



# TRINE CENTER FOR TECHNICAL TRAINING



## C-101 Certified Industry 4.0 Associate-Basic Operations

### 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:

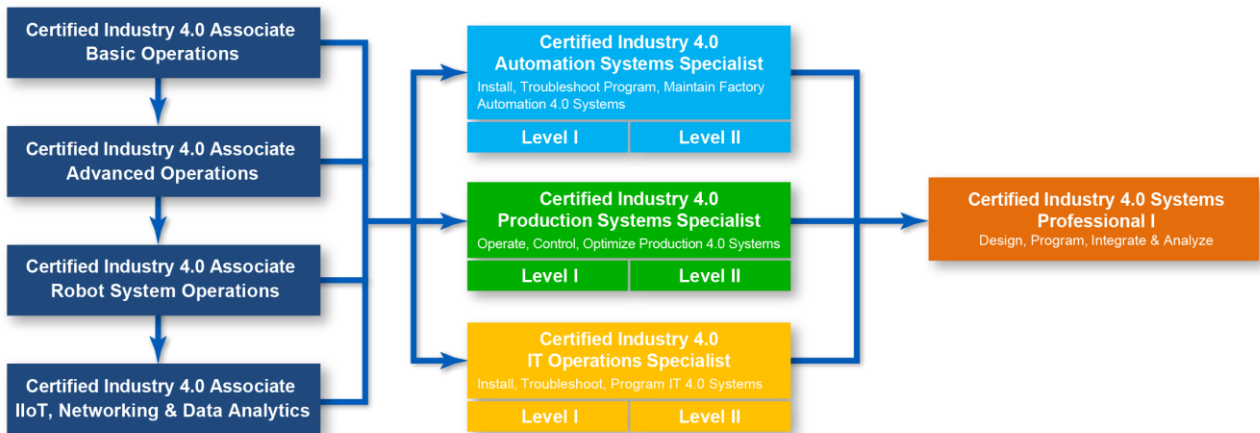
- Associate
- Specialist
- Professional



## 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-101 Certified Industry 4.0 Associate-Basic

### E-Learning Content

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| <ol style="list-style-type: none"><li>1. Introduction to Advanced Manufacturing</li><li>2. Technology and Advanced Manufacturing</li><li>3. Industrial Internet of Things</li><li>4. Safety Responsibilities</li><li>5. Machine Safety</li><li>6. Practicing Safety in the Workplace</li><li>7. Emergency and Accident Response</li><li>8. Hazardous Materials Standards</li><li>9. Hazardous Material Handling and Storage</li><li>10. Fire and Electrical Safety</li><li>11. Work Area Safety</li><li>12. Types of PPE</li><li>13. Equipment Safety</li><li>14. Material Handling Safety</li><li>15. Hand Tools 1</li><li>16. Dimensional Measurement</li><li>17. Measurement Conversion</li><li>18. Introduction to Print Reading</li><li>19. Multiview Drawings</li><li>20. Blueprint Dimensions and Notes</li></ol> | <ol style="list-style-type: none"><li>21. Tolerancing</li><li>22. Manufacturing Drawings and Scales</li><li>23. Caliper Measurement</li><li>24. Micrometer Measurement</li><li>25. Mechanical Power</li><li>26. Introduction to Fluid Power</li><li>27. Pneumatic Power</li><li>28. Basic Cylinder Circuits</li><li>29. Basic Electrical Circuits</li><li>30. Electrical Voltage and Current Measurement</li><li>31. Electrical Resistance Measurement</li><li>32. Power in Electrical Circuits</li><li>33. Control Logic Circuits</li><li>34. Electrical Control Diagrams</li><li>35. Relay Control Circuits</li><li>36. Basic Robot Operation</li><li>37. Basic Robot Programming</li><li>38. Introduction to Electronic Sensors</li><li>39. Lean Production Concepts</li><li>40. SACA TEST STUDY GUIDE - CERTIFIED INDUSTRY 4.0 ASSOCIATE I</li></ol> |
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### Skill Boss Technical Trainer for Gold Certification



Amatrol's Skill Boss Manufacturing (95-MSB1 / 95-MSB2AB) offers organizations performance-based assessment for evaluating the skill levels and competencies of future machine operators. This system fits onto a standard tabletop and features an electric motor, variable frequency drive, human-machine interface, pneumatic pick-and-place module, and much more! When setup, this system will quality test and sort blocks made from plastic and metal. Skill Boss Manufacturing was designed to assess the hands-on skills needed by today's modern manufacturing production areas including assembly & machine operation.

