



E-Learning for Charging Station Developer

June 2024

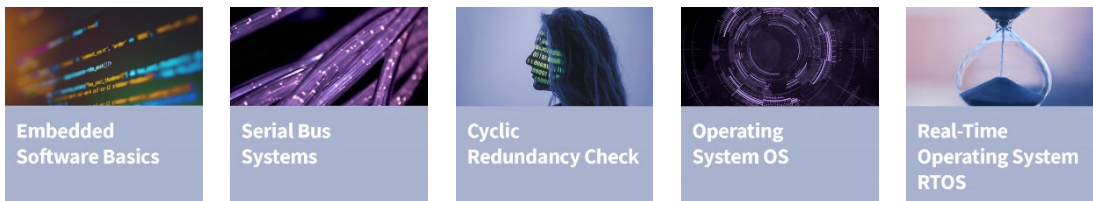
The combination of courses is perfect for a charging station developer.



Courses within the e-learning package

The "Charging Station Developer" e-learning package is a comprehensive program that equips learners with essential knowledge and skills in the field of embedded software development, electronics and electrical engineering and in addition also provides e-mobility and charging knowledge. This package covers a wide range of topics to provide a well-rounded understanding of the subject.

1. Embedded Software Development: This first part is providing you with know-how to become proficient in embedded software development.



Embedded software basics, dives into fixed-point arithmetic and floating-point arithmetic, essential for understanding numerical representation and calculations in embedded systems. ...

Serial bus systems are a critical component of embedded systems, and learners will gain insights into their architecture, protocols, and components. The OSI model is also covered, providing an understanding of layered communication systems.

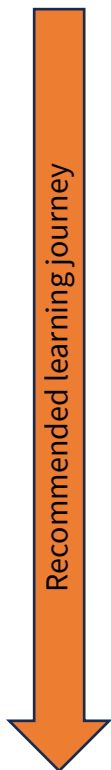
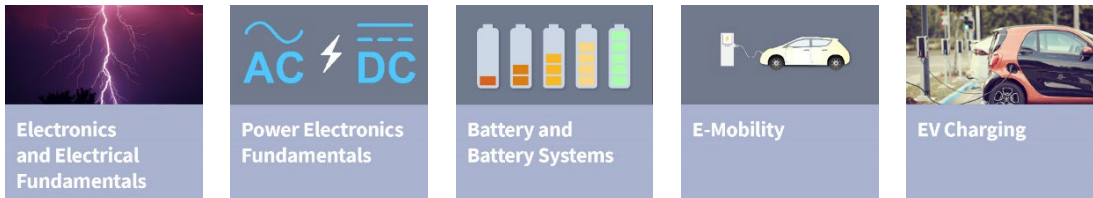
The **cyclic redundancy check CRC** provides important further details which are often needed in bus communication.

Operating systems, are explored in-depth, focusing on kernel operations, multitasking, safety considerations, and common challenges in embedded OS development.

The operating system in an embedded application has real-time requirements and thus a **Real-Time Operating System** is needed. We cover different real-time requirements, time and event-based tasks and more.

2. Electronics, battery technology, and e-mobility specific know-how

This second part is dedicated to electronics and technology know-how which is the knowledge foundation for e-mobility.



Electronics and electrical fundamentals encompassing topics like electronics and magnetism, circuitry, alternating current circuits, and the basics of power electronics.

Power electronics fundamentals is delving into semiconductors, introduces the concepts of the half bridge which is used to control electrical machines and finally is going into thermal design and application examples.

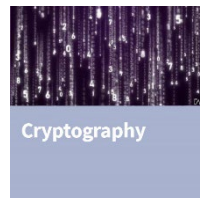
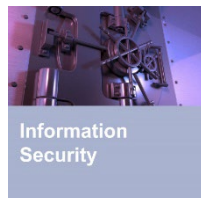
For e-mobility **battery and battery systems** are important for energy storage. First you learn all you need to know about battery cells, then battery systems are explained in detail followed by an introduction to battery management systems.

