB Harmony 3 hands-on lab classes and is a good introduction to MPLAB Harmony before attending classes focused on specific middleware stacks.	1.5	1	Updated	Attendees registering for this class should have some familiarity with embedded firmware development using C language.
23017 DEV7	  Creating Simple Embedded Applications with 32-bit MCUs/MPUs Using the MPLAB® Harmony v3 Peripheral Libraries	MPLAB® Harmony v3 provides graphical tools and easy to understand peripheral libraries that simplify the use of Microchip's 32-bit microcontrollers and microprocessors. In this hands-on class, you will learn to navigate and manage project settings with MPLAB® Harmony Configurator (MHC), set up and configure peripherals, and generate optimized code tailored to your requirements, which is automatically integrated into new or existing embedded projects. Learn how to leverage the MPLAB® Harmony power to quickly develop an embedded application and get your project off the ground in minimal time!	3	4	New	Attendees registering for this class should have a basic understanding of C language programming for SAM/PIC32 systems using Microchip's MPLAB® X IDE, debugger, and GCC language tools.
23018DEV8	  Creating Advanced Embedded Applications with 32-bit MCUs/MPUs using the MPLAB® Harmony v3 Software Framework	MPLAB® Harmony is a modular framework that provides inter-operable firmware libraries for 32-bit microcontroller and microprocessor application development. This class shows how the MPLAB® Harmony drivers, system services and middleware enables you to rapidly develop bare-metal and RTOS applications.	3	4	New	Attendees registering for this class should have a basic understanding of C language programming for SAM/PIC32 systems using Microchip's MPLAB® X IDE, debugger, and GCC language tools.
23019 DEV9	  Designing an Efficient FreeRTOS™ Application Using MPLAB® Harmony v3 Framework	This class will introduce you to the process of designing FreeRTOS™ applications using the MPLAB® Harmony Framework. We will demonstrate appropriate design patterns and how to implement them within Harmony. We will take advantage of peripheral drivers and APIs available from FreeRTOS and Harmony to optimize application design.	3	3	Updated	MPLAB® Harmony Framework, RTOS basics



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Class	Title	Abstract	Hours	Tech Level	Type	Prerequisites
Firmware Design and Compilers						
23021 FRM2  	Advanced Concepts of the C Programming Language	Take your C programming skills to new heights! The objective of this class is to enable you to use advanced C programming language constructs and techniques to create more structured and portable code. You will be able to create structures, unions, and bit fields. You will use advanced pointer concepts to allow very flexible data access and create arrays of pointers, arrays of structures and unions, and pointers to arrays of structures and unions. You will create nested structures and unions along with flexible 'typedef' methods to set up data structures and variables. Function pointers are an important concept of the C programming language and you will use arrays and structures of function pointers to create portable and flexible state machines. Finally, dereferenced double pointers are discussed in detail. This class includes seven instructor-led hands-on labs that clearly demonstrate each concept. You will use MPLAB® X IDE with the powerful built-in simulator and Microchip XC32 C compiler to analyze the actual effect of coding implementations on variables and to see the interaction of program and data memory values. You will learn these C language topics from a non-hardware framework so that you can focus on learning the C language instead of the microcontroller architecture. The techniques taught in this class are universal ANSI-C concepts of the C programming language. Before attending this class, attendees should be proficient with the fundamentals of C programming and have experience writing embedded C firmware.	3	4	New	Attendees registering for this class should have a thorough knowledge of the fundamentals of the C programming language.
23022 FRM3	Taming Embedded C	Using practical, concrete examples for PIC®, AVR®, and SAM microcontrollers, the enigmas of the C programming language will be explained. The hidden secrets of Microchip debugging tools will be revealed. This class in programming microcontrollers focuses heavily on technique and practical methods. This class is targeted at attendees who have some facility with programming microcontrollers in C, debugging real-world applications, and solving programming challenges. Attendees will take their programming, debugging, and problem solving to the next level using best-practice advice from experts at Microchip.	3	3	Updated	

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Class	Title	Abstract	Hours	Tech Level	Type	Prerequisites
Firmware Design and Compilers continued						
23024 FRM5  	ARM® Cortex® M0+ and M4 Basic and Advanced Peripherals Bare Metal C Coding	The objective of this class is to enable you to quickly get started with embedded development using the SAM ARM® Cortex® M0+ and M4 microcontrollers. This class enables you to start from the ground-up with code development on these devices. You will also be able to setup the clocking structure and access basic peripherals like the system interrupt controller, external pin interrupt controller, analog-to-digital converter, input/output pin control, timers and output waveform generators. You will know how to setup the digital frequency locked loop (DFLL) clocking in both open- and closed-loop modes and use the Direct Memory Access Controller to perform data transfers. You will also learn how to use the powerful Event System to perform complex functionality without any intervention from the CPU. This lecture and instructor-led hands-on lab class focuses on using bare metal C code (no code configurator or library framework) to write code for these devices. The ATSAME54 M4 microcontroller is used in this class, but the material also applies to the peripherals on almost all SAM ARM Cortex® M0+ and M4 microcontrollers. You will use MPLAB® X IDE to program and debug hardware on the SAME54 Xplained PRO board. This is not an in-depth Cortex hardware architecture class, but many architecture basics will be covered. Attendees registering for this class should have some experience using the C programming language to write firmware for embedded microcontrollers.	3	3	New	Attendees registering for this class should have some experience using the C programming language to write firmware for embedded microcontrollers.
Linux						
23027 LNX2  	Introduction to Embedded Linux	In this class, you will explore the Microchip ATSAMA5D27-SOM1-EK1 evaluation platform running a Yocto Embedded Linux Distribution. You will be introduced to the embedded Linux boot sequence and the different components that make up a board support package. Basic concepts of Flattened Image trees and Device Tree Overlays, its need and evolution will be discussed. You will explore the tools, such as SAM-BA programmer, and resources required by new users to start embedded Linux development on the Microchip wiki. The concept of user and kernel space will be introduced. This class includes hands-on exercises where you will explore the underlying hardware using different Linux tools and sub-systems. Specifically, i2c, gpio, network, device tree, udev, run-levels, start-up scripts, Linux virtual file systems - procfs, sysfs and debugfs, will be covered. You will see how to access different peripherals from user space using C and MPIO, a Python-based utility.	3	2	Updated	Attendees should be comfortable using Linux





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Class	Title	Abstract	Hours	Tech Level	Type	Prerequisites
Linux continued						
23028 LNX3  	Advanced Topics in Embedded Linux	In this class, you will explore two Linux concepts that are important to embedded system designers: a device tree and a device driver. You will become familiar with a device tree model, explore Linux device drivers, kernel configuration and build, deploying images on non-volatile memory, and peripheral interfaces. For the hands-on exercises, you will start with a fully functional embedded Linux distribution running on a SAMA5D27-SOM1_EK1 evaluation board. You will then connect a daughter card containing a variety of devices. You will add device driver support for these devices to the Linux kernel, modify the device tree to add the new devices to the board configuration, and write and execute user-space scripts to exercise these new peripherals.	3	4	Updated	Attendees registering for this class should have working knowledge of the Linux command line environment and basic knowledge of peripherals on an embedded system. While not required, prior participation in the LNX2 class would be beneficial.
23030 LNX5  	Exploring Linux Build Systems: Creating your first Embedded Linux System with Buildroot	In this hands-on lab class you will configure and create a bootable embedded Linux image and project development environment for the SAMA5D27-SOM1-EK1 development kit using the Buildroot build automation tool. You will explore the basics of Buildroot and more advanced features allowing you to set up a production-ready build environment to target your own hardware, and how to use the build system for application development. We will cover concepts such as build environment configuration, target package selection and customization, patching, filesystem overlays, addition of custom packages, as well as tips, tricks, and pitfalls to watch out for.	3	4	New	Attendees registering for this class should have attended the LNX2-LNX3 classes.
Functional Safety						
23034 FS1	Introduction to Functional Safety	Embedded engineers are increasingly required to comply with functional safety standards. This class provides an overview of functional safety and the guidelines to follow when designing an embedded system with safety requirements. Topics include fundamental functional safety concepts, industry standards, software processes and relevant coding guidelines.	1.5	1	Updated	
23035 FS2	Implementing Functional Safety	This intermediate Functional Safety class covers hazard and risk analysis, safety manuals, and application examples. It also explains how an application developer can analyze and customize the contents of an FMEDA based on the application's peripheral requirements, and present high-level examples of some key safety features and common diagnostic techniques.	1.5	2	New	Attendees should have a basic knowledge of Functional Safety terms and guidelines or have attended the FS1 class.





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Functional Safety continued						
23204STL  <b>3<sup>rd</sup> Party Content</b>	Functional Safety - 2 real world examples from concept to certification	The first part of this lecture will show the integration of SIL3 STO Safety Functions into existing Drive Controller Products - Systemtechnik LEBER has managed the integration of the safety function according to SIL3 / Ple, Cat. 3 beginning from the first concept down to the final approval. The functional safety assessment was successfully certified by TÜV NORD CERT GmbH Essen. (Notified Body 0044). The second part of this lecture will detail how to integrate an eFuse in power distribution networks - The presentation exemplary shows the application of system engineering methods aiming for an optimal design of eFuses in an individual application environment. This includes a holistic view on the complete electrical system, from energy storage / generation through distribution by the on-board network up to the consumers.	1.5		New	
Bootloaders						
23036 BTL1   	Bootloaders Using MCC – Device Side	This class will focus on generating a bootloader using MPLAB® X IDE and the MPLAB Code Configurator (MCC) and incorporating it into your application. We will look at the resources required, along with a review of common "gotchas" to avoid. The material in this class will also cover advanced bootloader features such as checking for an existing valid application, methods for switching between application/bootloader modes, calculation of the checksum over a specific range of memory, and fail-safe bootloading. PIC24 differences will also be presented.	3	3	Updated	
23037 BTL2   	Host Design: Communication with MCC Generated Bootloader	This class will be a introduction to the knowledge required to begin developing a Host application (embedded, or software) to interact with the MCC Generator Bootloader Embedded Code command syntax, which supports a range of family devices. The core materials of this class will describe how to read and interpret a Hex file created by MPLAB® X IDE during project compilation. The class will also describe how to 'chunk' the data into sections to update end-application on embedded devices, and analyze the command chain pattern used by the existing Unified Host Java Host. Finally, this class will briefly detail how to create an initial concept, or Custom Host application by using the current Java developed Unified Host as an initial starting point for development. It will also briefly describe the communication facades leveraged by the java application.	1.5	4	New	Attendee should have complete knowledge about the MCC Generated Bootloader Embedded Code. Advanced Coding knowledge is suggested.

