2025

BRICS SKILLS COMPETITION

(BRICS+ FUTURE SKILLS & TECH CHALLENGE)

Digital Control Technology

BRICS-FS-51

Technical Description

(International Final)

October, 2025

Content

I. Project Introduction

1.1 Project Description

1.1.1 Name of the Skills Competition

2025 BRICS Skills Competition (BRICS Future Skills and Technology Challenge) - Digital Control Technology. Competition Item Code: BRICS-FS-51.

1.1.2 Description of the Skills Competition

The Digital Control Technology project of the BRICS Skills Competition is based on national vocational standards and enterprise job requirements. It assesses participants' abilities in 3D design, programming, debugging, fault diagnosis, and comprehensive application of digital control systems. Participants are required to complete the mechanism design of the digital control system, the design of the control program, the debugging of the process flow system, the uploading of data to the cloud platform, and the connection with the MES (Manufacturing Execution System) to realize digital control and visual display.

The Digital Control Technology Competition is a professional technical event focusing on the field of modern industrial automation and intellectualization. It aims to promote the application and development of digital control technology through the combination of practice and innovation. With industrial control systems, intelligent algorithms, the Internet of Things (IoT), and data-driven control strategies as the core, the competition provides a platform for college students, researchers, enterprise engineers, and other groups to demonstrate their technical capabilities and exchange innovative ideas. It assesses the participating teams' abilities in analyzing and solving practical problems, innovating, creating, organizing and managing, and coordinating in engineering scenarios.

This competition item adopts the team competition format, where 2 participants in each team collaborate to complete the competition tasks.

1.2 Relevance and Importance of This Document

This document contains the standards required for this skills competition, as well as information on the evaluation principles, methods, and procedures for managing the competition.

Every expert and participant must know and understand this technical specification.

In case of any conflict between the technical specifications in different languages, the English version shall prevail.

II. Skill Standards

2.1 General Description of Skill Standards

Skill standards specify the knowledge, understanding, and specific skills that represent international best practices in technical and vocational performance. They will reflect the global consensus on what the relevant job roles or occupations represent in industry and enterprises.

The skills competition is designed to reflect the international best practices described in these skill standards and the extent to which they can be achieved. Therefore, these standards serve as a guide for the training and preparation required for the skills competition.

The standards are divided into different sections with titles and reference numbers.

Each section is assigned a percentage of the total score to indicate its relative

importance in the standards. This is usually referred to as "weight". The sum of all percentages is 100. The weights determine the allocation of scores in the grading criteria.

Through the test items, the scoring scheme only evaluates the skills listed in the standards. They will reflect the standards as comprehensively as possible under the constraints of the skills competition.

The scoring scheme will be implemented in accordance with the scores assigned in the standards to the extent practically possible. A variation of up to 5% is allowed, but the weights assigned in the standard specifications shall not be changed.

Section		Importance (%)
1	**3D Design of Work Units**	20
	Contestants are required to understand and comprehend the following: ● Computer hardware, software and their application programs; ● The NX software system under the Win10 64-bit operating system, and be able to configure correct environment parameters for the software system they use, as well as manage computer documents properly; ● The mechanical structure composition of equipment and its working principle; ● Product part drawings and assembly drawings that comply with GB (National Standards of the People's Republic of China) or ISO (International Organization for Standardization) standards.	
	Contestants shall be able to: ● Use the software platform for 3D geometric modeling of parts; Proficiently apply 3D modeling technologies based on sketches and features; ● Proficiently configure attributes for parts (physical properties, material, texture, color, luster, reflection, shadow); ● Use the software platform for 3D assembly modeling; ● Carry out 3D assembly based on the understanding of product principles; ● Modify or create new parts or assemblies according to existing part/component drawings or 3D models;	