This course on **E-Mobility** ensures that the learner is getting to know the overall context. This includes trends, used cases, and market aspects. You will get an overview on electric charging and get to know the electric vehicle system including the powertrain system, the electric drive system, functional safety and energy management.

Next, we go into more detail on **EV charging**. This includes general charging know-how on automated charging, charging use cases and grid interaction. After this we delve into the charging communication which takes place between the electric vehicle and the charging station.

3. IT-Security

In this part essential knowhow on information security and cryptography is provided.



Information security is the first e-learning course dealing with IT-security and introduces you to all the basic terms in this field.

In the realm of **cryptography**, learners will explore both classical and modern cryptography, including encryption techniques such as the Caesar Cipher, Vigenère Cipher, DES (Data Encryption Standard), AES (Advanced Encryption Standard), Diffie-Hellman Key Exchange, and RSA. This knowledge is vital for securing embedded systems and data.

This e-learning package is tailored for those aspiring to, whether you are a beginner or seeking to enhance your existing skills. Upon completion, you will possess the knowledge and capabilities required to excel in automotive software development.

Delivery Content

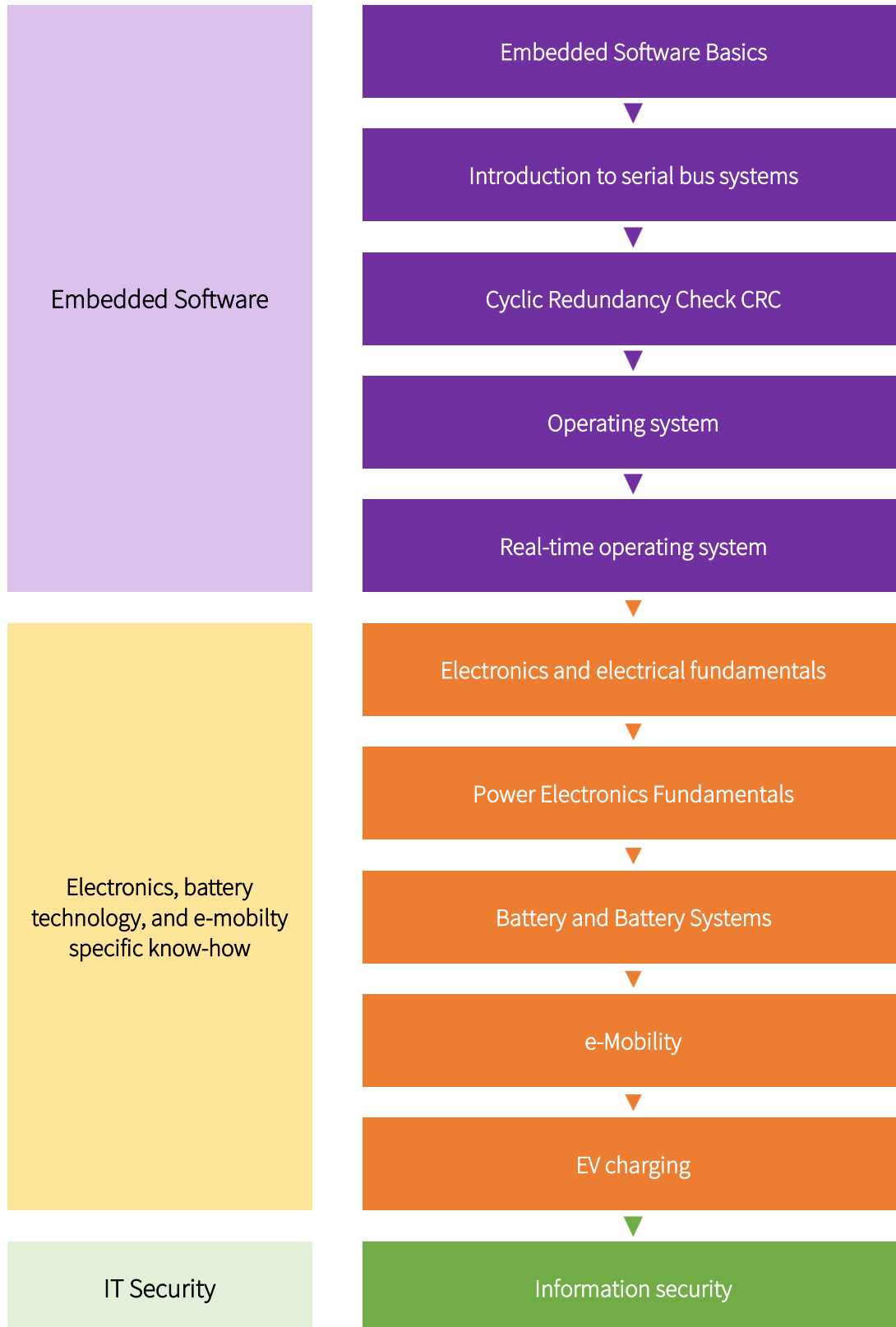
Access

- for one user
- to all e-learning courses
- for the purchased time period

of the Embedded Academy.

Recommended Learning Journey

The Automotive Application Software Developer e-learning package is composed of several e-learning courses. We recommend the following order for learning.





E-Learning Content

1) Embedded Software Basics

- Language: English, German
- Course objective: The aim of this course is to provide a sound basic knowledge on which other topics, such as AUTOSAR, can build.
- Course content: This course provides an e-learning on **fixed point arithmetic** and on **floating point arithmetic**. Two ways of storing binary numbers are described, and limitations and typical errors of the methods are explained. This helps to avoid beginner mistakes and enables a quick introduction to the basics of embedded software.
- Duration: 1 hours, 15 minutes
- Study time: 6 hours, 15 minutes
- Further insights: <https://embedded-academy.com/en/courses/embedded-software-basics/>

2) Introduction to Serial Bus Systems

