



# TRINE CENTER FOR TECHNICAL TRAINING



## C-201 - Electrical Systems I

### Skill Standards

#### Abstract

Defines the knowledge, skills, and abilities required to succeed in positions (e.g. controls engineer or maintenance technician) that install, troubleshoot, program, and maintain factory automation in a modern environment that uses Industry 4.0 technologies.

Version 1.3

# Introduction to SACA

The Smart Automation Certification Alliance (SACA) is a non-profit foundation whose mission is to develop and deploy modular Industry 4.0 certifications for a wide range of industries. The vision is to provide highly affordable, accessible certifications that significantly increase the number of individuals who possess the skills represented by these credentials, thereby ensuring that companies have the highly skilled workers they need, and individuals are prepared to be successful in a “connected enterprise” world.

## Industry-Driven Quality

SACA certifications are industry-driven, developed by industry for industry. They use a rigorous process that starts with the development of truly international skill standards, developed and endorsed by leading experts in Industry 4.0 technology throughout the world. Certifications examinations are created based on these standards, pilot-tested and statistically analyzed to ensure quality. Each certification includes a proctored hands-on evaluation (Gold) and an online, multiple choice test (Silver) to confirm that candidates have a knowledgeable foundation for certification success. SACA uses an annual standards and examination review process for all certifications to ensure that the certifications continue to remain highly up-to-date.

## Certifying Individuals

Individuals can receive certifications through Trine University, an authorized SACA certification center. SACA ensures any certification center maintains high standards with proctored exams, certified evaluators, and approved equipment for consistent hands-on evaluation.

## Certification Structure

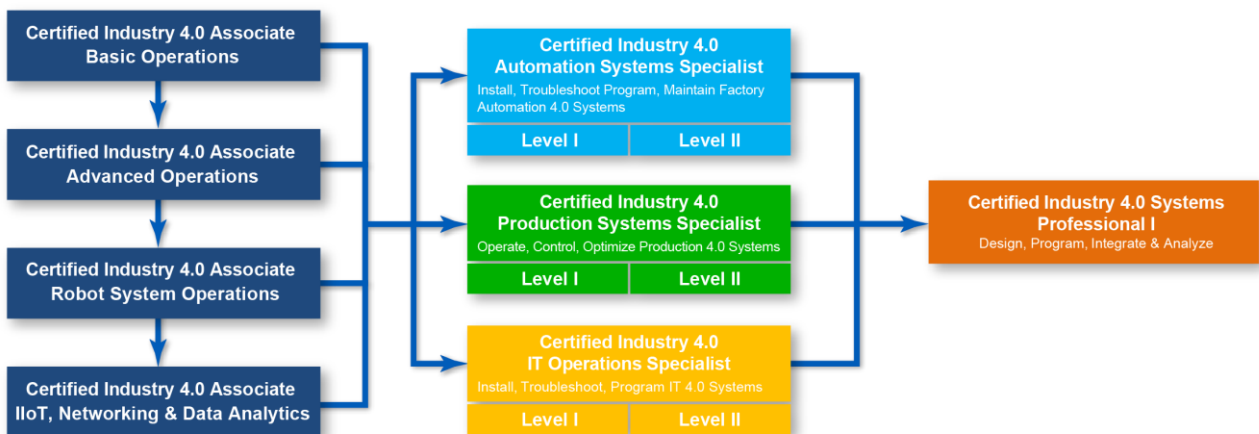
SACA certifications use a modular structure to enable them to fit into wide range of individual needs and industries and educational environments. The three SACA certification categories include:

- Associate
- Specialist
- Professional

## SACA Certification Structure

Each certification is stackable. Individuals can start with one certification and add other certifications to customize their documented skills. Certifications are occupationally focused so they prepare individuals for specific occupations.