	● Apply assemblies or parts to other application programs for re-application.	
2	**Virtual Design of Digital Twin Equipment**	20
	Contestants are required to understand and comprehend the following: ● The practical application of engineering software, scientific and design twin equipment, device drivers, and sensing systems; ● The definition of the interrelationship between physical equipment and twin equipment; ● The principles and related applications of electrical engineering and pneumatics; ● The connection and debugging of twin platform software based on the process requirements and functional control processes of real equipment, as well as the debugging methods for twin equipment based on simulation debugging.	
	Contestants shall be able to: ● Read technical specification documents and look up technical instructions required for the project; ● Define attributes for various components, including the setting of mechanical attributes (such as rigid bodies, collision bodies, and kinematic pairs) and electrical attributes; ● Design virtual twin equipment using software; Conduct testing on virtual equipment, and optimize and improve existing problems; ● Identify and resolve software faults of twin equipment; ● Design equipment systems for specific industrial applications;	
3	**PLC/HMI Programming and Debugging**	40
	Individuals are required to understand and comprehend the following: ● Principles and applications of electrical control; ● Software operation and programming methods of the relevant programming platforms corresponding to the competition controller; ● Writing PLC and HMI control programs and conducting debugging in accordance with requirements; ● Controlling the movement of equipment such as cylinders and servos in the simulation platform; ● Defining sensors in the twin equipment according to control requirements and feeding back the sensor data into the control system logic.	
	Individuals shall be able to: ● Analyze and understand the operation process and functional requirements of equipment;	

	● Design control flowcharts for PLC and HMI, and compile control I/O charts, control sequence diagrams, network structure diagrams, data interaction tables, etc.; ● Write software control programs for PLC and HMI, and set relevant parameters such as operation, network, and time; ● Make appropriate modifications and recheck the program to correct errors so as to ensure the desired results are achieved; ● Implement new additional software and hardware options	
4	**Operation and Debugging of Virtual Equipment Systems**	20
	Individuals are required to understand and comprehend the following: ● The working principles and debugging methods of various sensors; ● The working principles of frequency converters and servo drives, as well as the control and application of pneumatics and hydraulics; ● The workflow of automated production lines and the process steps and flows of automated production lines; ● Selecting and defining corresponding mechanical kinematic pairs based on the movement of automated production lines; ● The method for defining the external input and output signals of twin equipment.	
	Individuals shall be able to: ● Select and use sensors correctly; ● Design the process flow of the production line correctly; ● Correctly use software to monitor and manage intelligent manufacturing production lines; ● Correctly apply pneumatic technology to integrate into the driving methods of the production line control process; ● Realize data integration and application with other simulation software platforms, such as HMI simulation, PLC simulation, and MES platforms; ● Put forward suggestions on operation strategies to maximize operation efficiency.	
	In Sum	100

III. Scoring Scheme

3.1 Scoring Method

The scoring of this competition is based on the result verification of the output files submitted by the participants for each project. If a participant engages in cheating or other rule-breaking behaviors during the competition, the referees will handle the case according to the severity of the violation; those with serious violations will have their results cancelled.

3.2 Scoring Rules

1. The participant with a higher total score shall be ranked higher.

2. If participants have the same total score, their rankings shall be determined by the scores of the modules in the order of Module 4, Module 3, Module 1, and Module 2—the one with a higher score in the corresponding module shall be ranked higher.

If the above two rules still fail to determine the ranking, the participant with the shorter accumulated competition time shall be ranked higher.

3.3 Scoring Basis

During the design of the competition item, the selection of standards and evaluation methods will be determined through the scoring scheme and competition questions. The evaluation basis includes, but is not limited to:

Serial No.	Scoring Item	Distribution of Scores to Each Item	Scoring Content
1	3D Design of Work Units	20%	3D Modeling Models, Model Saving Formats, Assembly Effects of Each Model; the built components shall be free from mechanical collisions, fit closely with each other, and have aligned holes and shafts.
2	Virtual Design of Digital Twin Equipment	20%	Check the attributes and signals of electromechanical objects
3	PLC/HMI Programming and Debugging	40%	disconnect external connections, use the "Runtime Viewer" and adopt the jogging mode to view virtual actions; view the virtual

			manual debugging of the corresponding mechanism through the virtual HMI; conduct single-station virtual debugging (excluding system joint debugging simulation) on the system unit models respectively to make them operate automatically in simulation according to process requirements.
4	Operation and Debugging of Virtual Equipment Systems	20%	MES downloads orders; the system model completes system joint debugging simulation in accordance with the process flow.