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Class	Title	Abstract	Hours	Tech Level	Type	Prerequisites
Touch/Gesture Sensing						
23038 TNG1	Capacitive Touch Sensing: Buttons, Sliders, Touch Pads and 3D Gesture - Overview	Touch is attractive for you and your customers - customers love the sleek design, you love the cost savings. This class will guide you through the complete touch solution portfolio from Microchip. From a single button to proximity, sliders, touch pads and even 3D gesture solutions. All to guide you to the best fitting solution for your application/ device.	1.5	1	Updated	
23039 TNG2	Capacitive Touch Sensing: Theory and Hardware Design Considerations	In this lecture class, you will learn how system physics impact the functionality of capacitive touch sensor designs. We will cover basic design rules, tricks to overcome design challenges, and methods to avoid common pitfalls. Once the basic foundation has been formed, we will then cover more advanced topics like how to design for water tolerance and how to work around EMC requirements.	1.5	2	Updated	To facilitate productive conversation, we recommend reading the Capacitive Touch Design Guide (AN2934) prior to attending. <a href="http://ww1.microchip.com/downloads/en/DeviceDoc/AN2934-Capacitive-Touch-Sensor-Design-Guide-00002934A.pdf">http://ww1.microchip.com/downloads/en/DeviceDoc/AN2934-Capacitive-Touch-Sensor-Design-Guide-00002934A.pdf</a>
23040 TNG3/4  	Implementing MCU-Based Robust Touch Buttons and Sliders Using Microchip's Touch Library	In this hands-on class, attendees will learn how to work with Microchip Touch Libraries to implement capacitive touch buttons and tune for desired sensitivity and response time to achieve robust touch performance. Tuning for low power, moist conditions, and noisy conditions will also be covered. We will also cover elements of TNG4 (US only class) and cover basics of our 2D Surface Library.	3	2	Updated	Attendees should have attended TNG2 or be familiar with capacitive touch design guidelines as well as a basic understanding of C, 8-bit PIC® MCU development, and be comfortable with the use of MPLAB® Code Configurator (MCC) and Atmel START.





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Class	Title	Abstract	Hours	Tech Level	Type	Prerequisites
<b>Touch/Gesture Sensing continued</b>						
23042 TNG5  	Designing with maXTouch® Technology Display Modules	This introductory hands-on class will guide you through how 2D capacitive maXTouch® technology touchscreen modules are integrated into customer end products. This class will help developers understand electrical, mechanical, and environmental challenges that can impact touch screen system designs and provide guidelines to overcome these obstacles. The labs used in this class will demonstrate configurability of robust touchscreen modules that are water resistant and support thick gloves. The class will use a maXTouch technology evaluation kit and maXTouch Studio Lite tool to help you better understand how the host will interact with the maXTouch device protocol. Additionally, you will learn how available drivers and easy to use debug tools, combined with Microchip's module partners' support, can simplify the process to move your designs from prototypes to production faster.	3	2	Updated	A basic understanding of touchscreen designs, and, while not required, classes TNG1 and TNG4 would be beneficial.
<b>Display Technologies</b>						
23044 GFX2  	PIC32 Graphics Development: Advanced Concepts and Techniques	Want to know how to leverage the capabilities of MPLAB® Harmony Composer Suite to maximize the capability of your PIC32 device to create rich modern graphics? Want to know about the latest applications and widget additions to MPLAB Harmony Aria Graphics Library? Then this is the right class for you! During the lecture, attendees will be exposed to features and concepts such as 8-bit palette, parallax, video, animation, multi-lingual support, input system service, display driver prototyping, image compression pros-and-cons, heap estimation, and image pre-rendering. Hands-on exercises will include advanced techniques such as frame buffer compression using 8-bit LUT, adding multi-lingual support, and leveraging the GPU for animation and parallax. The lecture will include a preview of the latest MPLAB Harmony development.	3	4	Updated	Attendees should have a strong working knowledge of the C programming language, and familiarity with the MPLAB® Harmony Graphics Composer Suite.
23045 GFX3  <b>3<sup>rd</sup> Party Content</b>	Graphics Design/Creating Compelling User Interfaces	What is the difference between a Graphical User Interface (GUI) and User Experience (UX) and how does a positive one differ from an experience that is just OK? Today Graphical User Interfaces and User Experiences are considered to be critical success factors for digital products and services. There are many elements that impact perception, usability, aesthetics and intuitive interaction. In this class we will learn from a 3rd party professional about what User Experience really is (and what it is not), which parts of it can be influenced in which ways and how to integrate a user centered design approach into the technical implementation. Note this class will be co-presented by representatives from Colorfy and Coeno.	1.5	2	New	

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Display Technologies continued						
23207 TAR	Implementing modern and efficient GUIs for MCUs and MPUs	Graphical User Interfaces are ubiquitous: You find them in home appliances, medical devices, industrial automation devices, everywhere. But implementing those for resource constrained devices is challenging as you need to deal with limited RAM and flash memories while the user expects a smartphone like result. In this class you'll learn how to implement a GUI with Embedded Wizard from scratch while taking care of nowadays' best practices when it comes to render graphics on a MCU, a MPU and beyond.	1.5			
3 <sup>rd</sup> Party Content						
Automotive Networking - CAN/LIN						
23046 AN1	CAN Protocol and Physical Layer Basics	This class discusses the basic operation of the classical CAN (Controller Area Network), CAN FD (Flexible Data-Rate) and CAN PN (CAN Partial Networking) protocols. From there, the class will drill down to specific areas such as bit timing, arbitration, error detection and recovery, as well as other areas which contribute to the overall robustness of the CAN protocol. Beyond that, attendees will be introduced to CAN transceivers and PCB board design considerations. This is a lecture class.	1.5	1	Updated	
23047 AN2	LIN (Local Interconnect Network) Low-Cost Serial Bus Design for Industrial and Automotive Applications	If you need low-cost, standardized network connectivity, LIN (Local Interconnect Network) is a UART-based serial communication system that could be just right. Intended to be used for distributed electronic systems, it is finding homes in the industrial, consumer and automotive markets. We will teach you the basics of the LIN bus including the definition of the protocol and the physical layer, and also the definition of interfaces for development tools and application software. This is a lecture class.	1.5	1	Repeat	
Serial Communication - I2C/SPI						
23048 SER1	Getting Started With I2C and SPI Communication	You have selected a microcontroller, but now you must decide how to interface with your on-board peripherals. What's the right bus for your embedded control application? In this class we will help you understand the key differences between the most common embedded peripheral serial buses, I2C and SPI, taking you from bit-level details to actual debug scenarios. You will understand how the features of each bus contribute to a robust system design, with key design tips discussed along the way. We will introduce basic debugging techniques to aid in common communication failures. This class is recommended for anyone using or planning to use I2C or SPI, or if you just want to learn more about board level serial communication, interfacing peripherals, and robust system design. This is a lecture class.	1.5	2	New	

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<b>Serial Communication - I2C/SPI continued</b>						
23049 SER2	Advanced Debugging for Serial Communications (I2C/SPI/UART)	Serial protocols (I2C/SPI/UART/etc.) are an integral part of most projects and even the best of us have struggled with issues that just did not make sense. We will explore the weird and wonderful world of some more advanced debugging techniques, learn what tool best applies for each situation and how to approach a new and never-before-seen bug. All of these will be brought into focus using real life, often expensive stories on both hardware and software issues related to serial communications and protocols.	1.5	2	New	Attendees registering for this class should have at least some basic knowledge of how SPI, UART, I2C protocols work or have attended the SER1 class.
<b>USB</b>						
23050 USB1	Introduction to USB 2.0 Part A: Basic Concepts and Tools	This class will provide an introduction to the basic concepts and tools of USB 2.0 such as topology, enumeration, endpoints, transfer types and classes. USB protocol analyzers, used to capture and decode USB traffic, will also be introduced.	1.5	1	Repeat	
23051 USB2	Introduction to USB 2.0 Part B: USB Physical Layer, Practical Design Methods, Test, and Debugging	This course covers the USB 2.0 HS/FS/LS protocol, HSIC, USB BC1.2 battery charging, the USB Type-C™ connector, and power delivery all within the scope of the physical layer. Guidelines are discussed for USB high speed system design including common best practices for layout, debugging, and USB logo compliance. Potential sources of noise and other pitfalls that can degrade performance and affect USB and EMC compliance are reviewed.	1.5	1	Repeat	
23053 USB4	Developing USB Host and Device Applications with MPLAB® Harmony USB Stack  	USB is now a standard serial communication channel to connect embedded systems to PCs or other USB devices. The USB Stack in MPLAB® Harmony allows you to easily develop a USB application on PIC32 and ATSAM USB microcontrollers. In this class you will learn how to configure the MPLAB Harmony USB Stack and use the provided APIs to exchange data between your Embedded application and a PC, and how to read and write files on an USB thumb drive connected to your USB Embedded Host application.	3	4	Updated	Attendees should be familiar with the USB 2.0 protocol and MPLAB® Harmony applications. MPLAB X IDE, XC32 and C language are used in this class and attendees need to be familiar with them.

