worldskills

Technical Description

Electronics

Skill 16

WorldSkills International, by a resolution of the Competitions Committee and in accordance with the Constitution, the Standing Orders, and the Competition Rules, has adopted the following minimum requirements for this skill for the WorldSkills Competition.

The Technical Description consists of the following:

1 Introduction

1.1 Name and description of the skill competition

1.1.1 The name of the skill competition is

Electronics

1.1.2 Description of the associated work role(s) or occupation(s)

Electronics Technicians work in a variety of settings, including workshops, laboratories, and manufacturing plants. They may also work in research and development facilities, where they contribute to the design, prototyping, and testing of new electronic equipment. They often work closely with electronics engineers and other technical and professional staff. Their role is crucial in maintaining electronic devices and systems. They may either be part of larger engineering teams or work independently on specific projects.

The primary purpose of an Electronics Technician is to apply electrical and electronic theory and related knowledge to the design, development, repair, adjustment, and modification of electrical components, circuitry, controls, and machinery. This work supports engineers in making design decisions and ensures that electronic systems and devices function correctly and efficiently.

The main tasks and processes of the role involve:

- design and development: assisting the design and development of electronic circuits and systems, preparing detailed drawings and specifications based on engineers' instructions
- testing and evaluation: conducting tests on electronic components and systems to ensure they meet required specifications. This involves setting up and operating specialised test equipment
- maintenance and repair: maintaining and repairing electronic equipment, including troubleshooting, replacing faulty components, and ensuring that systems operate smoothly
- documentation and reporting: documenting and reporting on their work, including test results, modifications, and repairs, for functionality, accountability and continuous improvement.

The value of an Electronics Technician will be found in:

- the creation and maintenance of functional electronic systems and devices. This is their main responsibility and can include everything from consumer electronics to industrial control systems
- improved efficiency and reliability from design to maintenance using proven modern techniques, materials, and processes
- the quality of the data, insights, and reports that support informed design decisions, better overall product quality, and innovation.

Attention to detail, problem-solving skills, and the ability to work collaboratively are crucial attributes of this role, together with a proactive concern for safety and continuous improvement. In summary: the character of a successful Electronics Technician is defined by a combination of technical proficiency, practical skills, effective communication, ethical conduct, and a commitment to continuous learning and sustainability.

1.1.3 Number of Competitors per team

Electronics is a single Competitor skill competition.

1.1.4 Age limit of Competitors

The Competitors must not be older than 22 years in the year of the Competition.

1.2 The relevance and significance of this document

This document contains information about the standards required to compete in this skill competition, and the assessment principles, methods, and procedures that govern the competition.

Every Expert and Competitor must know and understand this Technical Description.

In the event of any conflict within the different languages of the Technical Descriptions, the English version takes precedence.

1.3 Associated documents

Since this Technical Description contains only skill-specific information it must be used in association with the following:

- WSI – Code of Ethics and Conduct
- WSI – Competition Rules
- WSI – WorldSkills Occupational Standards framework
- WSI – WorldSkills Assessment Strategy
- WSI online resources as indicated in this document
- WorldSkills Health, Safety, and Environment Policy and Regulations
- WorldSkills Standards and Assessment Guide (skill-specific)

2 The WorldSkills Occupational Standards (WSOS)

2.1 General notes on the WSOS

The WSOS specifies the knowledge, understanding, skills, and capabilities that underpin international best practice in technical and vocational performance. These are both specific to an occupational role and also transversal. Together they should reflect a shared global understanding of what the associated work role(s) or occupation(s) represent for industry and business (www.worldskills.org/WSOS).

The skill competition is intended to reflect international best practice as described by the WSOS, to the extent that it can. The Standard is therefore a guide to the required training and preparation for the skill competition.

In the skill competition the assessment of knowledge and understanding will take place through the assessment of performance. There will only be separate tests of knowledge and understanding where there is an overwhelming reason for these.

The Standard is divided into distinct sections with headings and reference numbers added.

Each section is assigned a percentage of the total marks to indicate its relative importance within the Standards. This is often referred to as the “weighting”. The sum of all the percentage marks is 100. The weightings determine the distribution of marks within the Marking Scheme.

Through the Test Project, the Marking Scheme will assess only those skills and capabilities that are set out in the WorldSkills Occupational Standards. They will reflect the Standards as comprehensively as possible within the constraints of the skill competition.

The Marking Scheme will follow the allocation of marks within the Standards to the extent practically possible. A variation of up to five percent is allowed, if this does not distort the weightings assigned by the Standards.

2.2 WorldSkills Occupational Standards

Section		Relative importance (%)
1	**Work organization and management**	**5**
	The individual needs to know and understand: • Principles and applications of good working practice for managing oneself, time, relations with other people, and physical and environmental resources • Company cultures, procedures and variations depending on size, location, and position in economies and markets • The importance of a sustainable mindset both broadly and in relation to electronics • Principles, considerations, regulations, and procedures for health and safety in the electronic environment	

Section		Relative importance (%)
	• The purposes, uses, care, maintenance, and storage of tools and equipment, together with their safety implications • The importance of efficient work habits within one's own workspace • Principles and techniques for measuring work efficiency and effectiveness • The importance of continuing personal development • The practical implications of professional responsibility and autonomy • The importance of self-knowledge, critical thinking, integrity, and the wellbeing of oneself and others.	
	The individual shall be able to: • Plan and organize one's work within the available time and other resources • Resolve challenges to completing assignments through personal organisation, prioritisation, or other suitable methods for each work environment • Maintain a professional demeanour in all circumstances • Proactively engage in continuing professional development • Exercise care in the workplace for personal and others' safety • Take appropriate preventative action to prevent accidents and minimise their impact if they occur • Proactively model sustainable practice • Regularly reflect on and review one's own working practice, outputs and outcomes • Contribute to the continuous improvement and development of the organisation or project.	
2	**Communication and interpersonal skills**	**5**
	The individual needs to know and understand: • Principles of human communication and their applications to the professional environment • Principles of technical communication and their applications to engineering and, specifically, to electronics • The purposes and applications of Information and Communication Technology (ICT) in the work environment and external interfaces • The interrelationship of language, behaviours, and culture, globally and in other dimensions • The range of communication and behaviours acceptable and effective in work environments with peers and hierarchies • Principles and techniques for effective teamwork • Principles and techniques for interacting with non-specialists, such as customers and other professions • The purposes and range of technical languages, including text, symbols, and numerals • The range of presentational techniques, including diagrams, graphs, and charts	