IV. Competition Tasks

4.1 Common Precautions

Whether for a single module or a series of independent or interrelated modules, the test items can evaluate the application of knowledge, skills, and behaviors defined in the Skill Specification.

Combined with the scoring scheme, the purpose of the test items is to provide comprehensive, balanced, and authentic opportunities for evaluating and scoring against the standards. The relationship between the test items, the scoring scheme, and the standards will be a key indicator of quality, just like the relationship between the standards and actual work performance.

The test items shall not cover aspects beyond the standards, nor shall they affect the scoring balance within the standards.

The evaluation of knowledge and understanding through the test items shall only be conducted based on their application in practical work.

4.2 Format/Framework of Competition Tasks

In accordance with the requirements specified in the provided work assignment document, participating teams shall complete the following four module tasks within the stipulated time:

Module 1: 3D Design of Work Units

Module 2: Virtual Design of Digital Twin Equipment

Module 3: PLC/HMI Programming and Debugging

Module 4: Operation and Debugging of Virtual Equipment Systems

4.3 Time Allocation and Score Weight for Competition Tasks

Module	Length of time （min）	Score weight
Module 1: 3D Design of Work Units	80	20
Module 2: Virtual Design of Twin Equipment	80	20
Module 3: PLC/HMI Programming and Debugging	120	40
Module 4: Operation and Debugging of Virtual Equipment Systems	80	20
Total	360	100

4.4 Competition Content and Requirements for Each Module

This competition item takes the digital control technology of a typical intelligent manufacturing production line as the background, and adopts technologies such as digital twin systems, automatic control, and data acquisition to complete the integrated debugging and maintenance of the production line system. In accordance with the requirements of the assignment document, participants shall independently design the implementation plan for digital control technology, including the installation, wiring, configuration, programming, and testing of key components such as sensors, programmable logic controllers (PLCs), and mechanisms. Based on different task requirements, they shall be able to complete work tasks such as material feeding, sorting, assembly, inspection, and warehousing. The edge layer shall conduct

data collection and transmission, while the enterprise layer shall use system operation status diagrams and data dashboards for digital monitoring, operation, and maintenance management.

This competition item mainly assesses participants' mastery of knowledge in digital twins, automatic control, intelligent manufacturing networks, industrial data transmission, etc.; their capabilities in system design and integration, including 3D design, construction, communication, debugging, digital monitoring, operation, and maintenance; as well as their professional qualities such as safety awareness, craftsmanship spirit, quality and cost control. It also evaluates participants' abilities in analyzing and addressing practical problems, innovating, creating, organizing and managing, and coordinating in engineering on-site scenarios.

Module No.	Module Name	Task Content
Module 1	3-D design of the work unit	1. Build up a 3D model 2. Assembly of the unit model
Module 2	Simulation design of twins equipment	1. Electromechanical Object Attribute Definition of Unit Model 2. Electromechanical Object Signal Configuration of Unit Model
Module 3	PLC/ HMI programming debugging	1. System Virtual PLC/HMI Programming and Debugging 2. Component Virtual Jogging Test 3. Mechanism Virtual Manual Debugging 4. Unit Simulation Automatic Debugging
Module 4	Commissioning of simulated equipment system operation	1. Virtual Equipment System Joint Debugging; 2. Virtual Equipment System MES Application

4.5 Announcement of Competition Tasks

The competition tasks will be announced 15 days before the competition via the official website of the competition.

4.6 Revisions to Competition Tasks

Approximately 30% of the competition tasks will be revised prior to the official start of the competition.

V. Skill Management and Communication

5.1 Expert Group

The Skill Expert Group consists of a Chief Expert, Deputy Chief Experts, and expert members, who are jointly responsible for further revising the relevant technical documents of this competition item.

5.2 Communication and Discussion

- Prior to the competition, training sessions, exchanges, and Q&A sessions for the competition item will be arranged to address questions related to software and hardware preparation, test environment deployment, etc.
- Communications before, during, and after the competition will also be conducted through the official communication group.

VI. Safety Requirements

6.1 Organizational Structure

1. A Competition Safety Support Team shall be established, with the team leader served by the director of the working group of this competition item. Members shall

be the safety supervisors of each competition venue. A safety supervisor shall be designated for each venue, who shall take full responsibility for the safety of the venue. In case of emergencies, the supervisor shall be responsible for dispatching rescue teams and professional rescuers, and arranging the evacuation of personnel in the venue.