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USB continued						
23054 USB5	Fundamentals of USB Type-C™ and Power Delivery and USB Power Supply Solutions	USB Type-C™ is a new standard that can provide a designer the ability to supply system power up to 100W, high-speed data of 10 Gbps and beyond, as well as high-definition video and audio, all while using a single low-cost cable. This course is tailored to engineers who want to understand the USB Type-C interface and the USB Power Delivery Protocol with practical advice on incorporating the technology into existing applications or new designs. Attendees will be introduced to a range of USB-C features such as Alternate Modes and Power Delivery, port and cable types, and product design requirements. While USB PD provides simplifications at the user level, it creates significant power conversion design challenges. This class provides a brief overview of how USB PD works and follows with a deeper dive into power conversion specific specifications and how they impact power converter design. Design concepts are reinforced through several real-world PD applications and demos and hands on exercises.	3	2	Updated	
23202GRL	PD and Automotive Networking Solutions	USB Power Delivery Technology, we will discuss differences in real world implementations between USB PD 2.0 and USB PD 3.0 PPS charging, best practices for USB Type-C charging products, and how to check signal integrity of USB cables and connector designs on PCB's. For Automotive Ethernet, we will discuss and cover Automotive Ethernet standardization and implementation of test methods : Compliance test plans as specified in ISO, Interoperability test plans, Device-level test plans, Component-level test plans	1.5		New	
Bluetooth						
23055 BLU1	Introduction to Bluetooth® Low Energy (BLE); Technology and Terminology	Bluetooth® Low Energy (BLE) was created to transmit small packets of data, while consuming significantly less power than previous classic Bluetooth devices and other solutions. This class will describe general characteristics and capabilities of the BLE protocol and radios which are part of a device. You will learn the fundamental concepts that will allow you to delve into more complex concepts of follow-on classes. A developer must understand the functionality of the capabilities of BLE and how to interact with it in your application. It is recommended that this class be taken prior to taking any of the more advanced BLE classes. A system designer must have a firm grasp BLE basics to implement a custom Bluetooth low energy application.	1.5	1	New	

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Bluetooth continued						
23056 BLU2  	Simple Cable Replacement with Bluetooth® Low Energy (BLE)	If you need to replace cables in your application with BLE but do not want to make a deep dive into the complexities of the Bluetooth protocol and stack, this class is for you. In this hands-on class, you will learn how to create a serial port replacement application using BLE in 15 minutes. This class expands on the basics of BLE discussed in the BLU1 class and will cover several practical hands-on applications. This class will also provide you with information on other BLE topics such as security, pairing, bonding, power management and range. This class will use the RN4870/71 modules for the hands-on labs and will cover both module-module and module-phone communication.	3	2	New	Attendees registering for this class should preferably have taken the BLU1 class.
23057 BLU3  	Creating Proof-of-Concept Android Apps for Bluetooth® Low Energy (BLE)	Creating professional mobile apps might be beyond the scope of most embedded design engineers, but if you just want to get started and learn to create simple proof-of-concept apps, then this class is for you. You will learn what development tools to use, how Android apps are structured, touch on key features of the Java language, and go into Bluetooth® Low Energy (BLE) support in more detail. The class will use Android phones to connect to Microchip BLE modules. The hands-on labs will cover the steps required to scan, connect, discover services, and send and receive data over a BLE connection.	3	3	Repeat	Attendees registering for this class should have a working knowledge of Bluetooth® Low Energy, preferably having taken the BLU1 class.
23059 BLU5  	Microchip Secure UART over BLE Library Hands On	Need to quickly develop an iOS or Android application to transfer data securely between your embedded system and the phone? In this hands-on class, you will learn how to use a set of library functions that will setup a wireless UART between your board and a Smartphone without the need to deal with the low-level control of the phone's Bluetooth® protocol. In addition, you will learn how to use the security layer library inspired by modern techniques such as SSL and TLS to manage the authentication of both ends: the phone and the embedded design equipped with our ECCX08.	3	2	New	
LAN						
23060 LAN1	Ethernet Hardware Design, Test, and Debug From Schematic to First Packet	This class will enable an engineer with no prior Ethernet knowledge to successfully design with Ethernet PHYs, controllers, and switches. The material explained in this class will reduce time to market and board respins for 10/100/1000 Mbps Ethernet hardware designs. The functional blocks which make up the physical and MAC layers (layers 1 and 2) will be explained along with the hardware interfaces between those building blocks and your embedded system. Schematic design, board layout, test, and debug will be explained while referencing lessons learned from years of Microchip's Ethernet hardware design.	1.5	1	Repeat	

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Class	Title	Abstract	Hours	Tech Level	Type	Prerequisites
<b>LAN continued</b>						
23061 LAN2	An Introduction to EtherCAT®, EtherCAT P and the Microchip LAN9252 Slave Controller	EtherCAT® is a robust, industrial, real-time field bus protocol based on Ethernet layer 1, which offers extremely low latency and real-time synchronous I/O control distributed across a wired Ethernet network. This class will discuss the key features of EtherCAT and demonstrate the functionality of the Microchip LAN9252 EtherCAT slave controller and its use in deterministic, real-time Ethernet-based control systems. The class will also explain how EtherCAT can be used for ANY low-cost distributed embedded system that requires high-speed, real-time, time-sensitive networked communication and control, and compare its benefits to and present compelling reasons for considering its deployment over standard Ethernet. EtherCAT P is a new standard for delivering power along and communications over a single cable, thus reducing wiring complexity. This technology will also be presented and discussed during the class. The course will cover the implementation of an EtherCAT master based on a Raspberry Pi® and walk through the implementation of slaves for real-time motor control and analog and digital I/O, demonstrating the speed and ease of bringing a system up. The class will also introduce and demonstrate the use of some of the key software tools that will assist in bringing your products to market.	1.5	1	Updated	
23062 LAN3	A Practical Introduction to Designing with Microchip Ethernet Switches	This course will introduce the features of an Ethernet switch, its standard interfaces, and how to add a switch to your hardware design. In addition to the hardware design, we will discuss how to properly connect an MCU or MPU to the switch and configure the host networking stack as well as provide an overview of the SW offerings for the managed Ethernet switches. We will explain how to use the most common Ethernet switch management features like VLANs, QOS Control, Spanning Tree Protocol, and IGMP and how practical examples of how these features can be used in real-world applications. Also, we will touch upon the Industrial Ethernet features, e.g., timing/synchronization, redundancy, as well as the concept of the Time Sensitive Networking (TSN) standard.	1.5	2	Repeat	Attendees should have an understanding of LAN fundamentals or have taken the LAN1 class.
<b>Security/Encryption</b>						
23063 SEC1	Cryptography Primer	Attendees of this class will learn the fundamentals of cryptography. The target audience is those unfamiliar with how cryptography works or those needing a refresher. Both symmetric and asymmetric cryptography will be covered and examples will be shown on how each are used in real-world examples. It will be shown how identity is created and used for authentication, integrity, and confidentiality.	1.5	1	Repeat	No prerequisites to take this class.

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Security/Encryption continued						
23064 SEC2	Anatomy of a Secure System	This class will prepare you to create a secure system using a layered security approach called "defense in depth". We will discuss suggested hardware, suggested cryptographic functions, and attributes all connections should have. We will cover secure access to cloud services as well as solutions for disposables/consumables, secure access, and Block Chain. While this class is still considered a beginner class in cryptography, some prior knowledge of the fundamentals of cryptography is required.	1.5	2	New	Attendees registering for this class should have attended the Cryptography Primer class (SEC1) or have equivalent prior knowledge of cryptographic fundamentals.
23065 SEC3	Crypto Key Storage - Challenges and Solutions	This class explains why it is critical to protect core cryptographic key and secret material in modern connected devices. We will show how key protection is related to communication, authentication, passwords and anti-counterfeiting. There will also be an overview of the various methods by which attackers can retrieve keys, secrets and code from integrated circuits and why software security implementations so often fail. We will show how hardware security elements such as the ATECC608A can protect the keys while simplifying the system design. We will also introduce some applicable industry standard certifications.	1.5	1	Repeat	
23066 SEC4	Authentication and Secure Communications for IoT Projects Using AWS IoT Core	This hands-on course addresses the security side of Internet of Things (IoT) projects, focusing on the authentication and secure communications issues that need to be considered when bringing a project from concept through production. Collaboratively taught by Microchip Technology Inc. and Amazon Web Services (AWS), a leader in cloud solutions, we explore provisioning, securing credentials, authentication, and secure communications from a secure element to the cloud using AWS IoT services and Amazon FreeRTOS™, an RTOS with curated cloud connectivity libraries built on the FreeRTOS kernel.	3	2	Updated	Attendees registering for this class should have a basic knowledge of Internet of Things and Internet Security.
23067 SEC5	How To Do Secure Boot and Secure Firmware Updates	This lecture class reviews and discusses secure boot and safe secure firmware updates and why they are important. We will define what secure boot is and what it is not. You will learn about secure firmware upgrades using sign, verify and encryption. Practical implementations of these effective security features will be shown in contexts including: Microchip flash microcontrollers, processors which boot from external memory, computing platforms, FPGA, and automotive applications. The ECC608A secure element and crypto co-processors are presented as enablers of secure boot and firmware upgrades. We will examine how specific attacks and unsafe operation are mitigated using secure boot and secure firmware upgrades.	1.5	2	New	SEC1, SEC2 are highly recommended. SEC3 or equivalent knowledge.