Section		Relative importance (%)
	• The importance of situational awareness, and one's potential impact on others • Principles and methods for formal reporting within and beyond the work setting.	
	The individual shall be able to: • Maintain professional relationships with others in the workplace and remotely • Use ICT as required in the work environment and for external communications • Present ideas and proposals to internal teams and external groups • Interact with clients, including explaining technical concepts straightforwardly • Share ideas and learn with others at work • Adapt one's language and behaviour to new situations, while maintaining professionalism • Challenge unacceptable language and behaviour by others, while being mindful of one's own language and behaviour • Apply effective record-keeping techniques to enable traceability for later development • Recognise and apply international symbols, diagrams, and languages • Comply with ISO and other required forms of communication wherever required or useful.	
3	**Hardware design and development**	**20**
	The individual needs to know and understand: • Engineering, electrical, and electronic principles and theory • Electronic components and devices • The development of system blocks or basic circuits including the areas of analog electronics, power electronics, digital systems, communication systems and embedded systems. • The role and uses of specialist (PCB design) software • Design principles and their application to their own role, expertise, and the assignment • In outline, the overall design cycle: ◦ Defining the problem or need ◦ In-depth research ◦ Ideating potential solutions ◦ Evaluating and selecting a promising solution ◦ Prototyping ◦ Testing and troubleshooting ◦ Making improvements ◦ Production	

Section		Relative importance (%)
	• Specifically, and in detail, the problem or need that is to be solved or met through electronic product design, creation, modification, or enhancement • How to conduct research and analysis that is in proportion to the need • High-level thinking skills including innovation and creativity • Evaluation and decision-making, accounting for known factors such as time and cost • Commonly used and International industry standard symbols ANSI (US) and IEC (EU) styles.	
	The individual shall be able to: • Read and interpret wiring diagrams, schematic drawings, or engineering instructions for assembling electronics units, and technical manuals • Design, create, or develop, new applications, ideas, relationships, systems, or products, including aesthetic contributions • Assist in the design and development of electronic circuits and systems • Calculate and select component values that are fit-for-purpose • Calculate design specifications or cost, material, and resource estimates, and prepare project schedules and budgets • Prepare detailed estimates of quantities and costs of materials and labour required for the manufacture and installation of electronic equipment, according to the specifications given • Use computer circuit simulation software to test that circuit designs are fit for purpose • Draw schematic circuits using schematic capture and PCB layout software • Use the 3D capabilities of PCB Layout software • Generate fit-for-purpose PCB manufacturing data.	
4	**Assembly, modification, and repair**	**25**
	The individual needs to know and understand: • Typical tools used in electronic assembly • The relevant industry standards of assembly (e.g. IPC 610 and others) • The relevant industry standards of repair (e.g. IPC 7711/7721 and others) • Safe working practices • ESD safe working practices.	
	The individual shall be able to: • Assemble components onto PCBs to create functional circuits • Identify and assemble and use electro-mechanical parts • Wire and form cables harnesses	

Section		Relative importance (%)
	• Implement, rework and repair mistakes in design to industry standards • Replace components according to industry standards • Repair and replace defective components on Printed Circuit Boards (according to industry standards) using hand-tools and through-hole and surface mount soldering techniques • Replace components or modules with ones not originally designed or intended for use in a PCB or System, to obtain temporary functionality or for use in prototypes.	
5	**Fault finding**	**5**
	The individual needs to know and understand: • The limitations and applications of test equipment • Fault detection methods for electronics systems • Contexts in which the function of fault finding takes place. • Common faults electronics systems • Effects of ESD and working safely with ESD sensitive devices.	
	The individual shall be able to: • Read and interpret electronic systems drawings and documents • Take measurements to test, set, adjust, and measure electronic components, modules, and equipment using measurement equipment that can measure and analyze voltage, currents, others electrical quantities and waveforms • Select the appropriate equipment to perform measurements • Use automatic test equipment • Analyze the correct principles of fault finding • Design and implement test strategies to localize/find faults • Utilize a range of tools and software to isolate faults • Determine causes of operating errors and the required action to repair • Test electronics units and components, using standard test equipment.	
6	**Embedded systems programming**	**25**
	The individual needs to know and understand: • Embedded systems • The application of microcontroller interfacing principles • Common MCU peripherals programming and interfaces to external peripherals power management techniques, e.g. watch-dog timers • Integrated Software Development Environments commonly used in industry.	

Section		Relative importance (%)
	The individual shall be able to: • Write, analyze, review and update C-code on embedded systems to handle specific jobs such as storing or retrieving data, and/or controlling other equipment or peripherals • Locate, correct, and re-compile syntax errors • Investigate whether the central processing unit of the system, or peripheral equipment are responding to a programme's instructions • Use common C functions and/or supplied C functions • Write functions to perform a specified task.	
7	**Measurement, documentation, and reporting**	**15**
	The individual needs to know and understand: • Tools and software used for documentation and reporting • Verification standards, methods, and reports to be used to record the results of calculations and measurements • Essential features to ensure the quality of measurements • The content, structure and presentation for reports serving different purposes.	
	The individual shall be able to: • Prepare detailed drawings and specifications on engineers' instructions • Draw schematic circuits using schematic capture and PCB layout software • Produce electronics drawings or other graphics representing industrial control, instrumentation, sensors, analogue, or digital telecommunications networks, using computer-aided design (CAD) software • Prepare reports in appropriate formats (pdf, doc, xls, etc) for each case (fault finding, modification, measurement, calculate and select component values that are fit-to-purpose) • Record calculations performed for each component, electrical quantity with its corresponding units of measurement • Record measurements of electronic circuits with the insertion of the designed parameters (e.g. amplitude, frequency, duty cycle, cut-off frequency, etc.) • Record evidence of successful repair (reports that include the nature, evidence, cause, and repairs performed on faulty units) • Complete digital reports, including all required data e.g. calculations, electronic circuit waveforms, symbols • Write clear design reports, including scheme comparisons, simulation verification results, and risk analysis conclusions.	
	Total	**100**

3 The Assessment Strategy and Specification

3.1 General guidance

Assessment is governed by the WorldSkills Assessment Strategy. The Strategy establishes the principles and techniques to which WorldSkills assessment and marking must conform.

Expert assessment practice lies at the heart of the WorldSkills Competition. For this reason, it is the subject of continuing professional development and scrutiny. The growth of expertise in assessment will inform the future use and direction of the main assessment instruments used by the WorldSkills Competition: the Marking Scheme, Test Project, and Competition Information System (CIS).