# Industry 4.0 Systems Occupational Certifications



## Associate Certifications

The Associate certifications include the following four (4) credentials:

- C-101 Certified Industry 4.0 Associate-Basic Operations
- C-102 Certified Industry 4.0 Associate-Advanced Operations
- C-103 Certified Industry 4.0 Associate-Robot System Operations
- C-104 Certified Industry 4.0 Associate-IIoT, Networking and Data Analytics

The Associate certifications are introductory certifications for those individuals working in an Industry 4.0 environment. These certifications are ideal for production technicians, IT professionals, and industrial maintenance technicians seeking to acquire Industry 4.0 skills.

## Specialist Certifications

Specialist certifications are modular certifications, consisting of a series of core and elective micro-credentials, each with its own hands-on practical assessment and a written (online) knowledge assessment. Core micro-credentials certify skills that are applicable to all companies, while elective micro-credentials can be added to match with regional or specific company needs.

- Automation Systems Specialist
- IT Systems Specialist
- Operations Specialist
- Electrical Systems Specialist
- Control Systems Specialist
- Robotics Specialist
- Network Systems Specialist
- Instrumentation Specialist
- Mechanical Systems Specialist
- Electro-Fluid Power Systems Specialist

## Certified Industry 4.0 Electrical Systems Specialist

SACA's Certified Industry 4.0 Electrical Systems Specialist certification prepares individuals to succeed as an industrial electrician in modern production environments that use Industry 4.0 technologies. In this role, individuals will install, troubleshoot, repair, and maintain industrial electrical circuits and electric motor systems.

### **Core Micro-Credentials:**

C-101 Associate-Basic Operations

C-201 Electrical Systems 1

C-202 Electric Motor Control Systems 1

C-204 Motor Control Troubleshooting 1

C-206 Electrical System Installation 1



## Certified Industry 4.0 Automation Systems Specialist

SACA's Certified Industry 4.0 Automation Systems Specialist certification prepares individuals to succeed in multi-skill maintenance technician positions in modern production environments that use Industry 4.0 technologies. This certification also features a variety of elective micro-credentials that are ideal for individuals seeking to become versed in Industry 4.0 automation or those pursuing SACA Professional Certification.

### Core Micro-Credentials:

C-101 Associate-Basic Operations  
C-201 Electrical Systems 1  
C-202 Electric Motor Control Systems 1  
C-203 Variable Frequency Drive Systems 1  
C-204 Motor Control Troubleshooting 1  
C-205 Sensor Logic Systems 1 (\*)  
C-206 Electrical System Installation 1  
C-207 Programmable Controller Systems 1 (\*\*)  
C-208 Programmable Controller Troubleshooting 1  
C-209 Pneumatic Systems 1  
C-210 Mechanical Power Systems I  
C-211 Industry 4.0 Total Productive Maintenance Management  
C-212 Ethernet Communications 1  
C-213 Smart Sensor and Identification Sys. 1  
C-214 Smart Factory Systems 1  
C-215 Robot System Operations 1 (\*\*\*)  
C-216 Robot Systems Integration 1

### Elective Micro-Credentials:

C-255 Hydraulic Systems 1  
C-256 Hydraulic Maintenance  
C-257 Process Control Systems 1  
C-258 Process Control Troubleshooting 1  
C-259 Rigging Systems 1  
C-260 Rigging Systems 2

(\*) - or SACA C101 Associate-Basic Operations and C-102 Associate-Advanced Operations Certifications

(\*\*) - or SACA C-102 Associate-Advanced Operations and C-104 Associate-IIoT and Data Analytics Certifications

(\*\*\*) - or SACA C-103 Associate-Robot Systems Certification

## Professional Certifications

SACA's Certified Industry 4.0 Professional certification is an engineering certification that focuses on analysis, design, and optimization of Industry 4.0 systems. It prepares engineers to succeed in positions in modern production environments that use Industry 4.0 technologies. The Certified Industry 4.0 Professional certification is designed in a modular format.

- Robot Systems Applications Design 1
- Smart Factory Systems Optimization 1
- Smart Factory Systems Optimization 2
- Smart Factory Systems Architecture Design 1
- Manufacturing Execution Systems 2
- Flexible Manufacturing Systems Optimization
- Process Simulation and Design 1





# SILVER & GOLD CERTIFICATIONS



All SACA Certifications can be attained on two levels: Silver and Gold.