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Class	Title	Abstract	Hours	Tech Level	Type	Prerequisites
Security/Encryption continued						
23068 SEC6  	Developing Secure Applications with Crypto Authentication Devices	This class will introduce you to some of the basic tools for developing authentication applications using the ATECCx08 secure element. In the first part of the class, you will be introduced to the CryptoAuthLib which is a Microchip developed open source library used to communicate with the secure element. You will use this library to perform secure symmetric authentication between two systems. Next, you will explore how to configure a blank ATECCx08 for specific use cases. After using the secure element to perform the cryptographic authentication, you will walk through exactly how the chip generates these magic values and actually use your computer to make the same calculations. Don't worry; it's easy! Finally, the lab will walk you through building and authenticating a very simple digital certificate. You will understand how certificates work after this lab!	3	1	Updated	Attendees registering for this class should have attended the Cryptography Primer class (SEC1) or possess an understanding of cryptographic fundamentals used in symmetric and asymmetric cryptography.
23069 SEC7  	Developing Secure Applications with Microchip Cortex®-M23 Flash MCUs TrustZone® Enabled Devices	The lecture portion of this class introduces Microchip's ultra-low power ARM® Cortex®-M23 Flash MCUs Family with optional TrustZone® capability. After an overview of TrustZone for ARMv8-M security principles, we will present our numerous added security features which perfectly complement TrustZone technology. The lab will cover how to create and deploy a TrustZone-based software solution. We will discuss how a secure application can coexist with a non-secure one and explain best practices to develop secure solutions. We will introduce Kinibi-M from Trustonic and explain how this security framework can help secure application development.	3	2	Updated	Attendees registering for this class should have C programming experience to run the lab portion.
23200IDM  	Addressing CyberSecurity challenges for IoT - a roadmap to dynamic security on 32bits Microcontrollers powered devices	Security: Use cases, all is about Privacy, confidentiality, Integrity and authentication. What industry influencers / governments are saying and doing to certificate your devices and services before going to market. How to protect your services against hackers? Let's implement security: What is the MCU 'security toolbox' expected by Device Makers and Application Developers? How to deploy services on the field: Making sure trust is at stake! We will also take a concrete example, and dive into the technology!	1.5			
23201ARM  	Partitioning and Deploying Secure Applications for Microchip Cortex®-M23 Devices using Open-Source Tools	"In the lecture portion of this class, attendees learn about Arm's Platform Security Architecture (PSA), a common security foundation for the whole IoT ecosystem. We will introduce Trusted Firmware-M (TF-M), which provides embedded developers with a reference trusted code base complying with the relevant Arm specifications. We will discuss best practices for partitioning applications into secure and non-secure parts, running on TrustZone enabled devices. In the demo portion, we will use CMSIS-Zone, an open-source tool from Arm, to manage the resources on an Arm8-M based device to enable secure/non-secure partitions. Finally, we deploy the application based on TF-M onto the device."	1.5			Attendees registering for this class should have C programming experience

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Class	Title	Abstract	Hours	Tech Level	Type	Prerequisites
Security/Encryption continued						
23210SEM  3 <sup>rd</sup> Party Content	Cryptography is not your enemy it is a real problem solver	"Cryptography is not your enemy it is a real problem solver. Some modern industrial standards like the IEC62443 are defining requirements which are among others solvable with crypto - if you have the right tools and if you know how to use it properly and trustfully. We will take a journey from the basics of cryptography to the real-world-use cases like cloud or IT connections or using crypto in industrial real-time-applications. We will also answer the question what secure elements like the ATECC608 is why you should or should not use it. You will learn about the different algorithm and technologies in conjunction with example use cases to get the focus on best practices and the most major mistakes that should be avoided. We will also oversee the risks and attacks we have to consider when using this technology. It is not the objective to discuss the mathematics but we want to give you the skillset to ask the right questions when starting a design and discuss about future requirements and define target you would like to protect. "	1.5			
23211ARD  3 <sup>rd</sup> Party Content	Arduino cloud and security	Arduino® is an open-source prototyping platform based on easy-to-use hardware and software. It's intended for anyone making interactive projects that require electronic control. Arduino provides a layer of hardware abstraction, so that no prior knowledge of electronics or microcontrollers is required. As such, it is perfect for beginners. Experienced engineers also use Arduino for rapid prototype development. Support is available in professional IDEs such as Atmel Studio and MPLAB® X IDE. Since 2005, a worldwide community of Makers has gathered around the Arduino open-source platform. Microchip AVR® microcontrollers were there from the outset, providing a simple but powerful computing engine. Artists, inventors, engineers and even school children use Arduino boards with Microchip MCUs to turn brainstorm into real working things. Microchip and Arduino are co-sponsoring a series of hands-on training seminars, trade shows and other events to help Makers turn working prototypes into successful products.	1.5			
Internet of Things (IoT)						
23070 IoT1	TCP/IP Introduction	In the Internet of Things, the Things must conform to the Internet, not the other way around. If you're just dipping your toes into the IoT, this class is for you. Adding network connectivity to an embedded product is complex. This class will explore the foundations of Internet communication and the Client-Server model. Routers, switches, IP and hardware addressing, DNS, DHCP, NAT, TCP and UDP transport layers, ports, sockets, and DNS will be explained. This class is meant for the engineer who has no problem setting up their own home network, but has not necessarily dove into the details of what all it takes for a client to retrieve a resource from a server.	1.5	1	New	

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Internet of Things (IoT) continued						
23208TER  <b>3<sup>rd</sup> Party Content</b>	Smart Metering System Example based on Terranova DLMS/COSEM protocol communication Libraries	"A class about how to implement a smart and secure metering system using the TSM Libraries from Terranova. The scenario is composed by a simple client/server application exchanging metering information using standard DLMS/COSEM protocol over tcp/ip. To concentrate the focus on the final application and less on firmware development, the metering server will run over a SAMA5D27 running Linux and exploiting the built-in hardware crypto engine to secure the protocol data."				
23071 IoT2	Small Things in a Big Network: Things to Consider When Creating Devices for the IoT	The internet's rules (RFCs) are the same for big and small machines. Constrained IoT devices prefer brevity and power conservation and thus require very efficient messaging protocols and data structures. This class will explore and contrast the usages of HTTP, MQTT, and CoAP, and HTML and JSON when working with various cloud services. We will explore how to future-safe a connected design with rapidly changing Web APIs. Some edge-connected devices are not IP based and might even be sub-GHz. We will cover the basics of that architecture along with considerations for edge nodes and internet gateways for them. Security in a constrained environment will be assumed here with the details covered in other classes.	1.5	1	New	
23072 IoT3	Wi-Fi® Introduction and Debugging Techniques	Most IoT devices end up connecting to the internet using Wi-Fi® either immediately or through a gateway. In this class you will get introduced to the basics of Wi-Fi (IEEE802.11) as a MAC layer protocol. You will also learn how to build a cheap Wi-Fi sniffer to debug your Wi-Fi environment. You will also get familiarized with the most common issues in a Wi-Fi network and how to identify them and possible solution. Additionally, you will learn how to debug upper layers issues (DHCP, TCP, UDP, etc.).	1.5	1	New	
23073 IoT4   	Get on the Google Cloud in Minutes Using PIC®/AVR® MCU-based IoT Solutions	The IoT solution is widely used for connecting simple sensors/actuators to securely exchange data to and from the cloud. Data visualization and processing render meaning to the exchanged information. This class will demonstrate how easy it is to create IoT sensor/actuator nodes, integrate them with the Cloud and view the data in real time using the comprehensive microchip solution that covers all aspects of security and data integrity. The development platform of your choice will be available: PIC-IoT WG or AVR-IoT WG development board. You will create a smart, secure and connected application using the PIC®/AVR® MCU IoT node with on-board ATECC608A secure element and WINC1510 Wi-Fi® module. Finally, you will learn to add new sensors/actuators to the PIC/AVR MCU IoT node to exchange data over the Google Cloud.	3	1	New	

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Internet of Things (IoT) continued						
23074 IoT5	The Google Cloud Demystified	As an embedded control developer, you have learned how to publish your IoT sensor data to the Cloud, but you might still be wondering what happens to it once it's on the "other" side. How can I visualize it? Where is it really now? Is it stored? Google provides many services and tools by arcane names, some enable analytics, others connect to home automation platforms and/or promise powerful machine learning, but how do you apply them to your data? In this class you will learn from the actual developers at Google (and partner Leverage) how the Google Cloud Platform can benefit your applications and help you develop the most advanced IoT applications with ease. Demos will be provided using the PIC-IoT and AVR-IoT development kits.	1.5	1	New	
23075 IoT6	Simplifying TCP/IP Applications with MPLAB® Harmony	If you don't know how TCP/IP works but you have to add network connectivity to your product, this is the right class for you. We will teach you the basics of TCP/IP, how the client-server model works, what ports and sockets are and how applications use them to create TCP/IP connections. The class will also teach you the fundamentals of network analysis with the well-known tool Wireshark. The hands-on part of the class utilizes Microchip's 32-bit MCUs with MPLAB® Harmony. You can learn the architecture and the fundamentals of the Harmony TCP/IP stack to interface your TCP/IP application with some common stack APIs. To make your life easier, the FreeRTOS™ task scheduler is used to simplify your application programming.	3	2	Updated	Attendees registering for this class should have experience in C programming language.
23076 IoT7	Controlling Your Embedded IoT Device Using Amazon Alexa	This class will show how to use a voice-controlled digital assistant (Amazon's "Alexa" or Google's "Google Assist") to control your custom, Wi-Fi® based embedded device. The class will focus on the Amazon AWS ecosystem and will show you how to enable any embedded Wi-Fi "end device" to be controlled by a voice digital assistant (the lab will use the Amazon Echo or Amazon Dot for the voice control). You will learn how to create voice "skills" for your end device (turning things on/off, up down, etc.). You will develop the skills using Amazon's voice simulator and then use voice commands to a local Amazon Echo/Dot to control your Wi-Fi based end device during this lab. During this class you will be exposed to elements including MQTT, JSON/Javascript, and the overall Amazon AWS ecosystem. Attendees who take this class may also be interested in class SEC4 - Authentication and Secure Connections for IoT projects using AWS IoT.	3	2	Updated	Basic understanding of Wi-Fi® terminology and fundamentals.