Assessment at the WorldSkills Competition falls into two broad types: Measurement and Judgement. For both types of assessment, the use of explicit benchmarks against which to assess each Aspect is essential to guarantee quality.

The Marking Scheme must follow the weightings within the Standards. The Test Project is the assessment vehicle for the skill competition, and therefore also follows the Standards. The CIS enables the timely and accurate recording of marks; its capacity for scrutiny, support, and feedback is continuously expanding.

The Marking Scheme, in outline, will lead the process of Test Project design. After this, the Marking Scheme and Test Project will be designed, developed, and verified through an iterative process, to ensure that both together optimize their relationship with the Standards and the Assessment Strategy. They will be agreed by the Experts and submitted to WSI for approval together, to demonstrate their quality and conformity with the Standards.

Prior to submission for approval to WSI, the Marking Scheme and Test Project will liaise with the WSI Skill Advisors for quality assurance and to benefit from the capabilities of the CIS.

4 Assessment Design and Practice

4.1 General guidance

This section describes the role and place of the Marking Scheme, how the Experts will assess Competitors' work as demonstrated through the Test Project, and the procedures and requirements for marking.

The Marking Scheme is the pivotal instrument of the WorldSkills Competition, in that it ties assessment to the standard that represents each skill competition, which itself represents a global occupation. It is designed to allocate marks for each assessed aspect of performance in accordance with the weightings in the Standards.

By reflecting the weightings in the Standards, the Marking Scheme establishes the parameters for the design of the Test Project. Depending on the nature of the skill competition and its assessment needs, it may initially be appropriate to develop the Marking Scheme in more detail as a guide for Test Project design. Alternatively, initial Test Project design can be based on the outline Marking Scheme. From this point onwards the Marking Scheme and Test Project should be developed together.

Section 2.1 above indicates the extent to which the Marking Scheme and Test Project may diverge from the weightings given in the Standards, if there is no practicable alternative.

For integrity and fairness, the Marking Scheme and Test Project are increasingly designed and developed by one or more Independent Test Project Designer(s) with relevant expertise. In these instances, the Marking Scheme and Test Project are unseen by Experts until immediately before the start of the skill competition, or competition module. Where the detailed and final Marking Scheme and Test Project are designed by Experts, they must be approved by the whole Expert group prior to submission for independent validation and quality assurance. Please see the Competition Rules for further details.

Experts and Independent Test Project Designers are required to submit their Marking Schemes and Test Projects for review, verification, and validation well in advance of completion. They are also expected to work with their Skill Advisor, reviewers, and verifiers, throughout the design and development process, for quality assurance and in order to take full advantage of the CIS's features.

In all cases a draft Marking Scheme must be entered into the CIS at least eight weeks prior to the Competition. Skill Advisors actively facilitate this process.

4.2 Assessment Criteria

The main headings of the Marking Scheme are the Assessment Criteria. These headings are derived before, or in conjunction with, the Test Project. In some skill competitions the Assessment Criteria may be similar to the section headings in the Standards; in others they may be different. There will normally be between five and nine Assessment Criteria. Whether or not the headings match, the Marking Scheme as a whole must reflect the weightings in the Standards.

Assessment Criteria are created by the person or people developing the Marking Scheme, who are free to define the Criteria that they consider most suited to the assessment and marking of the Test Project. Each Assessment Criterion is defined by a letter (A-I). **The Assessment Criteria, the allocation of marks, and the assessment methods, should not be set out within this Technical Description. This is because the Criteria, allocation of marks, and assessment**

methods all depend on the nature of the Marking Scheme and Test Project, which is decided after this Technical Description is published.

The Mark Summary Form generated by the CIS will comprise a list of the Assessment Criteria and Sub Criteria.

The marks allocated to each Criterion will be calculated by the CIS. These will be the cumulative sum of marks given to each Aspect within that Assessment Criterion.

4.3 Sub Criteria

Each Assessment Criterion is divided into one or more Sub Criteria. Each Sub Criterion becomes the heading for a WorldSkills marking form. Each marking form (Sub Criterion) contains Aspects to be assessed and marked by Measurement or Judgement, or both Measurement and Judgement.

Each marking form (Sub Criterion) specifies both the day on which it will be marked, and the identity of the marking team.

4.4 Aspects

Each Aspect defines, in detail, a single item to be assessed and marked, together with the marks, and detailed descriptors or instructions as a guide to marking. Each Aspect is assessed either by Measurement or by Judgement.

The marking form lists, in detail, every Aspect to be marked together with the mark allocated to it. The sum of the marks allocated to each Aspect must fall within the range of marks specified for that section of the Standards. This will be displayed in the Mark Allocation Table of the CIS, in the following format, when the Marking Scheme is reviewed from C-8 weeks. (Section 4.1 refers.)

		CRITERIA								TOTAL MARKS PER SECTION	WSSS MARKS PER SECTION	VARIANCE
STANDARDS SPECIFICATION SECTION		A	B	C	D	E	F	G	H			
	1	5.00								5.00	5.00	0.00
	2		2.00					7.50		9.50	10.00	0.50
	3								11.00	11.00	10.00	1.00
	4			5.00						5.00	5.00	0.00
	5				10.00	10.00	10.00			30.00	30.00	0.00
	6		8.00	5.00				2.50	9.00	24.50	25.00	0.50
	7			10.00				5.00		15.00	15.00	0.00
TOTAL MARKS		5.00	10.00	20.00	10.00	10.00	10.00	15.00	20.00	100.00	100.00	2.00

4.5 Assessment and marking

There is to be one marking team for each Sub Criterion, whether it is assessed and marked by Judgement, Measurement, or both. The same marking team must assess and mark all Competitors. Where this is impracticable (for example where an action must be done by every Competitor simultaneously, and must be observed doing so), a second tier of assessment and marking will be put in place, with the approval of the Competitions Committee Management Team. The marking teams must be organized to ensure that there is no compatriot marking in any circumstances. (Section 4.6 refers.)

4.6 Assessment and marking using Judgement

Judgement uses a scale of 0-3. To apply the scale with rigour and consistency, Judgement must be conducted using:

- benchmarks (criteria) for detailed guidance for each Aspect (in words, images, artefacts, or separate guidance notes). This is documented in the Standards and Assessment Guide.
- the 0-3 scale to indicate:
  - 0: performance below industry standard
  - 1: performance meets industry standard
  - 2: performance meets and, in specific respects, exceeds industry standard
  - 3: performance wholly exceeds industry standard and is judged as excellent

Three Experts will judge each Aspect, normally simultaneously, and record their scores. A fourth Expert coordinates and supervises the scoring, and checks their validity. They also act as a judge when required to prevent compatriot marking.