- Language: English, German
- Course objective: The aim of this course is to introduce learners to all the important basic terms for the topic of serial bus systems.
- Course content: This course is designed to introduce you to important basic terms related to serial bus systems. Terms concerning hardware and software are explained.
The focus of the first e-learning lies on very **general basic terms** that are relevant to most bus systems. For example, the terms bit rate, baud rate, latency, clock signal and router are explained, or what a protocol and a protocol stack actually are. At the beginning of the e-Learning, typical application areas of serial bus systems and their advantages over other systems are described.
The second e-learning deals with the **OSI model**, which is a reference model for communication systems and protocols. Two components of this model are particularly relevant for bus systems: the so-called physical layer and the data link layer.
The last two e-learning courses are based on these mentioned layers. One of them covers basic terms of the **physical layer**, the other one those of the **data link layer**.
- Duration: 2 hours, 50 minutes
- Study time: 14 hours, 10 minutes
- Further insights: <https://embedded-academy.com/en/courses/introduction-to-serial-bus-systems-en/>

3) Cyclic Redundancy Check CRC

- Language: English, German
- Course objective: The aim of this course is to understand how to calculate various CRC checksums
- Course content: The e-learning course consists of three e-learning units:

“CRC Definition,” “CRC-8,” and “CRC-16.” In this course, you will acquire the necessary knowledge to understand the calculation of CRC checksums. The first module imparts the definition and function of the CRC checksum. The modules are organized in ascending order of CRC sums, and the calculations are always explained using examples.

In the “**CRC Definition**” module, we uncover its significance, explore various CRC lengths, and delve into its principles, including functionality, polynomial representation, and generator polynomial.

In “E-Learning **CRC-8**,” we delve deeper into CRC-8 calculation, explaining steps with examples. Explore how the sender generates the CRC-8 checksum and how the receiver verifies message accuracy.

Continuing the journey, “**CRC-16**” explores CRC-16 calculation through detailed examples. Learn how CRC-16 is generated and verified, addressing diverse message lengths. Whether new to CRC or seeking a deep dive, this course empowers your understanding.