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Class	Title	Abstract	Hours	Tech Level	Type	Prerequisites
Internet of Things (IoT) continued						
23203AWS  <b>3<sup>rd</sup> Party Content</b>	Amazon Web Services, solutions from node to gateway	There is no one-size-fits-all approach to developing cloud-connected systems. To enable the creation of smart, connected and secure designs, Microchip has expanded its collaboration with Amazon Web Services (AWS) to support cloud-connected embedded systems from the node to the cloud. Supporting AWS IoT Greengrass, Amazon FreeRTOS and AWS IoT Core, Microchip provides all the components, tools, software and support needed to rapidly develop secure cloud-connected systems. Learn how this collaboration builds end-to-end IoT solutions for everything from edge node applications to the gateway. This remote management includes over-the-air (OTA) updates to device deployed across many locations.				
23077 IoT8   	Simple Linux Based IoT Edge Node	Linux is used in many embedded devices from security cameras to home appliances. This class will teach you how to build a Linux edge node that is smart and connected to the cloud. You will learn the different requirements to connect to popular cloud vendors such as AWS, Google and Azure. You will also learn how to write a simple Python application that reads data from sensors available on real-world designs and sends this data to the cloud for fast prototyping. In the lab you will utilize the SAMA5 MPU to connect to the Azure cloud platform.	1.5	2	New	Attendees registering for this class should have basic knowledge of Linux (attend LNX1, LNX2 if necessary) and python.
23078 IoT9   	Bridging Sensor to the Cloud Using 802.15.4 Mesh Network	The 802.15.4 protocol is one of the de-facto standards in the world of networking. It covers both the 2.4 GHz and subGHz spectrums. The SAMR30 transceiver operates in the Sub-GHz spectrum. Wi-Fi® is currently the dominant protocol used in IoT applications. However, multi-protocol networks, including Wi-Fi and 15.4, are becoming more common. During this class you will learn how to develop a wireless sensor network based on 802.15.4. A Wi-Fi gateway and a cloud-based server will also be used. The end-nodes will be deployed in a MESH type topology. The labs will feature Microchip's IEEE 802.15.4 compliant single-chip solution that combines an ARM® Cortex®-M0+ based 32-bit microcontroller and RF transceiver, the Xplained Pro development platform and the Studio 7 IDE.	3	2	Updated	
23079 IoT10	LoRa® Basics - Introduction to LoRaWAN™	The LoRa® technology was created to transmit small packets of data over very long distances. The technology is extending the reach of IoT by combining long-range wireless connectivity with low power. This class will describe the general characteristics and capabilities of the LoRa technology and the LoRaWAN™ protocol. It will also demonstrate how simple peer-to-peer communication can be enabled using LoRa technology for long-distance communication between two devices. Attendees will learn the fundamental concepts that will allow them to delve into more complex concepts and labs of the more in-depth LoRa protocol hands-on class.	1.5	1	New	



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Internet of Things (IoT) continued						
23080 IoT11  	Securely Connect Your IoT Device with LoRaWAN™ Protocol to The Things Network	Using a technical hands-on approach, this class will address the challenges when building an IoT system, such as system integration, power consumption optimization, provisioning, security, RF performance and operations. Solutions will be provided using the SAM R34 - the industry's lowest power LoRa® SiP MCU, the Microchip LoRaWAN™ stack, and the ECC608 Secure Element. This class will cover real use cases, such as energy management, street lighting, smart home and smart building and tracking. The class will walk through connecting a LoRaWAN-enabled endpoint through a LoRaWAN gateway to The Things Networks servers and finally to an end application.	3	3	New	
23209WIT  <b>3<sup>rd</sup> Party Content</b>	Secure over-the-air update solution using containers (Full Metal Update) and automation framework for testing (Witekio Lab) applied to a LoraWan scenario.	"Witekio will introduce FullMetalUpdate, its secure open source over-the-air update solution, and WitekioLab, its in-house tool for automated and continuous testing of embedded systems. Both presentations will be supported by a set of demos showcasing Witekio's implementation of a LoraWan gateway on the latest Microchip ATSAMA5D27-WLSOM1-EK1 development kit and making use of multiple Microchip Lora RN2483 Mote development boards for sensor nodes. FullMetalUpdate - A secure open source over-the-air update solution using containers. In this talk, we will introduce FullMetalUpdate, a fully integrated open source solution that offers a brand new approach to system updates by using Yocto to generate containers and OSTree to deploy them. FullMetalUpdate is based on hawkBit for the update management server, Yocto for the build server, OSTree for the deployment, runC for the container runtime, and systemd for the life cycle management of the containers. WitekioLab - Automated and continuous testing. This talk introduces WitekioLab (name STC), a tool developed by Witekio to facilitate automated and continuous testing of embedded devices. Users can continuously verify that their product's feature set continues to work throughout development and ensure that issues are identified as soon as they appear. By eliminating the 'testing barrier', more robust products can get to market quicker and save companies weeks of effort at the end of a development cycle."	1.5			

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Class	Title	Abstract	Hours	Tech Level	Type	Prerequisites
Internet of Things (IoT) continued						
23205SP  <b>3<sup>rd</sup> Party Content</b>	Security Aspects for IoT projects	<p>The security of IoT has been highlighted as one of the critical factors for the success of the deployment in the major digital transformation opportunity we are living. In this talk we go over the concept of IoT security from two angles. First we describe state-of-the-art approach at IoT security as a process, with three major phases: design, implementation and operation. For each phase it is necessary to highlight threats and assets, define roles and responsibilities, and elaborate the security dimension of the project development.</p> <p>In the second part of the talk we look at practical aspects for implementing security in an IoT scenario. Silicon devices today offer a great set of security features: secure elements, microcontrollers with trust zone, cryptographic hardware acceleration, security protocols and more. We go over these features highlighting how they can contribute to fulfilling all the security requirements of the application. Those contributions are put in perspective of attacks and threats identified in the first part.</p> <p>The aim of the talk is to give a comprehensive overview of the security aspects for an IoT project and the actions to be taken.</p>	1.5			
23206MOZ  <b>3<sup>rd</sup> Party Content</b>	Improve Your IoT Products with Mozilla's Open Source WebThings Framework	<p>Both businesses and consumers have a hard time understanding how to take advantage of IoT devices -- what works with what? Are my data secure and protected? Am I in control? Mozilla has built an open source web of things framework (part of our participation in the W3C WoT interest group) to engage both developers and industry in its mission to improve privacy, security, and interoperability around IoT. Our decentralized framework helps break the vertical "cloud integration" paradigm (where each vendor builds a proprietary silo) and instead gives users ownership and control of their IoT data.</p>	1.5			

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Class	Title	Abstract	Hours	Tech Level	Type	Prerequisites
<b>Analog and Mixed Signal</b>						
23081 AMS1  	Analog Simulations Using the MPLAB® Mindi™ Analog Simulator	An analog simulator can help to reduce design cycle times by allowing an engineer to explore and understand the circuit's behavior, details, and nuances - mitigating risks from non-testable specifications and functionality due to costs and time. This hands-on class will teach you how to use the MPLAB® Mindi™ analog simulator platform, which provides optimized SIMetrix and SIMPLIS simulation tools for developing and qualifying both mixed signal and power supply circuits for your design needs using Microchip's analog portfolio.	3	2	New	Familiarity with general amplifier topologies like DC inverting amplifier, DC non-inverting amplifier, buck and boost switching regulator topologies. Ability to read a bode plot and interpret a bode plot and waveform data from graphs is a bonus. Mindi tool fundamentals can be found at <a href="http://microchipdeveloper.com/mindi:start">http://microchipdeveloper.com/mindi:start</a> .
23082 AMS2	Sensor System Design 1: Using Analog Techniques for Sensor Data Processing, A Practical Design Study	The course will demonstrate techniques to accurately extract a low level signal from background noise and wandering baseline using signal processing in the analog domain. The course will demonstrate a practical design from design requirements to prototype using Microchip's analog simulation tools and based on an ECG front end. We will begin with initial design requirements and an explanation of why these constraints exist. Solutions to these constraints will also be discussed. We will then demonstrate a simulation of the design using the MPLAB® Mindi™ analog simulator thereby demonstrating the capabilities of the simulator. Microchip libraries, component selection, etc. This section will also cover filters and amplifiers. The final section will cover the implementation including any constraints. It will touch upon PCB layout, thermal considerations, EMI, and the testing of the design. Note that there are other MASTERS classes for in-depth information on these areas of PCB Design.	1.5	3	New	Familiarity with general amplifier topologies like inverting amplifier, non-inverting amplifier, and theoretical understanding of second order filters. In addition, familiarity with Microchip's MPLAB® Mindi™ analog simulator or attending the AMS1 class would be beneficial.
23083 AMS3 	Sensor System Design 2: Interfacing of Analog Sensors to Digital Controllers	This class provides an overview of interfacing an analog sensor to a digital controller in your application. Once the sensor requirements have been defined in your application, the focus is on obtaining the sensor data in an effective manner. This class covers key signal conditional concepts such as filtering, aliasing and anti aliasing filters, oversampling and ADC requirements. This class will include a number of real-world application examples to demonstrate the topics.	1.5	3	Updated	

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Class	Title	Abstract	Hours	Tech Level	Type	Prerequisites
<b>Batteries</b>						
23105 BAT1	Battery Charging Fundamentals: Battery Chemistry, Terminology, Profiles and Charging Topologies for Real-World Products	This class will introduce you to standard charge profiles for several common battery chemistries including Li-Ion, LiFePO4, NiMH and Lead Acid. We will then dismantle a number of real-world products and discuss their charging and battery requirements. Next we will learn how to read a datasheet to determine the charge parameters and become aware of common issues with the provided data. Finally we will review several charging topologies including linear, boost and buck, and discuss the pros/cons of each.	1.5	1	Repeat	
<b>Signal Integrity and PCB Design</b>						
23110 SIG2	EMC Demystified	This class unravels the mystery behind the discipline of EMC and its impact on embedded systems design, with particular emphasis on microcontroller based applications. Intuitive relationships, rules of thumb, and a minimum of math are used to guide the participant through the fundamentals of EMC from both an RF emission and immunity perspective. The effects of noise on microcontroller performance are presented and demonstrated through case studies and live demos. Various hardware and software techniques to help avoid and/or resolve real-world EMC problems are discussed. After this class, you will be able to design new products with EMC in mind, reducing the likelihood of EMC related issues later in the process. You will also be able to better understand and mitigate EMC problems in existing product designs.	3	2	Repeat	
<b>Motor Control</b>						
23086 MC1	Beginner's Guide to Sensored and Sensorless BLDC Motor Control Using Microchip's 8-bit and 16-bit Device	Having problems with sensored and sensorless BLDC motor control and don't know where to start? Overwhelmed with complicated and complex motor control solutions that are available? This class is designed for engineers who wants to learn embedded motor control who have little or no background on motor control. The purpose of this class is to introduce the theory and algorithm behind BLDC motor control, how to implement a sensored 3-phase BLDC motor control on an 8-bit MCU (PIC18F Family) and sensorless 3-phase BLDC motor control with Back-EMF filtering using the majority function of a 16-bit MCU (dsPIC® DSC). This class serves as preparation for the DSC Motor Control Workshop. The class is divided into 3 parts: lecture on BLDC motor control theory, demonstration of 8-bit Motor Control Implementation, and 16-bit motor control implementation. A demo will show the step-by-step implementation of a BLDC motor drive using the MPLAB® Code Configurator (MCC) for an 8-bit sensored control and digital BEMF filtering routine for the 16-bit sensorless control. The controls will be implemented on dsPICDEM™ MCLV-2 Development Board with a PIC18F and dsPIC33 PIM, respectively.	1.5	1	New	The attendees should have basic understanding of Embedded C, MPLAB® X IDE and MCC.