4.7 Assessment and marking using Measurement

Normally three Experts will be used to assess each Aspect, with a fourth Expert supervising. In some circumstances the team may organize itself as two pairs, for dual marking. Unless otherwise stated, only the maximum mark or zero will be awarded. Where they are used, the benchmarks for awarding partial marks will be clearly defined within the Aspect. To avoid errors in calculation or transmission, the CIS provides a large number of automated calculation options, the use of which is mandated.

4.8 The use of Measurement and Judgement

Decisions regarding the choice of criteria and assessment methods will be made during the design of the competition through the Marking Scheme and Test Project.

4.9 Skill assessment strategy and procedures

WorldSkills is committed to continuous improvement including reviewing past limitations and building on good practice. The following skill assessment strategy and procedures for this skill competition take this into account and explain how the marking process will be managed.

1. Hardware Design module
2. Embedded Systems Programming module
3. Modification and Measurement module

Procedures

- Groups of Experts are formed for each of the three (3) modules to be assessed;
- Chief Expert allocates four (4) Experts for each sub criteria to assess;
- Chief Expert nominates an assessment team leader for each sub criteria. The assessment team leader is responsible for the recording of results;
- The team leader of each marking group needs to be fluent in English;
- The Independent Test Project Designer proposes the outline of the marking standard to the project marking group;
- Experts start marking after the end of each module. Each Expert marking group can organize the marking schedule after consultation with the Chief Expert;

- Experts may not mark their compatriot Competitor. In this case, the assessment team leader will perform this role.
- Assessment is completed each day (if possible);
- Only the Expert marking group for a specific sub criterion assesses the sub criteria. All other Experts must leave the assessment area if they are not involved in assessment;
- Where functionality of hardware is marked, the functionality should be assessed at the workbench of the Competitor. Dependent on the applicability and sensitivity of the task the SMT decide how this will be achieved;
- The assessment procedure for each individual module must be set up by the assessment team with the reference documents, solutions, and/or designs from the Independent Test Project Designer before the start of the assessment;
- The marking documents, especially the detailed marking forms, are kept secret until the end of the corresponding module.

5 The Test Project

5.1 General notes

Sections 3 and 4 govern the development of the Test Project. These notes are supplementary.

Whether it is a single entity, or a series of stand-alone or connected modules, the Test Project will enable the assessment of the applied knowledge, skills, and behaviours set out in each section of the WSOS.

The purpose of the Test Project is to provide full, balanced, and authentic opportunities for assessment and marking across the Standards, in conjunction with the Marking Scheme. The relationship between the Test Project, Marking Scheme, and Standards will be a key indicator of quality, as will be its relationship with actual work performance.

The Test Project will not cover areas outside the Standards or affect the balance of marks within the Standards other than in the circumstances indicated by Section 2. This Technical Description will note any issues that affect the Test Project's capacity to support the full range of assessment relative to the Standards. Section 2.1 refers.

The Test Project will enable knowledge and understanding to be assessed solely through their applications within practical work. The Test Project will not assess knowledge of WorldSkills rules and regulations.

Most Test Projects and Marking Schemes are now designed and developed independently of the Experts. They are designed and developed either by the Skill Competition Manager, or an Independent Test Project Designer, normally from C-12 months. They are subject to independent review, verification, and validation. (Section 4.1 refers.)

The information provided below will be subject to what is known at the time of completing this Technical Description, and the requirement for confidentiality.

Please refer to the current version of the Competition Rules for further details.

5.2 Format/structure of the Test Project

The Test Project is a series of three (3) standalone or integrated modules.

5.3 Test Project design requirements

Test Projects should reflect the purposes, structures, processes, and outcomes of the occupational role they are based on. They should aim to be a small-scale version of that role. Before focusing on practicalities, SMTs should show how the Test Project design will provide full, balanced, and authentic opportunities for assessment and marking across the Standards, as set out in Section 5.1.

Modules may consist of PC boards that include conventional and surface mount components. Wiring, mechanical assembly, subunits may also be included.

Modification and measurement module

Final module is presented at the competition.

The boards may be conventional Through Hole (TH), Surface Mount Technology (SMT), or mixed technology boards. Surface Mount Devices (SMD) shall have no less than 0.5 mm of pin pitch.

And all surface mounted passive devices shall not be smaller than 0805 footprint. The boards must have a solder mask and optionally silkscreen (component designator).

The Independent Test Project Designer will supply at least one modified project. The Independent Test Project Designer will demonstrate a functioning project to Experts and Competitors at the competition but not show the modified board.

There will be a kit with components and the Competitor has to choose the appropriate components. The Competitor will not need to request any components. All boards are pre-built prior to the competition.

The skills tested throughout this module are:
- the ability to quickly get into an unknown circuit
- the ability to modify a circuit so that it acts differently (e.g. other gain of amplifier, other filter bandwidth, other logic behaviour).
- the level of PCB modification skills (e.g. de-soldering without damage)
- the ability to verify the changes through measurements

All electronic parts brought to the Competition should be in anti-static bags. Integrated Circuits to be brought in anti-static boxes inserted in anti-static foam.

The modifications can be but not limited to: anything related to traces, design errors, layout errors, defective components, substitute equivalent component, manufacturing issues.

The modifications will be told in the task.

Modifications should follow rework standard (IPC-7711A/7721A).

The modifications must be proven by measurements before and after modification.

Test Project Designer will supply a checklist of functionalities of the provided hardware without modifications which will be checked by Competitors in order to see if the starting point is the same for everyone.

There should not be any secret or hidden faults in the Test Project.

Hardware prototype design module

The hardware design may contain analogue, digital, and microcontroller(s), or a mixture of such components

This module involves three (3) phases:

• Phase 1: Development of circuit(s)

During phase one the Competitor must design a complete or partial circuit. The circuit(s) may be tested through simulation. For simulation LTspice is used.

• Phase 2: Design of PCB-board layout

During phase two the Competitor is given a reference schematic design. This circuit schematic is used by the Competitor and a double-sided Printed Circuit Board (PCB) is designed. The Competitor must prepare manufacturing documents: Gerbers, drills files, pdfs, Bills of Material (BOM), etc. The Competitor is given a component library that contains the schematic symbols and footprints needed to complete the PCB except for one or two components. The Competitor is expected to create the schematic symbol, and footprint for these one or two components. The Competitor may use their country's schematic drawings conventions.