2. A coordination mechanism shall be established with relevant departments such as public security, fire protection, judicial administration, transportation, health, food, and quality inspection to ensure competition safety, formulate emergency plans, and handle emergencies in a timely manner. Dedicated contact lines shall be set up for medical staff, fire-fighting personnel, and security guards, and corresponding contacts shall be identified, who shall be connected with by the venue safety supervisor. The layout of the competition venue and the use of equipment shall be carried out in strict accordance with safety construction regulations. The venue layout shall be divided into zones, evacuation routes shall be set in accordance with safety requirements, and diagrams of safety evacuation passages and routes shall be posted in prominent positions on the walls.

6.2 Competition Item Safety Management

1. The installation of competition equipment and facilities shall be carried out in strict accordance with safety construction standards, and power wiring and electrical installation shall comply with specifications.

2. Fire extinguishers shall be placed in accordance with fire safety requirements, and a responsible person shall be designated to use them in case of emergencies.

3. The competition rules of the competition item shall clearly specify the national

(or industrial) safety standards, regulations, and qualification certificate requirements for relevant professional positions.

4. The Competition Item Working Group shall provide safety training to all referees and staff of the competition item before the competition. In accordance with the requirements of relevant regulations, a sound safety accident prevention system shall be established, and training shall be provided to participants before the competition to avoid personal injury accidents.

5. The Competition Item Expert Group shall develop a special plan to ensure the safety of the process of competition question setting, storage, distribution, recovery, and evaluation.

6.3 Competition Environment Safety Management

1. Before the competition, the Competition Item Working Group shall organize personnel to inspect the competition site, accommodation facilities, and transportation support, and put forward clear requirements for safety work. The layout of the competition venue, as well as the equipment and facilities in the venue, shall comply with relevant national safety regulations. A simulated test of the competition venue shall be conducted to identify potential problems. The undertaker shall eliminate safety hazards in accordance with the requirements of the Competition Item Working Group before the competition.

2. Warning lines shall be set around the competition venue to prevent irrelevant personnel from entering and avoid accidents. Necessary labor protection equipment shall be provided to participants at the competition site in accordance with the requirements of relevant professional positions. For operation links with potential

risks, referees shall check and confirm that the equipment is in normal condition before the competition, and strictly prevent participants from making incorrect operations during the competition.

3. To ensure the smooth progress of this competition, the undertaking college shall establish a corresponding safety support system during the competition, which shall be implemented by the Security, Campus Environment, and Health Medical Support Team.

(1) During the competition, all vehicles and personnel entering the competition area must present valid certificates and take the initiative to show them to the staff.

(2) Before the start of the competition, participants shall carefully read the relevant precautions for the competition and the emergency evacuation diagram.

(3) Referees shall supervise the entire process of inspection before power-on of the electrical control system at the competition venue, and promptly remind and stop any potential operational hazards.

(4) Each competition equipment shall use an independent power supply to ensure safety. Participants shall save their work in a timely manner when conducting computer programming to avoid data loss caused by sudden power outages.

(5) During the competition, participants shall strictly abide by safety operating procedures. In case of emergencies, they shall immediately cut off the power supply and evacuate in an orderly manner under the arrangement of the staff.

(6) All personnel shall strictly abide by the competition venue rules, and it is forbidden to bring prohibited items into the venue.

(7) Security personnel shall promptly report any safety hazards to the venue responsible person.

(8) Smoking is strictly prohibited in the competition venue, and security personnel shall not transfer their certificates to others.

(9) In case of safety problems, personnel shall quickly evacuate the site in accordance with the emergency evacuation route under the guidance of security personnel.

4. The Competition Item Working Group and the undertaker shall, in areas of the competition venue with dense personnel and intersecting vehicle/pedestrian flows, not only set up complete indicator signs and increase the number of guides but also open backup passages.

5. During the competition, the undertaker of the competition item shall increase manpower in key positions of venue management and establish a safety management log.