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Class	Title	Abstract	Hours	Tech Level	Type	Prerequisites
Motor Control continued						
23088 MC3  	dsPIC® Digital Signal Controllers (DSCs) Motor Control Workshop	This 4 hour workshop class is for those aiming for a clear understanding of 3-phase brushless permanent magnet motors and their control at the fundamental level. BLDC (Brushless DC) and permanent magnet synchronous motor (PMSM) designs are reviewed along with the classic control algorithms used for each. The material covers the dsPIC33xx architecture and motor control peripherals, along with an in-depth look at the Microchip demo board, MCLV-2. The workshop will also provide three hands-on labs using a dsPIC33CK256MP506, which will cover sensorless BLDC (six step) control, sensorless BLDC (six step) control and sensorless PMSM (Field Oriented) control. These labs will also use a new high-speed "X2CScope" virtual oscilloscope for tuning and control purposes. This class provides a foundation from which further motor control refinements and control techniques can be explored with confidence.	3	2	Updated	Attendees should have previous experience with Embedded C, dsPIC® DSCs, a basic understanding of motor control peripherals like ADC, PWM, Comparator, OP-AMP, a basic knowledge of brushless motor structure and some understanding of analog topologies such as a 3 phase bridge.
23089 MC4  	Workshop on Field Oriented Control and Vectored Windmilling of PMSM Motors on 32-bit ARM® Cortex® M4 MCUs	The primary objective of this class is to help attendees understand and visualize the concepts of Field Oriented Control (FOC) and vectored windmilling of PMSM Motor. Field oriented control enables efficient, noise free and improved control dynamics of a permanent magnet motor and vectored windmilling allows for an "On-the-Fly" sensorless start of an already spinning motor without any additional sensors. In addition, this class covers motor control specific features of SAME54 (32-bit ARM® Cortex® M4 based) microcontroller. This class allows a hands-on opportunity to experience the sensorless FOC of PMSM using PLL estimator on SAME54 powered by Microchip's all new and easy to use MPLAB® Harmony 3 embedded software framework.	3	2	Updated	Attendees attending this class should have previous experience with Embedded C, a basic understanding of peripherals like the ADC and PWM, and basic knowledge of a permanent magnet synchronous motor (PMSM).
23090 MC5	Advanced Stepper Motor Control Using dsPIC33CK Device	Stepper motors have a unique advantage of running in "open loop mode" (where coils are energized in a timely manner) and still perform position control. While such a mode of operation is simple, it is grossly inadequate for demanding applications such as 3-D printers where any vibration or overshoot will degrade the quality of performance. For controlled operation and for faster response, (bipolar) stepper motors should use sophisticated current control, which can be easily accomplished using the high-speed PWM and ADC from the latest dsPIC33CK generation devices. This class will cover the various control schemes of stepper motors (open and closed current control) and how they are achieved using dsPIC33CK devices.	1.5	2	New	Attendees should have worked on motor/power control.



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Class	Title	Abstract	Hours	Tech Level	Type	Prerequisites
<b>Motor Control continued</b>						
23091 MC6	Open Source Graphical Programming and Rapid Prototyping Using SCILAB/X2C for 8/16 and 32-bit MCUs from Microchip	This class is for those who want to model and simulate systems and then run auto-generated code on a target microcontroller from the same tool set. It scales across many target uCs and system types, but is particularly relevant to motor control. The powerful combination of tool features enables rapid development and verification of practical system performance against the theoretical prediction. An introduction into SCILAB/X2C and the capabilities of the tools is given. Then, motor control demos for different uC platforms are shown to simulate and then spin brushless motors running advanced sensor-less algorithms. The integrated real time X2C virtual oscilloscope (available separately as a MPLAB® X IDE plugin) will be used to measure target variables, aid debugging and verify practical system performance. The efficient, scaleable tool set can be used to develop numerous systems. Participants will learn how to configure the tools, develop a model, simulate an application, generate code and verify system performance. This class is a prerequisite for the MC7 hands-on class.	1.5	1	Updated	Knowledge of Microchip development tools like MPLAB® X IDE, XC compiler and MCC is required
23092 MC7	  Open Source Graphical Programming and Rapid Prototyping Hands-on Class Using SCILAB/X2C for 8/16 and 32-bit MCUs from Microchip	In this class you will do a hands-on training based on what you have learned in the SCILAB/X2C lecture class. In the first part you will work with a basic demo to get familiar with the software packages and the capabilities of the tools. You will learn how to setup a framework project in MPLAB® X IDE using MCC, how to develop a model, simulate the model on the PC and how to generate code that executes on the target platform. X2C will be used to tune parameters online in real-time and verify the behavior of the real application. In the second example, a high end motor control demo of a sensorless field oriented control PMSM motor will be used to simulate a complete motor control application. Once the model is programmed onto the MCLV-2 board, real-time signals are monitored and controlled and observer parameters are tuned for optimal performance. The MC6 class is a mandatory prerequisite for this class.	3	2	Updated	Microchip development tools knowledge is required (MPLAB® X IDE, XC, MCC, programmer/ debugger).

### Tech Levels

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- 3: Previous hands-on working experience with the topic is necessary.
- 4: Thorough knowledge and working experience with the topic is necessary.
- 5: Advanced – attendees should already have expertise in the topic before attending



This symbol indicates online preparation materials are being created for this class. We will contact you when they're available.

## 2019 MASTERs Conference Class List

Class	Title	Abstract	Hours	Tech Level	Type	Prerequisites
<b>Power Supplies and Power Conversion</b>						
23093 PC1	Fundamentals of Switch-Mode Power Converters	Switch-mode power converters are widely used primarily because of their high efficiency and small size. To some, switch-mode converters are mysterious devices yet the basic principles of switch-mode converters are fairly simple. This introductory class presents the principles and concepts of switch-mode converters and lays the foundation needed for the more advanced power conversion classes. The class starts with the fundamental principles of energy storage and processing common to all switch-mode converters, inductor volt-second and capacitor charge balance. Using these principles and a "follow the energy" approach, the operation of the most common switch-mode converters is explained. Converters discussed in some detail include the buck, boost, and flyback converters. After this class it is suggested that those interested in switch-mode power take the PC2 which provides an introduction to feedback and control loops for switch-mode power converters.	1.5	1	Repeat	
23094 PC2	Fundamentals of Switch-Mode Power Converter Control	This class provides an introduction to applying feedback and control concepts to make practical analog control circuits for switch-mode power converters. While 23093 PC1 is not a prerequisite, this class builds on the concepts presented in that class. The class starts with a review of feedback and the desirable characteristics of a control loop. Then the control loop of the buck converter is examined, leading to the design equations for the error amplifier/compensator. The K-factor method is introduced as a way to quickly get a stable and well performing feedback loop. The last part of the class is an overview of current mode control and its advantages. While there is a fair amount of algebra, the focus of the discussion is on understanding the concepts and principles. After this class those interested in designing power converter control loops with digital control should take the PC3 class, which provides in-depth information on how to design digital controllers for switch-mode power converters.	1.5	1	Repeat	
23095 PC3	Fundamentals of Digital Switched-Mode Power Converter Control	This technical session is aimed at firmware engineers and embedded systems programmers who need to learn the foundation principles needed for fully digital compensator design and implementation. This session covers all topics necessary to design stable digital control loops on dsPIC® DSC devices. Topics such as discrete time control systems, Z transforms and linear difference equation coefficient calculations are presented in a step-by-step manner and additional, specific aspects and challenges of discrete time domain signal generation, sampling processes and number conversion are discussed and supported by live demos. The material covered will also be necessary for understanding many of the other technical sessions at the conference.	3	2	Repeat	Basic knowledge of switched-mode power supply control fundamentals is required. Attendees should have basic understanding of power supply topologies and control concepts covered by the classes PC1 and PC2.