All Competitors must use Autodesk Fusion 360 Electronics for PCB design. Competitors will only be required to use schematic, layout, and library functionality of Fusion 360.

The PCB design rules are supplied during the competition.

If the own PCB layout is chosen but violates the design rules, the PCB will be produced with the next available tools.

• Phase 3: Production and assembly of PCB

During phase three the prototype PCB is assembled and tested. If problems/errors in design are recognized at this stage they may be repaired.

The board will primarily use Surface Mount Technology. ICs must have 0.5 mm of pin pitch or greater. All surface mounted passive devices shall have an 0805 footprint or bigger.

Assembly should follow standard (IPC-610).

The Independent Test Project Designer will bring a functioning sample and all components (with extras). The individual will have a selection of components to choose from in their design.

The PCB is manufactured at the competition by the Competition Organizer between Competition Day 2 (C2) and the afternoon of Competition Day 3 (C3).

Embedded Systems Programming module

This module has the individual write C code for an embedded system. The embedded MCU is an ARM Cortex M0+: STM32L052.

All Competitors have to use same STM32Cube IDE for programming debugging and STM32CubeProgrammer for testing/flashing .hex files.

The device Programmer is the ST-LINK/V2 or newer.

The Independent Test Project Designer may prepare a custom PCB with a connector for the ST-LINK. The Competition Organizer will supply the The Independent Test Project Designer may prepare a custom PCB with a connector for the WorldSkills MCU board. The Competition Organizer will supply the WorldSkills MCU board, the custom task PCB and ST-LINK programmer.

Phase one is mostly related to the microcontroller functionality. It is mostly about set up the microcontroller configurations and usage of internal peripherals (e.g. external interrupts, timers, communication interfaces, ADC, DAC, external device drivers). There may not be given a template for that phase.

Phase two is more about an application. The microcontroller will be set up already. The task is about extending an already existing project (e.g. control of display, control interface/interaction with user, displaying sensor values, do something with sensor values).

A solution HEX-File will be given to demonstrate the expected functionality of the task, and to verify the functionality of the task hardware. Demonstration videos of the solution are provided.

Time allowed: 17 hours

Module	Time allowed	Suggested day
Hardware Design module	9 hr (3 hr A1, 3 hr A2, 3 hr A3)	A1 and A2 on C1 and A3 on C4
Modification and measurement	3 hr	C2
Embedded Systems Programming	5 hr (2h + 3h)	C3

General notes on modules

Each Independent Test Project Designer of modules will:

- Meet the Test Project design requirements;
- Supply documents that use a minimum number of words;
- Supply a small project brief;
- Supply parts lists; circuit diagrams, data sheet packs.

Project documentation is brought to the Competition in Microsoft Word. The Independent Test Project Designer is encouraged to use illustrations, diagrams, and videos to reduce the amount of text that requires translation.

The Independent Test Project Designer will use MS office tools or software used in the competition to create documentation.

Where possible, circuit diagrams, photographs, line drawings, etc. are used for all Modules and wording should be as brief as possible.

Specifications for Test Project modules

All Test Project modules must be powered by +/- 24V or less. Test Projects must be possible to complete using equipment on the IL.

All Test Project modules should be designed to be completed in the time allotted. Any HF, VHF, or higher frequency design or communications must be module based (e.g. Zigbee, 802.11, etc.)

5.4 Test Project coordination and development

The Test Project MUST be submitted using the templates provided by WorldSkills International (www.worldskills.org/expertcentre). Use the Word template for text documents and DWG template for drawings.

5.4.1 Test Project coordination (preparation for Competition)

Coordination of the Test Project/modules will be undertaken by the Skill Competition Manager.

5.4.2 Who develops the Test Project/modules

The Test Project/modules are developed by an Independent Test Project Designer (ITPD) in collaboration with the Skill Competition Manager

5.4.3 When is the Test Project developed

The Test Project/modules are developed according to the following timeline:

Time	Action
Fifteen (15) months prior to the Competition	The ITPD is identified and a Confidentiality Agreement between WSI and the ITPD is organized.
Two (2) months prior to the Competition	The Test Project/modules are sent to the WorldSkills International Skills Competitions Administration Manager.
At the Competition	The Test Project is presented to Experts and Competitors during the briefing at the beginning of each Module.

5.5 Test Project initial review and verification

The purpose of a Test Project is to create a challenge for Competitors which authentically represents working life for an outstanding practitioner in an identified occupation. By doing this, the Test Project will apply the Marking Scheme and fully represent the WSOS. In this way it is unique in its context, purpose, activities, and expectations.

To support Test Project design and development, a rigorous quality assurance and design process is in place (Competition Rules sections 10.6-10.7 refer.) Once approved by WorldSkills, the Independent Test Project Designer (ITPD) is expected to identify one or more independent expert(s), and trusted individuals initially to review the Independent Test Project Designer's ideas and plans, and subsequently to verify the Test Project, prior to validation.

A Skill Advisor will ensure and coordinate this arrangement, to guarantee the timeliness and thoroughness of both initial review, and verification, based on the risk analysis that underpins Section 10.7 of the Competition Rules.

5.6 Test Project validation

The Skill Competition Manager coordinates the validation of the Test Project/modules and will ensure that it can be completed within the material, equipment, knowledge, and time constraints of Competitors.

5.7 Test Project circulation

The Test Project/modules are not circulated prior to the Competition. The Test Project/modules are presented to Experts and Competitors on at the beginning of each Module.

All programme and firmware package versions are circulated via the WorldSkills Discussion Forum two (2) months prior to the Competition.

5.8 Test Project change

Due to the Test Project being developed by an Independent Test Project Designer (ITPD), there is no change required to be made to the Test Project/modules at the Competition. Exceptions are amendments to technical errors in the Test Project documents and according to infrastructure limitations.

5.9 Material or manufacturer specifications

Specific material and/or manufacturer specifications required to allow the Competitor to complete the Test Project will be supplied by the Competition Organizer and are available from www.worldskills.org/infrastructure located in the Expert Centre. However, note that in some cases details of specific materials and/or manufacturer specifications may remain secret and will not be released prior to the Competition. These items may include those for fault finding modules or modules not circulated.

This list is continuously updated by the Competition Organizer as new information is available. As it is the policy to not publish details about manufacturer, model, etc. until the Competition

Organizer has a signed contract with their sponsor/supplier it is recommended that Experts periodically look at the IL to ensure they don't miss any critical information.

However, the Independent Test Project Designer is expected to identify all tools and equipment needed to complete their Test Project on the Infrastructure List.

