

Control Software Engineer

Alternate Titles: Automation Engineer, Manufacturing Automation Engineer, Process Automation Engineer, Integration Engineer, SCADA Engineer, Application Engineer, Software Engineer, Batch Control Engineer, Systems Analyst

Description: Control Software Engineers analyze user requirements, procedures, and problems to develop automation systems control configuration. They develop the functional specifications, coding strategy, logic, and control configuration structure. They develop and direct software system testing and validation procedures, and oversee all configuration and documentation.

Sources of Material: Certified Automation Professional Body of Knowledge, Automation Competency Model, Control Systems Engineer (CSE) Examination Specification.

Performance Domains:

Domain I: Software System Design

Domain II: Development

Domain III: Installation and Testing

Domain I: Software System Design - the conceptual design of the software to be used in control and information systems.	
Task 1: Establish standards, templates, and guidelines as applied to the automation system using the information gathered in the definition stage and considering human-factor effects in order to satisfy customer design criteria and preferences.	
Knowledge of:	Process Industry Practices (PIP) (Construction Industry Institute) Programming Languages <ul style="list-style-type: none"> ▪ C/C++ ▪ G-Code (CNC) ▪ Visual Basic ▪ IEC - 61131 <ul style="list-style-type: none"> ▪ Instruction List ▪ Ladder Diagram ▪ Function block ▪ Structured Text ▪ Sequential Function Chart ▪ Electronic Device Description Language (EDDL) ▪ Vendor standard programming and configuration software. Customer standards Vendor standards

	<p>Template development methodology</p> <p>Measurement and control element devices</p> <p>Applicable standards (e.g., ISA S5, S88)</p>
Skill in:	<p>Developing programming standards</p> <p>Selecting and sizing instrument equipment</p> <p>Designing low-voltage electrical systems</p> <p>Preparing drawing using AutoCAD software</p>
Task 2: Define the data structure layout and data flow model considering the volume and type of data involved in order to provide specifications for hardware selection and software development.	
Knowledge of:	<p>Data requirements of system to be automated</p> <p>Data structures of control systems</p> <p>Data flow of controls systems</p> <p>Productivity tools and software (e.g., InTools, AutoCAD)</p> <p>Entity relationship diagrams</p>
Skill in:	<p>Modeling data</p> <p>Tuning and normalizing databases</p>
Task 3: Select the physical communication media, network architecture, and protocols based on data requirements in order to complete system design and support system development.	
Knowledge of:	<p>Industrial Digital Field Protocols (including but not limited to)</p> <ul style="list-style-type: none"> ▪ AS-i ▪ DeviceNet ▪ Foundation Fieldbus ▪ HART ▪ INTERBUS ▪ Modbus ▪ PROFIBUS DP & PA <p>Vendor protocols</p> <p>Ethernet/IP and other open industrial networks</p> <p>Physical requirements for networks/media</p> <p>Physical topology rules/limitations</p> <p>Network design</p> <p>Security requirements</p> <p>Data storage and archive practices</p>
Skill in:	<p>Designing system communications based on chosen networks and communication protocols</p>
Task 4: Develop a functional description of the automation solution (e.g., control scheme, alarms, HMI, reports) using rules established in the definition stage in order to guide development and programming.	
Knowledge of:	<p>Control theory</p> <ul style="list-style-type: none"> ▪ Basic processes (e.g., compression, combustion, distillation, hydraulics, etc.)

