



# TRINE CENTER FOR TECHNICAL TRAINING



## C-206 Electrical System Installation 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:

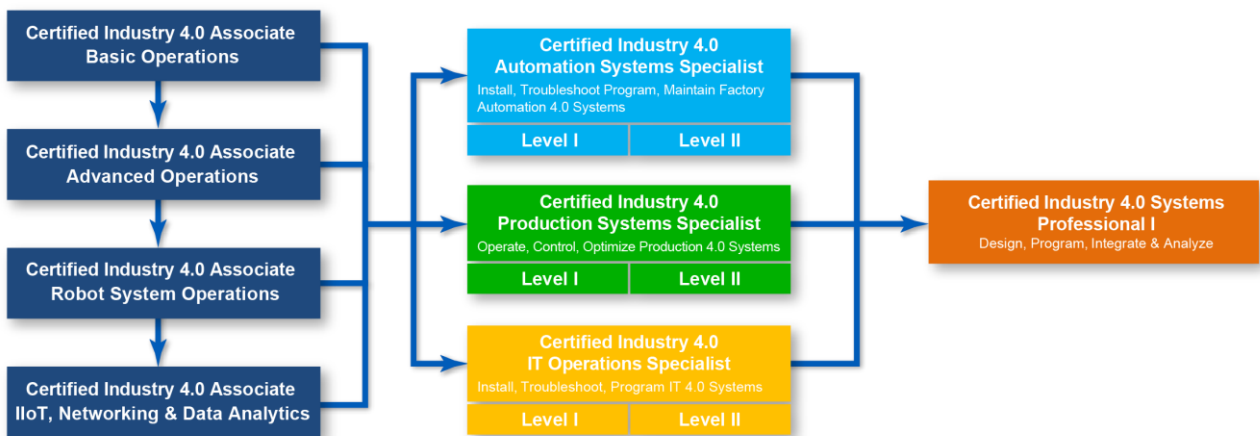
- Associate
- Specialist
- Professional



## 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-206 Electrical System Installation I

### E-Learning Content

1. Introduction to Electrical Control Wiring
2. Panel Wiring Fundamentals
3. Grounding Control Systems
4. Connecting Wires in Panels
5. Wiring a Motor
6. Electro-Pneumatic Valves
7. Electro-Pneumatic System Installation
8. SACA Test / Study Guide

Prepares individuals to install and test/commission electrical motor control circuits using these electrical components: control cabinet enclosures, 3-phase AC motors, reversing magnetic motor starters with overloads, control relays, timer relays, pushbutton switches, selector switches, limit switches, pressure switches, indicators, electro-pneumatic solenoid valves, safety disconnect switches, and circuit protection. Key skills include: adhering to motor control installation safety rules, using proper PPE, reading electrical wiring installation diagrams, sizing circuit protection, installing components on DIN rails and cabinet panels, installing and testing ground systems, wiring motors for high and low voltage, selecting and preparing wire for installation, attaching of wire to terminal strips and components/motors, and routing of wire with raceways/conduits

### 850-MT6B Technical Trainer for Gold Certification



Amatrol's Electrical Wiring Learning System (850-MT6B) allows learners to study and practice electrical wiring skills: installing control wiring in an electrical panel; installing wiring into limit switches, solenoids, and pressure switches; and understanding the importance of correct wire size, material, and insulation. The 850-MT6B is an invaluable industrial wiring technician training system for careers like electricians and industrial maintenance technicians that wire control panels and operator panels on manufacturing machines. The 850-MT6B includes real-world components such as a 3-phase motor, pushbuttons, switches, valves, and a 24VDC power supply all mounted on a mobile workstation.

## 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**

**Trine University Contact**

**Jason Blume**

Executive Director – Innovation One

260.665.4265 Office

260.417.4454 Mobile

[blumej@trine.edu](mailto:blumej@trine.edu)

**Jacob Bradshaw**

Technical Automation Instructor – TCTT

260.665.4313 Office

260.571.2020 Mobile

[jbradshaw19@trine.edu](mailto:jbradshaw19@trine.edu)

## C-206 Electrical System Installation I Skill Standards

- **Introduction to Electrical Control Wiring**
  - Can you describe the function of an electrical print?
  - Can you explain the cross-reference symbols and notes on an electrical print?
  - Do you know how to interpret an electrical print?
  - Can you describe the function of an electrical panel?
  - Can you explain how to arrange panel wiring to terminal blocks?
  - Do you know how to size and install electrical terminal blocks?
- **Panel Wiring Fundamentals**
  - Can you determine the number of wires to run between panels?
  - Do you know how to determine wire colors for control panel wiring?
  - Can you explain how to size overcurrent protection devices?
  - Do you know how to install and test circuit protection devices?
  - Can you size a safety disconnect switch?
- **Grounding Control Systems**
  - Can you explain the NEC grounding requirements for electrical systems?
  - Can you describe how to install an electrical grounding circuit?
  - Do you know how to inspect and verify an electrical grounding circuit?
- **Connecting Wires in Panels**
  - Can you describe the function of panel wire-ways?
  - Do you know how to terminate panel wires?
  - Can you explain two methods used to identify wires connecting two panels?
- **Wiring a Motor**
  - Do you know three common methods of wire bundling?
  - Can you explain how to secure wire bundles in an electrical panel?
  - Can you describe how to connect a motor to a control panel?
- **Electro-Pneumatic Valves**
  - Do you know how to adjust a pressure regulator?
  - Can you explain the operation of a 5-port, 3-position pneumatic DCV?
- **Electro-Pneumatic System Installation**
  - Can you interpret a pneumatic schematic diagram?
  - Can you describe how to connect pneumatic system control wiring?
  - Do you know how to adjust pneumatic actuator speed?