6 Skill management and communication

6.1 Discussion Forum

Prior to the Competition, all discussion, communication, collaboration, and decision making regarding the skill competition must take place on the WorldSkills skill-specific Discussion Forum. (http://forums.worldskills.org). Skill related decisions and communication are only valid if they take place on the WorldSkills Discussion Forum. The Chief Expert (or an Expert Lead appointed by the Skill Management Team) will be the moderator for this Discussion Forum. Refer to the Competition Rules for the timeline of communication and competition development requirements.

6.2 Competitor information

All information for registered Competitors is available from the Competitor Centre (www.worldskills.org/competitorcentre).

This information includes:

- Competition Rules
- Technical Descriptions
- Mark Summary Form (where applicable)
- Test Projects (where applicable)
- Infrastructure List
- WorldSkills Health, Safety, and Environment Policy and Regulations
- Other Competition-related information

6.3 Test Projects and Marking Schemes

Circulated Test Projects will be available from www.worldskills.org/testprojects and the Competitor Centre (www.worldskills.org/competitorcentre).

6.4 Day-to-day management

The day-to-day management of the skill competition during the Competition is defined in the Skill Management Plan that is created by the Skill Management Team. The Skill Management Team comprises the Skill Competition Manager, Chief Expert, and the Expert Leads. The Skill Management Plan is progressively developed in the six (6) months prior to the Competition and finalized at the Competition. The Skill Management Plan can be viewed in the Expert Centre (www.worldskills.org/expertcentre).

6.5 General best practice procedures

General best practice procedures clearly delineate the difference between what is a best practice procedure and skill-specific rules (section 9). General best practice procedures are those where Experts and Competitors CANNOT be held accountable as a breach to the Competition Rules or skill-specific rules which would have a penalty applied as part of the Issue and Dispute Resolution procedure including the Code of Ethics and Conduct Penalty System. In some cases, general best practice procedures for Competitors may be reflected in the Marking Scheme.

Topic/task	Best practice procedure
Standards and Assessment	• Competitors during their work and Experts during the assessment need to follow the Standard and Assessment Guide which is located on the WorldSkills website. • Competitors during their work and Experts during the assessment need to follow the Standard and Assessment Guide. • Experts must follow the Standards and Assessment Guide.
Tools/ infrastructure	• Competitors and Experts must wear ESD straps when handling PCBs and components.
Online Meetings	• Mandatory online meetings with new and experienced Experts and the SMT (e.g. 6 months, 3 months before competition)

7 Skill-specific safety requirements

7.1 Personal Protective Equipment

Refer to WorldSkills Health, Safety, and Environment Policy and Regulations for Host country or region regulations.

Task	Sturdy shoes with closed toe and no heel with ESD	Safety glasses with both protective sides	Dust mask	Protective Gloves (with no breakage)
General PPE for safe areas	Optional			
At the workbench	Optional	Optional		
Brazing, cutting, machining	Optional	√	Optional	Optional
Work with hazardous substances (e.g. cleaning)	Optional	√	Optional	Optional

8 Materials and equipment

8.1 Infrastructure List

The Infrastructure List details all equipment, materials, and facilities provided by the Competition Organizer.

The Infrastructure List is available at www.worldskills.org/infrastructure.

The Infrastructure List specifies the items and quantities requested by the Skill Management Team for the next Competition. The Competition Organizer will progressively update the Infrastructure List specifying the actual quantity, type, brand, and model of the items. Note that in some cases details of specific materials and/or manufacturer specifications may remain secret and will not be released prior to the Competition. These items may include those for fault finding modules or modules not circulated.

At each Competition, the Skill Management Team must review and update the Infrastructure List in preparation for the next Competition. The Skill Competition Manager must advise the Director of Skills Competitions of any increases in space and/or equipment.

At each Competition, the Technical Observer must audit the Infrastructure List that was used at that Competition for the upcoming WorldSkills Competition.

The Infrastructure List does not include items that Competitors and/or Experts are required to bring and items that Competitors are not allowed to bring – they are specified below.

8.2 Competitors toolbox

Competitors are not allowed to send a toolbox to the Competition. All tools are provided by the Competition Organizer.

8.3 Materials, equipment, and tools supplied by Competitors

It is not applicable for Competitors to bring materials, equipment, and tools to the Competition area at any time including familiarization day.

However, Competitors are required to supply their own Personal Protective Equipment as specified in section 7 skill-specific safety requirements.

Furthermore, Competitors are allowed to bring:

- Their own non-programmable standard keyboard; (If the Competitor does not bring their own keyboard a standard US layout keyboard is used. Competitors are allowed to change keyboard language to their personal preference. Competitors are allowed to place stickers on keys.)
- Personal Protective Equipment (safety glasses, shoes, gloves, ear protection (no electronics inside), mask

Native language to English translation dictionary

- Competitors can use a commonly available English to native language dictionary during the Competition. They cannot use custom or subject specific dictionaries.
- The dictionary must be in paper form, electronic dictionaries are not allowed if it is not provided by the Competition Organizer.

8.4 Materials, equipment, and tools supplied by Experts

Experts are required to supply their own Personal Protective Equipment as specified in section 7 skill-specific safety requirements.

Experts are responsible that Interpreters bring their own PPE.