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## 2019 MASTERS Conference Class List

Class	Title	Abstract	Hours	Tech Level	Type	Prerequisites
Power Supplies and Power Conversion continued						
23097 PC5	Fundamentals of Power Integrity in Embedded Systems	Technology in the digital world continues to move swiftly towards higher performance and capabilities. Even relatively simple user interfaces today are equipped with SuperSpeed USB or Gigabit Ethernet interfaces in conjunction with powerful graphics controllers interconnected with high performance MPUs or FPGAs and their external high-speed memory blocks in extremely small footprints. With increasing complexity and performance, the dominance of high-frequency specific aspects are significantly impacting the design of the entire power distribution network (PDN). Complementary to classes SIG2 on signal integrity and PNP10 about specific pitfalls in MPU designs, this class is introducing fundamental power integrity related design aspects covering PCB and chip-level influences, component selection of individual voltage regulator modules (VRM) and decoupling aspects of their high-speed loads to achieve maximum system reliability and performance. Modelling and physical dependencies will be shown on live demonstrators.	1.5	3	Repeat	Attendees should have basic understanding of power supply topologies and control concepts covered by the classes PC1 and PC2.
23098 PC6	Practical Aspects in Power Integrity: Topology Selection and Step-by-Step VRM and PDN Design for Flat-Impedance	Foundational theory needed for flat-impedance PDN design is first summarized and condensed in a few simple equations. The flat-impedance VRM and PDN design procedure is exemplified using a Peak Current Mode Controller while the design process is supported by experimental data. The decoupling capacitors selection process for flat-Z PDN profile is illustrated by measurements from a concept board. VRM output resistance programming using inductor DCR as a current sensor is addressed, and relevant design equations are explained. The design process is validated by measurements from a constant-frequency hysteretic regulator board. The effects of L/DCR time constant mismatches in the current sensing network on the VRM output impedance are also analyzed. Measurements of VRM output impedance characteristics under different control topologies are shown and the implications on output capacitor size to achieve VRM flat-impedance profile are discussed.	1.5	3	New	The class "PC5-Fundamentals of Power Integrity in Embedded Systems" should be attended prior to attending this class.

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# 2019 MASTERS Conference Class List

Class	Title	Abstract	Hours	Tech Level	Type	Prerequisites
Power Supplies and Power Conversion continued						
23100 PC8	Advanced SMPS Design Using Programmable Mixed Signal Controllers	Many new fields of application such as advanced lighting, energy storage or advanced cross-system power management in industry 4.0 applications require power supply solutions which are more intelligent and adaptive to their environments. These solutions can also help system integrators to reduce cost by increasing reliability and reducing efforts for maintenance. In this class we will focus on software-configurable analog PWM controller architectures, their target applications and design tools provided to build customized single- and multi-block switched-mode power supply stages using Microchip's latest graphical design tools. This course will guide you step by step through the design process of creating customized on-chip power control blocks for advanced applications focusing on DC/DC converters and LED lighting. In addition we will offer an Open Lab evening class with the ability to play with the material you learned about in that class. Details on the open lab session will be provided during class.	3	2	Updated	Attendees of the class should have knowledge of switch mode power supply topologies, PWM controller architectures and control concepts or should at least have attended the PC1 and PC2 classes.
23102 PC10	Developing Power Management Solutions for Battery Powered, IoT and Embedded Systems Using the MPLAB® Mindi™ Analog Simulator	This class starts by identifying power management requirements for common battery powered, IoT and embedded applications. Power system solutions for each are identified and compared for performance, complexity and size. The selected solution will be modeled using the MPLAB® Mindi™ analog simulator to validate that it meets the key requirements.	1.5	2	New	
23103 PC11	Power over Ethernet (PoE) Design Considerations	As a result of the Microsemi acquisition, Microchip now offers Power over Ethernet (PoE) solutions, including both Power Sourcing Equipment (PSE) and Powered Device (PD) solutions. This course will offer an introduction to PoE technology and to the new IEEE802.3bt Standard. In addition the course will offer detailed PD design techniques intended to help the PD designer avoid common pitfalls. Topics will include design techniques for isolation, EMI, thermal, line transformer, layout and noise as well as DC/DC design tips for cost vs. efficiency considerations.	1.5	2	New	

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## 2019 MASTERS Conference Class List









Class	Title	Abstract	Hours	Tech Level	Type	Prerequisites
Power Supplies and Power Conversion continued						
23104 PC12	Fundamentals of Wireless Power	Wireless power transfer techniques are widely used to transfer power from one system to another in a wide range of applications. Qi is the most widely adopted wireless charging standard and it has proliferated into nearly all consumer cell phone brands. Qi's broad market adoption and open standards make Qi an ideal choice for IOT and other portable device where non-contact, connector-less charging is valuable. This class will focus on the basics of wireless charging, with an emphasis on Microchip designs. During the session, attendees will learn the basics of wireless charging, technology limitations, the Qi protocol, how to select and tune antennas, as well as implementation tips and tricks. After taking this class the student will be confident in executing basic wireless charging designs suitable for product incorporation. Note: this class will be co-presented by a representative from Würth Elektronik.	1.5	1	New	

## 2019 EU MASTERs Experts On Site

Company	Expertise
<p>Amazon Web Services</p> 	<p>Microchip has expanded its collaboration with Amazon Web Services (AWS) to support cloud-connected embedded systems from the node to the cloud. Supporting AWS IoT Greengrass, Amazon FreeRTOS and AWS IoT Core, Microchip provides all the components, tools, software and support needed to rapidly develop secure cloud-connected systems. Beside their lecture class during our MASTERs event this will give you an opportunity to get in touch with them.</p>
<p>Arduino</p> 	<p>Arduino® is an open-source prototyping platform based on easy-to-use hardware and software. It's intended for anyone making interactive projects that require electronic control. Arduino provides a layer of hardware abstraction, so that no prior knowledge of electronics or microcontrollers is required. As such, it is perfect for beginners. Experienced engineers also use Arduino for rapid prototype development. Support is available in professional IDEs such as Atmel Studio and MPLAB® X IDE. Since 2005, a worldwide community of Makers has gathered around the Arduino open-source platform. Microchip AVR® microcontrollers were there from the outset, providing a simple but powerful computing engine. Artists, inventors, engineers and even school children use Arduino boards with Microchip MCUs to turn brainstorm into real working things. Microchip and Arduino are co-sponsoring a series of hands-on training seminars, trade shows and other events to help Makers turn working prototypes into successful products.</p>
<p>ARM</p> 	<p>ARM will be able to talk about their Platform Security Architecture (PSA), a common security foundation for the whole IoT ecosystem. During their lecture class at our MASTERs event they will introduce Trusted Firmware-M (TF-M), which provides embedded developers with a reference trusted code base complying with the relevant Arm specifications. Use the opportunity during our Expert Evening to address any additional questions.</p>
<p>Arrow</p> 	<p>Our World is changing Rapidly. Innovation and business adoption of Digital Transformation, IoT and now AIoT are challenging the resources of many designers. This can be further complicated by the new security compliance and regulatory requirements for key applications. All of this can mean extended design cycles, project risk or even project failure. As a trusted technology partner and engineering services company, Arrow can support customers with technology adoption, project execution and design for manufacturing.</p>
<p>Microchip CAE Team</p>  <p>Technical Support</p>	<p>Looking for insights on your design, what products and solutions to explore, stuck in your development, get things clarified or simply need help with debugging? Microchip Technical Support is available 24 x 5. Learn how you can reach us through different channels (support portal or phone). Explore the tips and tricks to navigate our support resources, tools, knowledgebase and make best use of them to speed-up your development. Join us at the Microchip Technical Support booth and find out more !!!</p>
<p>Coderus</p> 	<p>Technology is only as good as the experience it offers to its users. At Coderus, whether we're developing apps for mobile, embedded technologies or something a little different, we take your objectives and work with them to put the user's experience first.</p>
<p>Colorfy/Coeno</p> 	<p>As Technology Doubles, Costs Halve And Opens Up New Markets Of Opportunity. Technology is rapidly transforming our world. We are now at a unique point in history where we see dozens of technologies on an accelerated path of growth. Let's discuss how innovation management and UX leverage these patterns and how closely technology, design and business models are linked and how they can disrupt any industry. We share examples and look into the process and how it affects organizations.</p>
<p>Emitron</p> 	<p>The emitron GmbH from Karlsruhe has been supporting customers for more than 20 years as a system integrator for embedded complete solutions at all levels of the development process. The product spectrum ranges from hardware and software design over application development and housing construction to series production and assembly, Made in Germany. Solutions for the Internet of Things (IOT), virtualization on multicore CPUs, security and safety are just as much a part of the offering as are customer-specific solutions and industrial real-time communication.</p>
<p>ONgeiner</p> 	<p>As power design partner for Microchip the ONgeiner team can help you to make your power ideas come true. The 25 head design &amp; engineering house "makes power invisible" by maximizing power density, shrinking size and even cut the cord. To reach this the ONgeiner team with more than 25y experience in power and chip design is working on leading edge Technology solutions like GaN on Silicon for "HF" Power solutions as well as analog &amp; digital power as well as wireless power to enable smallest designs with highest reliability for industrial, commercial and mobility markets.</p>