SACA Silver Certifications are awarded to candidates who successfully pass the written knowledge exam delivered online through the SACA testing portal. Silver Certifications are ideal for individuals seeking to validate online core achievement or when hands-on testing is not available.



SACA Gold Certifications are awarded to candidates that successfully pass the written knowledge exam and successfully complete a hands-on performance assessment on SACA-approved equipment. Gold Certifications are ideal for individuals seeking to show they possess job-ready, hands-on Industry 4.0 skills.





## C-201 Electrical Systems 1

### E-Learning Content

1. Basic Electrical Circuits
2. Electrical Measurements
3. Circuit Analysis
4. Inductance and Capacitance
5. Combination Circuits
6. Transformers
7. SACA Test / Study Guide

Prepares individuals to connect, adjust, operate, troubleshoot, and analyze electrical circuits using basic electrical components: resistors, capacitors, inductors, DC motors, solenoids, manual switches, relays, fuses, circuit breakers, transformers, and indicators. Other key skills include: adhering to electrical safety rules, reading electrical circuit diagrams, applying Ohm's Law and Kirchoff's Law, using digital multimeters, interpreting series/parallel circuits, and assessing power/circuit protection.

### 990-ACDC1 Technical Trainer for Gold Certification



Amatrol's Portable AC/DC Electrical Learning System (990-ACDC1) teaches the fundamentals of AC and DC electrical systems used for power and control in industrial, commercial, agricultural, and residential applications. The 990-ACDC1 offers industry-relevant skills including how to operate, install, design, and troubleshoot basic AC and DC electrical circuits for various applications. The 990-ACDC1 includes a variety of switches and other components so learners can build different circuits, which will help them to recognize industrial component styles and learn how to troubleshoot them effectively.

## SACA FAQ's

### ***Who and What is SACA?***

[Smart Automation and Certification Alliance](#) is a third-party certification body whose purpose is to validate technical knowledge and ability and prepare the next generation of skilled workers.

Each SACA certification is stackable, allowing individuals to start with one certification and add other certifications to customize their documented skills. Certifications are occupationally focused so they prepare individuals for specific occupations in the world of Industry 4.0.

### ***How will SACA contribute to Student Success in the Workforce?***

SACA credentials provide students industry driven competencies in an applied learning (hands on lab) format. These skills translate directly to jobs that are in high demand, great paying, and leading to exciting lifelong career paths.

### ***What's the difference between Silver and Gold SACA certifications?***

Silver is a theory only, multiple choice, proctored exam. Exams are 1 - 2 hour in length and varies from 40 to 100 questions depending on the subject.

Gold is a combination of theory in addition to hands on skills. This is the lab portion of the certification and vastly ranges from 15 minutes to 4 hours till completion depending on the subject.

### ***Are Instructors required to be SACA certified?***

Yes! Instructors must earn the SACA certification for the courses they teach to be credentialed.

### ***How do Instructors earn SACA Silver certifications?***

Instructors can take the theory exam before or at the same time as the exam is being taken with the students. Trine University will help you with this process.

### ***How do Instructors earn SACA Gold certifications?***

Instructors will work with Trine University to complete and validate the hands-on skills required.

### ***What resources are students allowed to use while taking the certification exams?***

Formulas are available within the testing environment as well as a calculator, and blank piece of paper.

Note: All resources are pending SACA approval and may be modified.



***How long do students or instructors wait before re-attempting a failed attempt?***

Re-attempts can be proctored again after 24 hours.

***Is Trine University an Authorized Certification Assessment Center for SACA?***

Yes! Trine University partnered with SACA in 2021 and Trine University has several Amatrol Industrial trainers that are SACA Gold certification approved.