- Duration: 1 hour, 20 minutes
- Study time: 6 hours, 20 minutes
- Further insights:
<https://embedded-academy.com/en/courses/cyclic-redundancy-check-crc/>

4) Operating System

- Language: English
- Course objective: The aim of this course is to provide a basic knowledge of operating systems and the various components and functions they contain.
- Course content: In this course, you learn what an **operating system** is. Therefore, you are familiarized with the kernel, which holds the core functionality of the operating system and you get to know the scheduler, which controls the execution of multiple tasks and allocates resources to them. This is covered in greater detail in the chapter “Multitasking”. To complete this course, safety and other advanced aspects are covered as well as the characteristics of embedded operating systems.
- Duration: 55 minutes
- Study time: 4 hours, 40 minutes
- Further insights: <https://embedded-academy.com/en/courses/operating-system/>

5) Real-Time Operating System

- Language: English
- Course objective: The aim of this course is to provide a basic knowledge of real-time operating systems. The learner will understand what a real-time operating system is and how it works.
- Course content: You will learn when **real-time operating systems** are needed and which requirements they have. In particular, we cover the difference between soft real-time requirements and hard real-time requirements. You will also encounter the term “timing analysis” and learn about the difference between time-based tasks and event-based tasks. At the end you will be familiarized with three scheduling algorithms, before we cover three typical problems: task starvation, deadlock and race conditions.
- Duration: 1 hour, 5 minutes
- Study time: 5 hours, 25 minutes
- Further insights:
<https://embedded-academy.com/en/courses/real-time-operating-system-en/>

6) Electronics and Electrical Fundamentals

- Language: English
- Course objective: The aim of this course is to provide a basic technical understanding of all relevant topics in the area of electricity.
- Course content: The first e-learning unit of this course is called “**Electronics and Magnetism**”. It covers the relationship between current, voltage and resistance, which is expressed by Ohm’s law. In addition, electric and magnetic fields are contrasted and different types of magnets are considered.
The second e-learning unit deals with the **important components of a circuit**, the capacitor and the coil, as well as the resulting phenomena and physical laws, the Lorentz Force, the Hall Effect and the principle of induction.
Furthermore, **direct current and alternating current** are analyzed. For the analysis of circuits, Kirchhoff’s Laws and the circuit types parallel circuit and series circuit are explained. With regard to alternating current, the Star connection and the Delta connection are considered. The topic of **AC circuits** is covered in greater detail. Therefore, the complex numbers are explained in order to then discuss the complex voltage and the complex current. Furthermore, this chapter covers the impedance and the Root Mean Square.
The last part of the e-learning contains an introduction to **power electronics**, which is based on semiconductor elements. In addition to teaching technical basics, it explains how various components can be constructed using semiconductors. Here, special attention is paid to the diode and the MOSFET. The user is therefore familiarized with the concept of the p-n-junction.
- Duration: 3 hours, 10 minutes



- Study time: 15 hours, 50 minutes
- Further insights:
<https://embedded-academy.com/en/courses/electronics-and-electrical-fundamentals/>

7) Power Electronics Fundamentals

- Language: English
- Course objective: The aim of this course is to provide a better understanding of power electronics fundamentals for engineers who are beginning to work in this field.
- Course content: In the first e-learning we clarify what **power electronics** is and where it is applied. It also includes an explanation of the electronic switch. We deal with an example of an electronic circuit, from which we derive basic components. In the e-learning “**Components of Power Electronics**” you learn about the semiconductor basics and components including MOSFETs and IGBT. The third e-learning is about the **half bridge**, that is used to control AC electrical machines and the last e-learning covers the topic of **thermal design and assembly**.
- Duration: 2 hours, 25 minutes
- Study time: 12 hours, 5 minutes
- Further insights:
<https://embedded-academy.com/en/courses/power-electronics-fundamentals/>

8) Battery and Battery Systems

- Language: English
- Course objective: The objective of this course is to gain a better understanding of the design and control of battery systems.
- Course content: In the first e-learning, we get to know the **battery cell** itself in more detail. We learn what materials it can be made of and how it works when it is charged and discharged. At the end, we will look at the parameters that influence the battery’s performance. The second e-learning is about the **battery system** of an electric vehicle, different cell types and battery safety. We take a look at the 48V battery as an example.
- Duration: 1 hour, 30 minutes
- Study time: 7 hours, 30 minutes
- Further insights:
<https://embedded-academy.com/en/courses/battery-and-battery-system-fundamentals/>

9) E-Mobility

- Language: English
- Course objective: The aim of this course is to introduce you to the topic of electric vehicles.