6. When participants enter their competition positions and referees/staff of the competition item enter their workplaces, the undertaker of the competition item shall remind and urge them not to carry communication devices, photography/recording equipment, or unauthorized recording tools. Security inspection equipment shall be used to conduct security checks on personnel entering key areas of the competition venue.

6.4 Living Condition Support

1. During the competition, the undertaker of the event shall uniformly arrange accommodation and catering for participants and instructors. The undertaker shall respect the religious beliefs and cultural customs of ethnic minority participants and arrange the accommodation and catering for ethnic minority participants and

instructors in accordance with relevant national ethnic and religious policies.

2. The accommodation arranged during the competition shall have the qualification for hotel and accommodation operation.

3. The traffic safety of organized visits and observation activities during the competition shall be the responsibility of the Competition Area Working Group. The Competition Item Working Group and the undertaker shall ensure the traffic safety of participants, instructors, referees, and staff during the competition.

4. Except for necessary safety isolation measures, relevant national laws and regulations shall be strictly observed to protect personal privacy and personal freedom.

6.5 Responsibilities of Participating Teams

1. When organizing participating teams, each participating unit shall arrange for the purchase of personal accident insurance for participants during the competition.

2. After the establishment of the participating team of each unit, relevant management systems shall be formulated, and safety education shall be provided to all participants and instructors.

3. Each participating team shall strengthen the safety management of personnel participating in the competition and connect with the venue safety management.

4. If a participating team has vehicles, all vehicles shall enter and exit the competition venue with certificates issued by the Competition Working Group, drive along designated routes, and park at designated locations.

6.6 Emergency Handling

In case of an accident during the competition, the discoverer shall report to the Competition Item Working Group at the first time and take measures to prevent the situation from worsening. The Competition Item Working Group shall immediately activate the emergency plan to resolve the problem. For competition items with major safety issues, the Competition Area Working Group shall decide whether to suspend the competition. After the incident, the Competition Area Working Group shall issue a detailed report on the situation.

6.7 Penalty Measures

1. If a major safety accident occurs in a competition item, the qualification of the undertaker to host the competition item shall be revoked.

2. If a major safety accident is caused by a participating team, the team's qualification for awards shall be cancelled.

3. If a participating team has major potential safety accidents and fails to correct them after being reminded and warned by the venue staff, the team's qualification to continue the competition shall be cancelled.

4. For staff who violate the rules, responsibilities shall be pursued in accordance with the corresponding system. Those who commit serious violations and cause major safety accidents shall be pursued for corresponding legal responsibilities by the judicial organs.

VII. Materials and Equipment

7.1 Materials, Equipment and Tools

(I) Standards for Competition Technical Platforms

The Competition Organizing Committee shall provide competition platforms, workbenches, computers, and relevant tool software.

(II) Recommended Competition Equipment and Technical Platforms

To ensure the openness, fairness, and impartiality of the competition, the selection of competition equipment, software, and technical platforms has undergone strict screening. All indicators comply with the relevant standards specified in the Equipment and Facility Management Measures for New Vocational Skills Competition Items, so as to ensure the smooth progress of the competition.

The competition equipment adopts training and assessment devices for digital control technology, including 9 work units: conveying and feeding, rotary feeding, height detection, steel ball assembly, sorting and detection, handling and assembly, guide rail handling, gantry handling, and intelligent warehousing.

Serial No.	Name	Main Technical Parameters
1	Digital Control Technology Training Assessment Equipment NX Model	Provide the NX model of the digital control technology training and assessment device, and carry out the splitting of the corresponding unit mechanisms as well as the deletion of electromechanical attributes.
2	Programming Software	It includes NX digital twin design and simulation software, TIA Portal programming software, simulation software such as S7-PLCSIM, S7-PLCSIM Advanced, and Manufacturing Execution System (MES), etc.

7.2 Recommended Layout of Competition Areas and Workstations

7.2.1 Requirements for Examination Station Layout

Examination station desks shall be arranged in a quiet, undisturbed environment with sufficient lighting and no obstacles. The computer for the examination shall be

placed in the center of the examination station desk. A chair suitable for one person to sit on shall be placed in front of the examination station desk, and the national flag of the participant's country shall be placed on the examination station desk.

7.2.2 Layout of Remote Workstations (See Diagram)