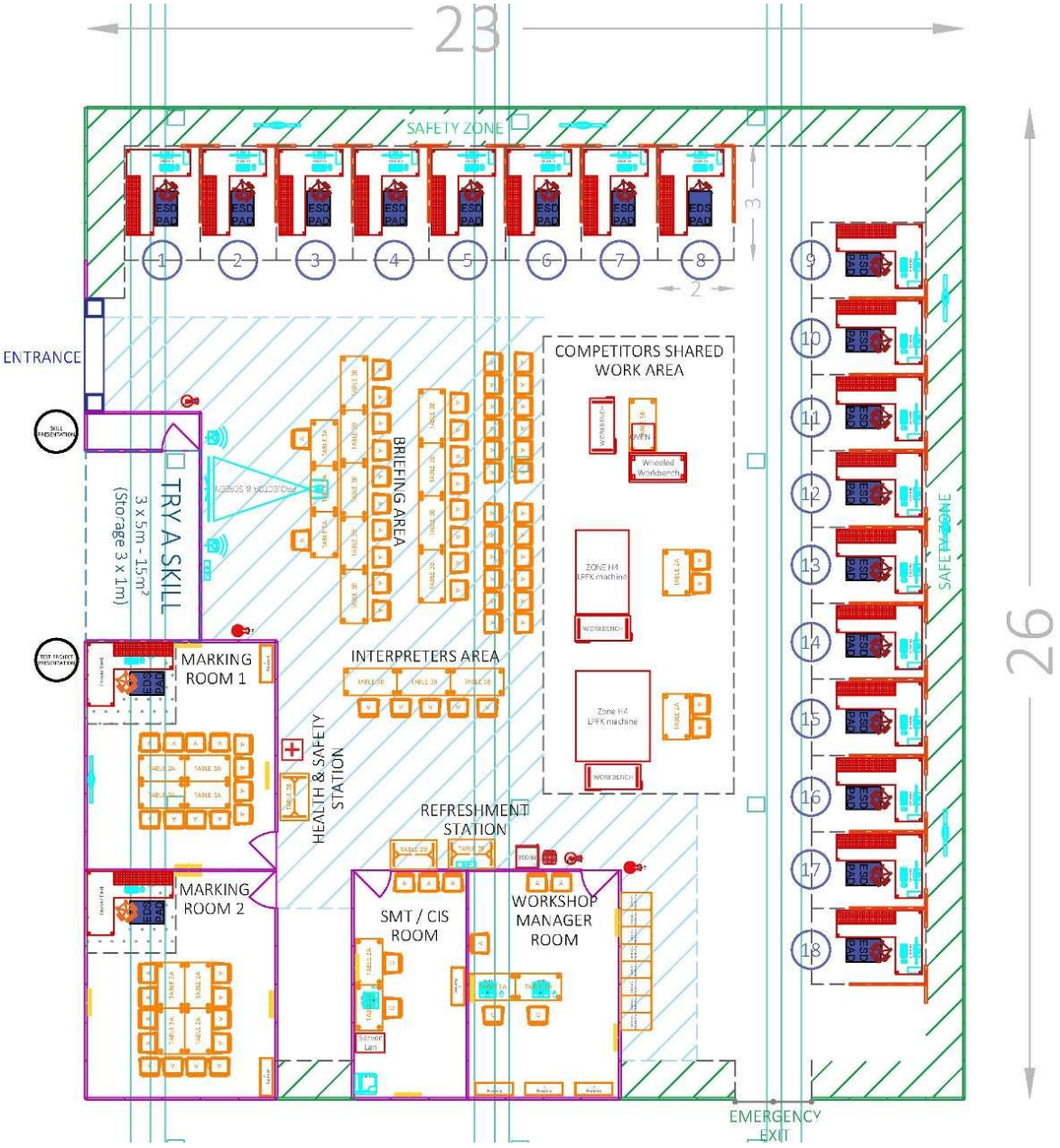
8.5 Materials and equipment prohibited in the skill area

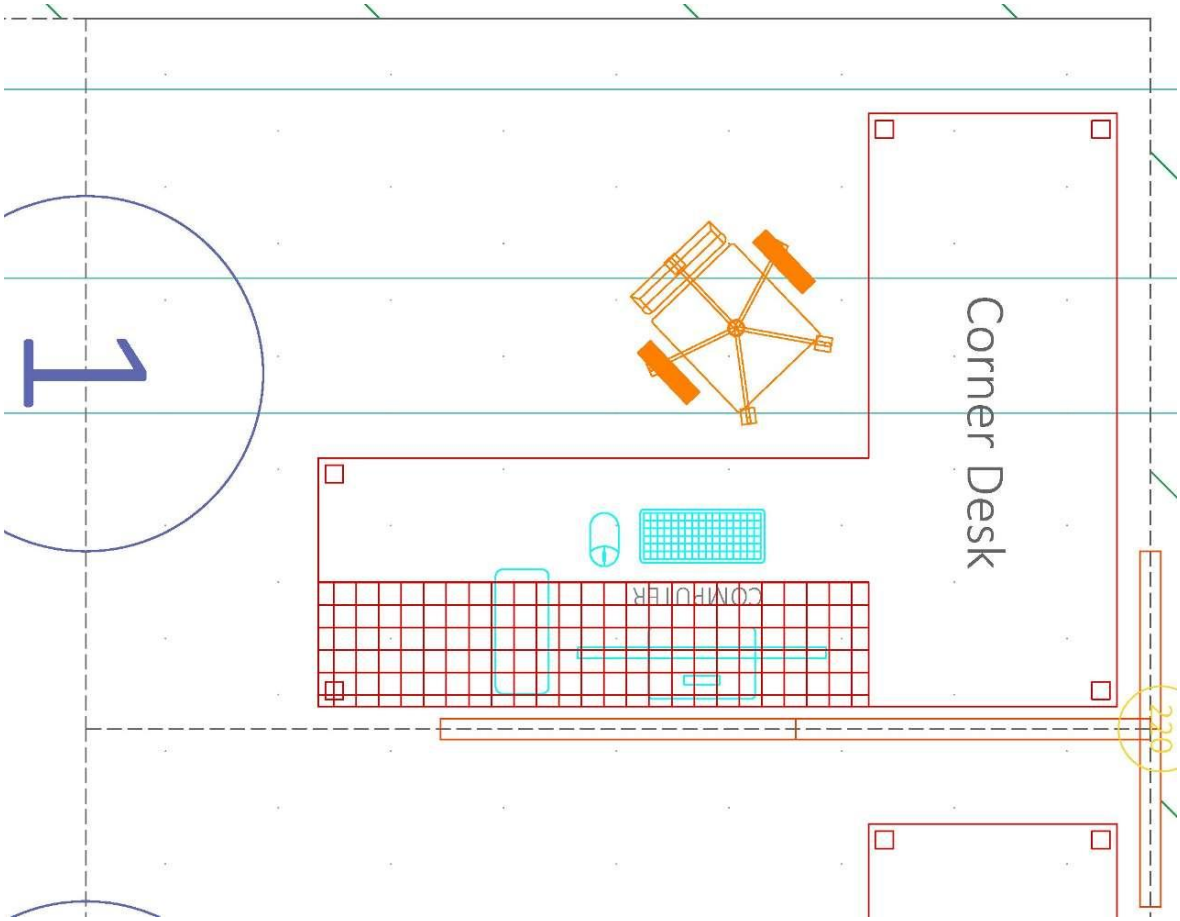
Competitors and Experts are prohibited to bring any materials or equipment not listed in section 8.3 and section 8.4.

8.6 Proposed workshop and workstation layouts

Workshop layouts from previous competitions are available at www.worldskills.org/sitelayout.