	<ul style="list-style-type: none"> ▪ Process dynamics (e.g., loop response, P-V-T relationships, simulations, etc.) ▪ Basic control (e.g., regulatory control, feedback, feed forward, cascade, ratio, PID, split-range, etc.) ▪ Discrete control (e.g., relay logic, Boolean algebra) ▪ Sequential control (e.g., batch) <p>Visualization, alarming, database/reporting techniques Documentation standards Vendors' capabilities for their hardware and software products General control strategies used within the industry Process/equipment to be automated Operating philosophy</p>
Skill in:	<p>Writing functional descriptions Interpreting design specifications and user requirements Communicating the functional description to stakeholders</p>
Task 5: Design the test plan using chosen methodologies in order to execute appropriate testing relative to functional requirements.	
Knowledge of:	<p>Relevant test standards Simulation tools Process Industry Practices (PIP) (Construction Industry Institute) General software testing procedures Functional description of the system/equipment to be automated</p>
Skill in:	<p>Writing test plans Developing tests that validate that the system works as specified</p>
Task 6: Perform the detailed design for the project by converting the engineering and system design into purchase requisitions, drawings, panel designs, and installation details consistent with the specification and functional descriptions in order to provide detailed information for development and deployment.	
Knowledge of:	<p>Field devices, control devices, visualization devices, computers, and networks Installation standards and recommended practices Electrical and wiring practices Specific customer preferences Functional requirements of the system/equipment to be automated Applicable construction codes Documentation standards</p>
Skill in:	<p>Performing detailed design work Documenting the design</p>
Domain II: Development - software development and coding.	
Task 1: Develop Human Machine Interface (HMI) in accordance with the design documents in order to meet the functional requirements.	
Knowledge of:	<p>Specific HMI software products Tag definition schemes</p>

	Programming structure techniques Network communications Alarming schemes Report configurations Presentation techniques Database fundamentals Computer operating systems Human/ergonomic factors HMI supplier options Human-Machine Interface Standards (e.g., ISA-SP77.60) Human-Machine Interfaces (e.g., ISA101)
Skill in:	Presenting data in a logical and aesthetic fashion Creating intuitive navigation menus Implementing connections to remote devices Documenting configuration and programming Programming configurations
Task 2: Develop database and reporting functions in accordance with the design documents in order to meet the functional requirements.	
Knowledge of:	Data Management <ul style="list-style-type: none"> ▪ Data Documentation ▪ Data Quality Issues ▪ Data Security ▪ Data Storage and Retrieval ▪ Database Operations and Maintenance ▪ Database Software ▪ Database Structure and Types ▪ Special Requirements of Real-Time Process Databases Relational database theory Specific database software products Specific reporting products Programming/scripting structure techniques Network communications Structured Query language Report configurations Entity diagram techniques Computer operating systems Data mapping
Skill in:	Presenting data in a logical and aesthetic fashion Administrating databases Implementing connections to remote applications Writing queries Creating reports and formatting/printing specifications for report output Documenting database configuration

	Designing databases Interpreting functional description
Task 3: Develop control configuration or programming in accordance with the design documents in order to meet the functional requirements.	
Knowledge of:	Specific control software products Tag definition schemes Programming structure techniques Network communications Alarming schemes I/O structure Memory addressing schemes Hardware configuration Computer operating systems Processor capabilities Standard nomenclature (e.g., ISA) Process/equipment to be automated
Skill in:	Interpreting functional description Interpreting control strategies and logic drawings Programming and/or configuration capabilities Implementing connections to remote devices Documenting configuration and programs Interpreting P&IDs Interfacing systems
Task 4: Implement data transfer methodology that maximizes throughput and ensures data integrity using communication protocols and specifications in order to assure efficiency and reliability.	
Knowledge of:	Industrial Communication Protocols (including but not limited to) <ul style="list-style-type: none"> ▪ BACnet ▪ Common Industrial Protocols ▪ ControlNet ▪ Ethernet-TCP/IP ▪ LonWorks ▪ Object-linked Embedding for Process Control (OPC) ▪ PROFINET Specific networking software products (e.g., I/O servers). Network topology Network protocols Physical media specifications (e.g., copper, fiber, RF, IR) Computer operating systems Interfacing and gateways Data mapping
Skill in:	Analyzing throughput Ensuring data integrity