## 2019 EU MASTERS Experts On Site

Company	Expertise
<p>Future</p> 	<p>Future Electronics has four Centre Of Excellence (COE) engineering centers in Europe. Each of the four Centres of Excellence is a development laboratory with its own specialism, staffed by experienced engineers who are experts in software development, circuit design and board layout. The key competences are : embedded computing, industrial automation &amp; motor control, connectivity &amp; sensing, power electronics &amp; lighting.</p> <p>The two types of services we are providing are :</p> <ul style="list-style-type: none"> <li>- Design assistance : on request from a customer, a specific reference design can be provided helping to overcome bandwidth issues or helping to adopt a new technology</li> <li>- Development of reference boards, available for all customers, to demonstrate new products in an application/system oriented manner</li> </ul>
<p>Granite River Labs</p> 	<p>GRL is an engineering services firm focused on solving tough hardware design and validation challenges. Led by a team of veterans from the test &amp; measurement and semiconductor industries, GRL offers a comprehensive set of services and deep domain expertise across a range of interfaces, disciplines, and test methodologies. They will fill one of our lecture slots during the MASTERS conference and you can use the Experts Evening to get in touch with them.</p>
<p>Idemia</p> 	<p>Idemia will host a lecture on Addressing CyberSecurity challenges for IoT - a roadmap to dynamic security on 32bits Microcontrollers powered devices. Use the Experts Evening to get in contact with them!</p>
<p>Ineltek</p> 	<p>Ineltek has developed a low-cost, simple-to-use family of E Ink E-paper display add-on boards for the Microchip Xplained Pro prototyping and evaluation platform – currently available with 1.5", 2.9" and 5.7" displays.</p> <p>Our Ineltek E Ink Xplained Pro boards make it easy to connect and easy to develop using E Ink's unique enabling technology in a Microchip ARM® or AVR® based development environment.</p> <p>Ineltek's support for your e-paper display development includes software libraries, example projects, 2D and 3D CAD for the displays and the PCB data to quickly prototype your own designs.</p> <p>Ineltek is a specialized pan-european demand-creation distributor of semiconductors, passive components and displays. The 1987 founded enterprise offers complete solutions due to our customers current and future innovations, high technical design-in service as well as customized solutions to our commercial and industrial customers.</p>
<p>Meteca</p> 	<p>Meteca has designed the bridge to fill the gap between the maker and industrial worlds: the Briki MBC (Modular Brick Concept), a small but powerful SoM, easy to use and already certified, which allows you to move from prototype to production in a fast, cheap and simple way.</p> <p>The first product of the MBC family is the MBC-WB, a dual processor SoM (Cortex M0+ and Tensilica Xtensa) with Wi-Fi and BT/BLE wireless interfaces plus CryptoAuth chip, for full embedded security from cloud to boot. Within its 62 pins the debug interfaces are exposed for both the MCUs, allowing full code control and going further the classical rigid master/ slave topology.</p>
<p>Mozilla</p> 	<p>Both businesses and consumers have a hard time understanding how to take advantage of IoT devices -- what works with what? Are my data secure and protected? Am I in control? Mozilla has built an open source web of things framework (part of our participation in the W3C WoT interest group) to engage both developers and industry in its mission to improve privacy, security, and interoperability around IoT. Our decentralized framework helps break the vertical "cloud integration" paradigm (where each vendor builds a proprietary silo) and instead gives users ownership and control of their IoT data.</p>
<p>Security Pattern</p> 	<p>Security Pattern offers expertise and solutions for creators of intelligent connected devices. Thanks to our deep knowledge of security and cryptography in the field of embedded devices we can help you in the three main phases of your projects: design, implementation and operation. Come and join us for our lecture class on how to address the protection of IoT devices or meet face to face during the Experts Evening.</p>
<p>Hardware and Firmware Optimization Team</p> 	<p>Most deeply embedded systems need tight integration between MCU peripherals and firmware to maximise performance and minimise system cost. Microchip has the Microcontroller products, the tools and the expertise to help you architect systems; systems are partitioned elegantly and effectively to provide a working solutions at the lowest total system cost and power consumption. Our focus here is on increasing peripheral complexity, using a core mostly for configuration, shorter design times with more effective tools, continuing investment across the full 8-bit, 16-bit and 32-bit products ranges keeping all options open. Come and discuss your Microcontroller system requirements with our experts and let us help you come up with ideas on how best to architect your system.</p>

## 2019 EU MASTERS Experts On Site

Company	Expertise
<p>Sematicon</p> 	<p>Cryptography is not your enemy it is a real problem solver. Some modern industrial standards like the IEC62443 are defining requirements which are among others solvable with crypto - if you have the right tools and if you know how to use it properly and trustfully. We will take a journey from the basics of cryptography to the real-world-use cases like cloud or IT connections or using crypto in industrial real-time-applications. We will also answer the question what secure elements like the ATECC608 is why you should or should not use it. You will learn about the different algorithm and technologies in conjunction with example use cases to get the focus on best practices and the most major mistakes that should be avoided. We will also oversee the risks and attacks we have to consider when using this technology. It is not the objective to discuss the mathematics but we want to give you the skillset to ask the right questions when starting a design and discuss about future requirements and define target you would like to protect. Join us for our lecture class or meet face to face during the Experts Evening</p>
<p>Systemtechnik Leber</p> 	<p>In our lecture class we will try to give you some insight on the engineering service we can offer. Come and meet with us during the Experts Evening if we need to dive deeper into your needs.</p>
<p>TARA Systems</p> 	<p>Embedded Wizard is TARA Systems' embedded GUI technology that enables you to create platform-independent and high-performance graphical user interfaces (GUI) on a wide range of embedded systems - from resource constrained MCUs to Linux-driven MPUs. Thanks to a comfortable IDE, instant prototyping facilities, efficient adaptation to your target hardware and our professional services, we help you to create sophisticated GUIs with minimum effort. Stop-by and get inspired by our latest demos running on various Microchip platforms - from SAMD51 to PIC32 to SAMA5 powered devices.</p>
<p>Terranova</p> 	<p>We create solutions. We take complex processes and make them simple. That's why since 2001, thanks also to constant research and renewal, we are leader in the Energy &amp; Utilities Market, supporting our clients with their digitalization, growth, business and market position consolidation process.</p> <p>All our software share a common matrix: they are flexible, modular and specifically developed to meet any requirements emerging from the market. Answer quickly and efficiently to the various needs, supporting the continuous innovation: that's what "digitalization" and its added value mean for us. Join our lecture class and meet us during the Expert Evening.</p>
<p>Witekio</p> 	<p>Innovation today starts with software. From hardware to the cloud, our expert software team will help you design, develop and integrate a powerful software system tailored to your needs. Join our Lecture class and meet us Face to Face during the Experts Evening.</p>
<p>Microchip Wired Network &amp; Automotive Solutions</p> 	<p>Microchip is a TOP 10 Automotive Semiconductor Supplier, serving the automotive market since more than 25 years.</p> <p>We are market leader in multiple application area's such as touch screens, automotive networking, infotainment connectivity and many more.</p> <p>Visit our automotive / wired network application team here on site to discuss your ideas, find out about Microchip capabilities and solutions.</p> <p>We have experts on site for</p> <ul style="list-style-type: none"> <li>- Networking ( Auto and Industrial )</li> <li>- Motor Control</li> <li>- HMI / Touch Screens / Buttons / Sliders / Wheels</li> <li>- Scalable Security Solutions</li> <li>- Power Conversion, Charging, Lighting, ISELED</li> </ul>
<p>Authentication and Cryptograph</p> 	<p>Microchip has a long-lasting experience as a supplier of Security solutions. Come to the Authentication &amp; Cryptography table and discuss your Security challenges with our experts! Secure cloud connectivity, authentication of disposable products will no longer be a mystery for you.</p>
<p>Microchip Embedded Software</p> 	<p>Microchip has a long history of supplying innovative software solutions to our customers that help them innovate, differentiate and reach the market faster. We specialise in MPLAB X, XC Compilers, Linux, RTOSs, Harmony and all of the middleware. Come and talk to our specialists and see how we can help you with your next challenge.</p>

## 2019 EU MASTERs Experts On Site

Company	Expertise
Microchip Wireless System Solutions 	Wireless is fast becoming the required method for connecting intelligent end products to Smart Devices and Cloud Services. If you are looking for insights into how you can leverage the power of IoT and apply it to your end products utilizing Wi-Fi®, Bluetooth®, LoRa and LoRaWAN™, 802.15.4 or proprietary system solutions OR how to build secure, reliable, robust, connected embedded systems, then come and talk to our Wireless System Solutions Team about your needs.
Motor Control 	We can spin every motor. Microchips 8/16 and 32bit Microcontrollers as well as FPGAs have the right peripherals to spin motors from the very low end (DC motor) to highly sophisticated control algorithms for PMSM motors that require a lot of calculation power. The analog and power portfolio helps to develop a complete MC application. With focus on MC development tools like motorBench, Scilab/X2C, Matlab and X2Cscope we provide the right tools for fast application development. Our MC experts spread around the world can help you to spin your motor quickly.
Linz Center of Mechatronics GmbH 	The Linz Center of Mechatronics GmbH (LCM) is your partner for research and development of new as well as for enhancement of existing technical products, system and processes. We support our customers, national as well as international production plants, from first concepts and feasibility studies up to the market launch. Our infrastructure allows production of prototypes and small lot sizes. The specific know-how of our employees in the different fields of mechatronics is our basis for technical and scientific cooperation. Based on this know-how, we emphasis new smart systems for industry. Our hard-and software solutions enable us to create systems, products and processes of the next generation for and together with our customers. One of our software tools is X2C, which is designed for the model-based development and code generation of real time control algorithms for microprocessor units. X2C accommodates all features required for making model-based design a superior alternative to manual code writing. Especially for complex control tasks, X2C greatly reduces the development time due to the intuitive graphical interface and avoids tedious bug-tracking due to a large number of tested library blocks.
Power Conversion 	Microchip supports your upcoming designs with our comprehensive portfolio and innovative solutions. The low power consumption solutions allow battery-powered systems to operate longer time while digitally enhanced products provide industry leading flexibilities in both development and production. Battery Management, Intelligent Power, Lighting, Automotive ....
Signal Chain and Timing 	Microchip is a Top 10 analogue supplier with a continually expanding analogue portfolio. Come and talk to the Sensors, Signal Chain and Timing Team to learn how to achieve higher accuracies at lower costs, increase design robustness in harsh environments (EMI, high temperature etc), use little power, learn about effective sensor management and understand signal chain architectures and complex data conversion. Linear, Thermal, Power Monitoring, Energy Metering and Multiparameter Data Converters Processing signals using CIPs, analogue peripherals, use of MCC Drivers for interfacing to sensor signals Smart Energy - Metering analogue front ends High performance clock synthesis and management
Touch Technologies 	Most embedded systems are adding touch controls to add features, improve aesthetics, reduce cost and improve ease of manufacture. Microchip is a leader in touch buttons, sliders, touch screens and 3D gesture solutions. We provide extremely robust low power solutions, and highly configurable open products, along with an experienced field engineering team who can help you design a system which will work well, be easy to manufacture and will not suffer from noise problems. You may not have previous experience to build a system without some help and guidance. We provide the dedicated ICs through to MCU peripherals with the source code and libraries to enable our customers to build and customise the most suitable solution for their application and level of knowledge. We have the most complete touch solutions in the industry, with a business unit dedicated to researching and developing next generation solutions. Come and discuss your requirements on any touch solutions with our experts.
FPGA 	FPGAs & SoC offer a wide range of unique features & flexibility in the industry that could be tailored to your specific product's needs. Come and meet our specialists to learn everything about all the benefits of using our FPGAs & SoC from security, reliability to low power and how to design a Custom Independent Peripherals.

# MICROCHIP MASTERS

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