## 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-101 Associate-Basic Operations Skill Standards

- **Introduction to Advanced Manufacturing**
  - Can you give three examples of advanced manufacturing tools and techniques?
  - Do you know the role of product design in Advanced Manufacturing?
- **Technology and Advanced Manufacturing**
  - Can you name three impacts of computers on Advanced Manufacturing besides automation?
  - Can you name three benefits of factory automation?
  - Can you describe how a CNC machine works?
  - Do you know the difference between an additive and a subtractive manufacturing process?
  - Can you name two types of robots?
  - Do you know the function of a PLC?
  - Besides alarm screens and error messages, do you know what else an HMI is used for?
  - Can you name some Software and New Emerging Technologies in Advanced Manufacturing?
- **Industrial Internet of Things**
  - Do you know the four industrial revolutions and the cause and benefits of each?
  - Can you name some components and applications of Industrial Internet of Things (IIoT)?
- **Safety Responsibilities**
  - Do you know the importance of safety policies?
  - Do you know the results of unsafe behavior?
  - Can you name four federal and state safety agencies?
  - Can you state the safety responsibilities within a company?
- **Machine Safety**
  - What are the clothing safety guidelines for machine operators?
  - What happens if someone doesn't follow machine operation safety guidelines?
  - Can you name three types of machine guards and state what to do if one is missing?
  - Do you know how machine interlocks and emergency stop controls effect an operation?
  - Do you know how to perform an electrical lockout/tagout?



- **Practicing Safety in the Workplace**
  - Can you state common types of injuries and accidents?
  - Do you know seven types of PPE?
  - Can you identify 11 types of hazards in the workplace?
- **Emergency and Accident Response**
  - Can you state the elements of an emergency action plan?
  - Do you know how to respond to an emergency?
  - Do you know how to respond to a workplace accident?
  - Do you know when and how to use an eyewash station?
  - Do you know when and how to report a workplace accident?
- **Hazardous Materials Standards**
  - Do you know the GHS and HCS communication standards?
  - Can you interpret the HazCom labeling and other hazardous material identification systems?
  - Can you state what a Safety Data Sheet does?
- **Hazardous Material Handling and Storage**
  - Do you know the guidelines for handling, storing and shipping hazardous materials?
  - Do you know the DOT Hazardous Material Identification System?
- **Fire and Electrical Safety**
  - Do you know the elements of a fire?
  - Do you know four types of fires and how to select a fire extinguisher for each type?
  - Do you know how to use a fire extinguisher?
  - Can you state the electrical safety guidelines?
- **Work Area Safety**
  - Do you know How to Maintain a Safe Work Station?
- **Types of PPE**
  - Can you state the types of head, eye, ear, hand and arm, foot, respiratory, and body PPE and their features and uses?
- **Equipment Safety**
  - Can you state the hand tool and the portable power tool safety guidelines?
- **Material Handling Safety**
  - Can you state the basic safety rules for forklift use?



- **Hand Tools 1**
  - Can you state the basic types of fasteners?
  - Do you know how parts are assembled using threaded fasteners?
  - Do you know how and when to use a wrench (combination, socket, backup, and hex key)?
  - Do you know how and when to use a screwdriver (straight-slotted and Phillips head)?
  
- **Dimensional Measurement**
  - Do you know how to use an SI machinist rule?
  - Do you know the importance of measurement accuracy, resolution and precision?
  - Can you correctly measure a length?
  
- **Measurement Conversion**
  - Can you convert from decimal US customary units to SI units and vice versa?
  - Can you convert measurements made in common fractions to decimal inches?
  
- **Introduction to Print Reading**
  - Do you know the alphabet of lines?
  - Can you interpret three drawing line types: object, hidden, and center?
  - Can you state the function of line precedence?
  
- **Multiview Drawings**
  - Can you interpret a third angle projection multiview drawing?
  - Can you interpret a first angle projection multiview drawing?
  - Do you know how to determine if a multiview drawing uses first or third angle projection?
  
- **Blueprint Dimensions and Notes**
  - Do you know how to dimension linear and circular features?
  - Do you know how to interpret hole and angular features?
  