***What do Employers have to say about SACA?***

*“Technology disruption is widening the gap between student learning and industry relevance of learning. At the same time, it is also shortening the shelf life of degrees and opening up variable pathways of learning. To narrow this gap, we are actively participating with the Smart Automation Certification Alliance and other industry stakeholders working alongside education to create relevant standards around Industry 4.0 and more importantly access to relevant stackable learning.”*

**- Michael Cook, Director Global Academic Partnerships, Rockwell Automation**

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## C-201 Electrical Systems 1 Skill Standards

- **Electrical Safety**

- Can you define and test a ground?
- Can you state the ten rules of electrical safety?
- Do you know the purpose of a lockout / tag out?

- **Basic Electrical Circuits**

- Can you state the two types of electrical current?
- Do you know how to use a circuit tester?
- Can you explain the functions of the four basic components of an electrical circuit?
- Can you name the two types of power supplies and their schematic symbols?
- Can you interpret an electrical schematic, which uses symbols?
- Do you know the schematic symbols for basic components?
- Can you describe three types of manual switch operators?
- Can you explain the functions of five types of electrical output devices?
- Can you interpret the function and states of a basic electrical circuit?

- **Electrical Measurements**

- Can you define voltage and state its units of measurement?
- Do you know how to use a voltmeter, analog and digital?
- Can you explain the voltage characteristics of series and parallel circuits?
- Can you define current and state its units of measurement?
- Can you use an ammeter, analog and digital?
- Can you explain the current characteristics in series and parallel circuits?
- Do you know how to use an ohmmeter, analog and digital?
- Can you explain resistance characteristics in series and parallel circuits?
- Can you explain how to measure continuity?
- Can you interpret the metric prefixes used on DMM,  $M\Omega$ ,  $K\Omega$ , mA,  $\mu A$ ?
- Do you know how to use a digital multimeter (DMM)?
- Can you define basic electrical units of measurement?



- **Circuit Analysis**

- Can you calculate series and parallel resistance?
- Do you know how to use Ohm's Law to solve for voltage, current and resistance in a circuit?
- Can you state Kirchhoff's Voltage Law for series and parallel circuits?
- Can you calculate series and parallel voltage given the resistors and supply voltage in a circuit?
- Can you define power and state its units of measurement?
- Can you calculate the total power given the resistors and supply voltage in a circuit?
- Can you mathematically use Kirchhoff's current law?
- Can you calculate series and parallel current?
- Do you know how to test and replace two types of circuit protection?
- Can you identify two types of circuit breakers and explain how to reset them?
- Can you interpret electrical schematics and wiring diagrams and symbols?

- **Inductance and Capacitance**

- Can you explain how electromagnetism works?
- Can you define inductance and state its unit of measurement?
- Can you state the effect of an inductor in a DC circuit and an AC circuit?
- Can you calculate total inductance and inductive reactance for series and parallel circuits?
- Do you know how to calculate the total load on an AC circuit with inductors?
- Can you define capacitance and give its units of measurement?
- Can you name three types of capacitors?
- Do you know how to safely discharge a capacitor?
- Do you know how to test a capacitor with a DMM?
- Can you state the effect of a capacitor in a DC circuit vs. an AC circuit?
- Can you calculate total capacitance and capacitive reactance for series and parallel circuits?
- Do you know how to calculate the total load on an AC circuit with capacitors?
- Can you calculate the time to charge and discharge a capacitor?
- Can you state the functions of capacitors and inductors in an electric power supply?
- Can you interpret reactive symbols?



- **Combination Circuits**

- Can you interpret series-parallel circuits?
- Do you know how to solve a combination circuit?
- Can you explain the operation of variable resistors?
- Do you know how to interpret a voltage divider network?
- Can you state and apply the four steps for troubleshooting a short circuit?
- Can you state and apply the three basic steps for troubleshooting an open circuit?

- **Transformers**

- Can you explain the operation of a transformer?
- Do you know how to calculate the output voltage of a transformer?
- Do you know how to troubleshoot a transformer with a DMM?
- Can you size a transformer given the voltage and load of the circuit?
- Can you know how to calculate transformer power loss?
- Do you know how to calculate the current load?
- Can you state two basic categories of transformers?
- Do you know how to design a control transformer circuit to provide a given output voltage?
- Can you explain the function of a tap on the secondary of a transformer?