- Course content: The e-learning introduce the user to different topics relevant to understand the relevance and scope of e-mobility.

First of all, the learner will be **introduced** to the correct terminology to talk about this topic. We will have a look at which trends influenced the growth of electric mobility and how this might have changed the (automotive) market. This also includes highlighting the different use cases of electric vehicles and explaining the model of the total cost of ownership (TCO), which allows for a calculation of the total costs of a vehicle during its lifetime.

The next e-learning then focusses more closely on **charging** itself. The basics of EV charging will be explained, as well as different charging standards and modes, charging plugs or bidirectional charging.

The unit on „**Electric Vehicle Systems**” concentrates on the system architecture and elements of the system powertrain. This includes discussing basic electric drive system design, considering aspects of functional safety and highlighting various elements of the system energy management.

- Duration: 2 hours, 20 minutes
- Study time: 11 hours, 40 minutes
- Further insights: <https://embedded-academy.com/en/courses/e-mobility/>

10) EV Charging

- Language: English, German
- Course objective: The aim of this course is to first introduce the learner to all important aspects of electric vehicle charging and then educate them about the more advanced topic of communication in electric vehicle charging.
- Course content: First of all, the learner is made familiar with the **basics** of EV charging (charging modes, standards, levels). Afterwards, one e-learning focusses in particular on **automated charging**. To place EV charging into relation to our everyday life, **use cases** of EV charging are discussed as well. Moreover, it is also important to be informed about the **grid interaction**, which includes topics such as energy production and green energy.

The focus of the next two e-learnings is then on **communication** in electric vehicle charging. Therefore, first the concepts of the pilot signal and the duty cycle are introduced, before various communication mechanisms are described, the **low-level and high-level communication** for instance. Low level communication is, roughly speaking, the basic handshake, while high-level communication involves the transmission of much more data – including encrypted data.

- Duration: 2 hours, 10 minutes
- Study time: 10 hours, 50 minutes
- Further insights: <https://embedded-academy.com/en/courses/ev-charging/>

11) Information Security

- Language: English, German



- Course objective: The aim of this course is to provide an overview of information security so that its interrelationships and importance become clear.
- Course content: The course is divided into two topics. First, important terms of **information security** are defined and the underlying goals are explained. Furthermore, it is clarified who is affected by information security and what it is needed for.
In the second e-learning unit, the **practical implementation of information security** is explained. Here, risks and threats are presented and explained using examples. Afterwards, the **information security management system** is defined and its functioning is explained. The introduction of this system is, among other things, the task of the information security officer. Finally, direct measures are explained on the basis of the 14 reference measure objectives, using ISO 27001 as a source.
- Duration: 1 hour
- Study time: 5 hours
- Further insights: <https://embedded-academy.com/en/courses/information-security-en/>

12) Cryptography

- Language: English, German
- Course objective: The aim of this course is to understand the various encryption methods, how they are used, and which mechanisms are most useful for which application during implementation.
- Course content: The course on cryptography is divided into two parts.
First, the focus is on **classical cryptography**, presented in three e-learnings. We begin with a general introduction to the topic, which is followed by a historical overview. Thereby, we will encounter the most famous classical encryption methods: the Scytale, the Caesar Cipher, the Vigenère Cipher, the One-Time Pad and the Enigma.
The second part then moves on from this historical encryption to **modern methods**, also divided into three e-learnings. Here, using the example of Alice and Bob, A to B encryption from the sender (A) to receiver (B) is explained for the three basic types (symmetric, asymmetric, and hybrid) and further illuminated using concrete methods such as the DES, AES, RSA and the Diffie-Hellman Key Exchange.
- Duration: 4 hours
- Study time: 20 hours
- Further insights: <https://embedded-academy.com/en/courses/cryptography/>