- **Tolerancing**
  - Can you define tolerance and explain its importance?
  - Can you interpret a conventional tolerance and a tolerance note?
  - Can you name the measuring reference point of baseline dimensioning?
  - Can you define maximum and minimum material conditions?
  - Can you name and explain three types of fits?
  - Can you state five types of geometric features?
  - Can you interpret A datum and a datum feature?
  - Can you interpret the blocks in a feature control frame?



- **Manufacturing Drawings and Scales**
  - Do you know how to interpret a drawing scale?
  - Can you interpret print notes, a title block, and a change block?
  - Can you interpret a materials block, and a tolerance block?
  - Can you interpret a process drawing and an assembly drawing?
  
- **Caliper Measurement**
  - Do you know the basic operation of a dial caliper?
  - Can you calibrate a dial caliper?
  - Do you know how to use a dial caliper?
  - Do you know what determines the resolution of a dial caliper measurement?
  
- **Micrometer Measurement**
  - Do you know the basic operation of a micrometer?
  - Can you read a micrometer with SI units?
  - Do you know how to test micrometer calibration?
  - Can you use an outside micrometer with SI units?
  
- **Mechanical Power**
  - Can you calculate mechanical power and its units of measurement?
  - Do you know two types of stored mechanical energy?
  - Can you measure forces and weights?
  
- **Introduction to Fluid Power**
  - Do you know the basic components of a hydraulic system?
  - Do you know the basic components of a pneumatic system?
  - Can you state three types of lubricants?
  - Can you define pressure and its units of measurement?
  - Can you calculate pressure, SI and US customary?
  - Do you know how to read a pressure gauge?
  
- **Pneumatic Power**
  - Can you state the pneumatic safety rules?
  - Can you connect and adjust a pressure regulator?
  
- **Basic Cylinder Circuits**
  - Can you explain the operation of a double-acting pneumatic cylinder?
  - Can you explain the operation of a 5-port, 3-position directional control valve?
  - Do you know the schematic symbols of basic pneumatic components?
  - Can you read and interpret a pneumatic schematic?



- **Basic Electrical Circuits**
  - Can you explain the operation of a basic electrical circuit?
  - Can you interpret a basic electrical schematic?
- **Electrical Voltage and Current Measurement**
  - Can you state Kirchhoff's circuit Laws?
  - Do you know the basic characteristics of series and parallel circuits?
  - Do you know two types of ammeters?
  - Can you use a DMM to measure current and voltage?
  - Can you interpret schematic symbols?
- **Electrical Resistance Measurement**
  - Do you know the resistance characteristics in series and parallel circuits?
  - Can you use Ohm's Law to analyze a circuit?
  - Can you define continuity and state its importance?
  - Can you use a DMM to measure continuity and resistance?
- **Power in Electrical Circuits**
  - Do you know electrical power and its units of measurement?
  - Can you calculate the power in a simple circuit?
  - Do you know The operation of a fuse and circuit breaker and how to replace or reset them?
- **Control Logic Circuits**
  - Do you know six elements of control logic?
  - Can you interpret a schematic of AND, OR, NAND, NOR, and Not Logic?
  - Can you explain the operation of MEMORY logic?
- **Electrical Control Diagrams**
  - Can you read and interpret a basic ladder diagram?
  - Can you read and interpret a power diagram?
  - Can you read and interpret a HOA control circuit in a ladder diagram?
- **Relay Control Circuits**
  - Can you read and interpret ladder diagram detached symbology?
  - Can you interpret the operation of a relay performing control logic?
  - Can you interpret the operation of a seal-in circuit?



- **Basic Robot Operation**
  - Do you know four types of robot classifications?
  - Can you identify five types of servo robots?
  - Do you know the basic operation of a servo robot?
  - Do you know the robot safety rules?
  - Can you power up and power down a servo robot?
  - Can you use a teach pendant to jog a servo robot?
  
- **Basic Robot Programming**
  - Can you transfer robot program files between a PC and robot controller?
  - Do you know how to run a robot program?
  
- **Introduction to Electronic Sensors**
  - Can you explain the operation of two types of transistors used in electronic sensors?
  - Can you state the five characteristics that affect inductive proximity sensor operation?
  - Can you state the five characteristics that affect capacitive proximity sensor operation?
  
- **Lean Production Concepts**
  - Can you differentiate value added and non-value-added activities?
  - Do you know what each S in 5S stands for?
  - Can you describe the eight deadly wastes?
  - Can you explain line balancing?