	<p>Troubleshooting</p> <p>Documenting configuration</p> <p>Configuring network products</p> <p>Network Configuration</p> <ul style="list-style-type: none"> ▪ Cable (Wire and Fiber Optic) Networks ▪ Network Component Configuration ▪ Network Diagnostics ▪ Network Management ▪ Wireless Networks <p>Interfacing systems</p> <p>Manipulating data</p>
<p>Task 5: Implement security methodology in accordance with stakeholder requirements in order to mitigate loss and risk.</p>	
Knowledge of:	<p>Basic system/network security techniques</p> <p>Customer security procedures</p> <p>Control user-level access privileges</p> <p>Regulatory expectations (e.g., 29 CFR Part 11)</p> <p>Industry standards (e.g. ISA99, Industrial Automation and Control System Security)</p>
Skill in:	<p>Documenting security configuration</p> <p>Configuring/programming of security system</p> <p>Implementing security features</p>
<p>Task 6: Review configuration and programming using defined practices in order to establish compliance with functional requirements.</p>	
Knowledge of:	<p>Specific control software products</p> <p>Specific HMI software products</p> <p>Specific database software products</p> <p>Specific reporting products</p> <p>Programming structure techniques</p> <p>Network communication</p> <p>Alarming schemes</p> <p>I/O structure</p> <p>Memory addressing schemes</p> <p>Hardware configurations</p> <p>Computer operating systems</p> <p>Defined practices</p> <p>Functional requirements of system/equipment to be automated</p>
Skill in:	<p>Programming and/or configuration capabilities</p> <p>Documenting configuration and programs</p> <p>Reviewing programming/configuration for compliance with design requirements</p>
<p>Task 7: Test the automation system using the test plan in order to determine compliance with functional requirements.</p>	

Knowledge of:	Testing techniques Specific control software products Specific HMI software products Specific database software products Specific reporting products Network communications Alarming schemes I/O structure Memory addressing schemes Hardware configurations Computer operating systems Functional requirements of system/equipment to be automated
Skill in:	Writing test plans Executing test plans Documenting test results Programming and/or configuration capabilities Implementing connections to remote devices Interpreting functional requirements of system/equipment to be automated Interpreting P&IDs
Task 8: Assemble all required documentation and user manuals created during the development process in order to transfer essential knowledge to customers and end users.	
Knowledge of:	General understanding of automation systems Computer operating systems Documentation practices (e.g., ISA-SP5.6, Software Documentation for Control Systems) Operations procedures Functional requirements of system/equipment to be automated
Skill in:	Documenting technical information for non-technical audience Using documentation tools Organizing material for readability
Domain III: Installation and Testing	
Task 1: Install configuration and programs by loading them into the target devices in order to prepare for testing.	
Knowledge of:	Control system (e.g., PLC, DCS, PC) Control Equipment <ul style="list-style-type: none"> ▪ Distributed Control Systems: Hardware and Configuration ▪ Process Automation Controllers: Hardware, Architecture and Communications ▪ Programmable Logic Controllers: Hardware and Configuration ▪ SCADA Systems: Hardware, Architecture, and Communications System administration

Skill in:	Installing software Verifying software installation Versioning techniques and revision control Troubleshooting (i.e., resolving issues and retesting)
Task 2: Test configuration and programming in accordance with the design documents by executing the test plan in order to verify that the system operates as specified.	
Knowledge of:	Programming and configuration Test methodology (e.g., factory acceptance test, site acceptance test, unit-level testing, system-level testing) Test plan for the system/equipment to be automated System to be tested Applicable regulatory requirements relative to testing
Skill in:	Executing test plans Documenting test results Troubleshooting (i.e., resolving issues and retesting) Writing test plans
Task 3: Maintain licenses, updates, and service contracts for software and equipment by reviewing both internal and external options in order to meet expectations for capability and availability.	
Knowledge of:	Installed base of system equipment and software Support agreements Internal and external support resources Lifecycle state and support level (including vendor product plans and future changes)
Skill in:	Organizing and scheduling Programming and configuring Applying software updates (i.e., keys, patches)