Example workshop layout





9 Skill-specific rules

9.1 General notes

Skill-specific rules cannot contradict or take priority over the Competition Rules. They do provide specific details and clarity in areas that may vary from skill competition to skill competition. This includes but is not limited to personal IT equipment, data storage devices, Internet access, procedures and workflow, and documentation management and distribution. Breaches of these rules will be solved according to the Issue and Dispute Resolution procedure including the Code of Ethics and Conduct Penalty System.

9.2 Skill-specific rules

Topic/task	Skill-specific rules
Use of technology – USB, memory sticks	• Competitors, Experts, and Interpreters are only allowed to use memory sticks provided by the Competition Organizer. No other memory sticks are to be inserted into the Competitor computers. • Competition memory sticks or any other portable memory devices must not be taken outside the workshop. • Competition memory sticks or other portable memory devices must be submitted to the Chief Expert at the end of each day for safe keeping. Note: The Competition Organizer may use specific software to check that the three previous rules are strictly followed. • The Chief Expert is exempt from this rule.
Use of technology – personal laptops, tablets, and mobile phones	• Competitors, Experts, and Interpreters are not allowed to bring personal laptops, tablets, or mobile phones into the workshop from C-4 until C4. • If Competitors, Expert, and Interpreters do bring these items into the workshop they must place them in their locker. They can use them at break times and take at the end of each day.
Use of technology – personal photo and video taking devices	• Competitors, Chief Expert, Experts, Workshop Manager, and Interpreters are not allowed to use personal photo and video recording devices in the workshop before the competition modules begin and during the translation and presentation of the module by the independent designer. • Once competition begins Competitors may not use photo and video recording devices. • Competitors, Experts, Interpreters, Workshop Manager, and visitors should obtain the consent of one of the Skill Management Team and those they wish to photograph.
Familiarization day	• PC time is limited. • The Competitor is allowed to use every software already installed on the software.

Topic/task	Skill-specific rules
	• No internet access is allowed.
Assessment process	• Groups of Experts are formed for each of the three (3) modules to be assessed; • Chief Expert allocates four (4) Experts for each sub criteria to assess; • Chief Expert nominates an assessment team leader for each sub criteria. The assessment team leader is responsible for the recording of results; • The team leader of each marking group needs to be fluent in English; • The Independent Test Project Designer proposes the outline of the marking standard to the project marking group; • Experts start marking after the end of each module. Each Expert marking group can organize the marking schedule after consultation with the Chief Expert; • Experts may not mark their compatriot Competitor. In this case, the assessment team leader will perform this role. • Assessment is completed each day (if possible); • Only the Expert marking group for a specific sub criterion assesses the sub criteria. All other Experts must leave the assessment area if they are not involved in assessment; • Where functionality of hardware is marked, the functionality should be assessed at the workbench of the Competitor. Dependent on the applicability and sensitivity of the task the SMT decide how this will be achieved; • The assessment procedure for each individual module must be set up by the assessment team with the reference documents, solutions, and/or designs from the Independent Test Project Designer before the start of the assessment; • The marking documents are kept secret until the end of the corresponding Module. • Competitors that use their own PCB design for assembly, will receive additional points. Competitors that use the reference PCB design will not receive these points. The decision has to be made by the Competitor by themselves at the end of PCB design. Hence, the Competitor will not see the reference PCB layout. The sheet to sign will be given with the task description. • The correctness of the exported gerbers should be checked by software . • For judgement, a reasonable time limit for inspection of the assessment criteria must be chosen by the assessment team leader to allow efficient marking. • First, the assessment group do the measurements of the circuit design task (A1) from the Competitor to be assessed in order to understand if the circuit works or lies within the task requirements or not. Afterwards the judgement(s) will be done.

Topic/task	Skill-specific rules
	• PCB Design: Gerbers, NC Drill files and BOM exporting: If no files are submitted or not OK, 0 points are awarded and the files are exported by Experts. • Assembly: The assembled PCBs must not be ranked from good to bad. The country code is not hidden. Hence, no blind marking. Every Expert should make their own opinion of the assembled PCBs. • Assembly: First, assess all SMT related aspects of all PCBs. Second, assess all THT related aspects of all PCBs and so on. Do not assess all aspects of one PCB and then go to the next.

10 Expert knowledge and experience

10.1 Requirements

Experts appointed for this skill competition must have the following knowledge and experience for the appropriate occupation or work role as documented in **section 1.1.2**.

1. Minimum qualification

- Vocational or technical training (Electronic Engineering or Electrical Engineering or Computer Engineering or Communication Engineering)

or

- Bachelor's degree (or equivalent) in Electronic Engineering (or Electrical Engineering or Computer Engineering or Communication Engineering)

2. Expected industry and/or TVET experience

- Graduates can work as installation and maintenance specialists, or in various roles within manufacturing, engineering, or related industries.
- Training teams to provide skills in troubleshooting, repairing, installing, and maintaining electronic equipment, programming microcontrollers, developing simulation tools, analyzing data, as well as the ability to interpret schematics and work with various tools and technologies.

3. Essential tools

List of must-have tools for an electronics Expert who wants to keep up with the latest technologies and practices:

- Electronic circuit design software (including circuit simulation software and PCB design tools)
- Laboratory instrumentation
- Microcontroller development platforms
- Version management software
- Project management and collaboration tools

4. Areas of specialism

Specialist in one or more areas such as:

- Analog Electronics
- Power Electronics
- Digital Systems
- Embedded Systems
- Signal Processing
- Telecommunications

5. Desired soft skills

For Electronics Experts to be successful, we suggest soft skills such as:

- Adaptability and flexibility
- Communication
- Problem-solving
- Resilience
- Teamwork and collaboration

- Time management and organization
- Stress management

6. Desired practical pkills

For Electronics Experts to be successful, we suggest practical skills such as:

- Problem-solving/diagnostic skills
- Diagnostic tool proficiency
- Lifelong learning

11 Visitor and media engagement

11.1 Engagement methods

Following is a list of possible ways to maximize visitor and media engagement:

- Try-a-Skill;
- Display screens outlining the tasks being performed;
- Test Project descriptions;
- Competitor profiles;
- Career opportunities;
- Daily reporting of Competition status;
- Display of interesting electronic project;
- Display of past Test Projects;
- Electronic game visitors can play;
- Encourage Independent Test Project Designer to develop Test Projects that are visually interesting and exciting;
- Encourage Independent Test Project Designer to allow open-ended solutions to tasks;
- Have the sponsor install a mini working electronic production line close to the workshop area.

12 Sustainability

12.1 Sustainable practices

This skill competition will focus on the sustainable practices below:

- Recycling;
  - Using Test Project from previous competition for different tasks;
  - Encourage use of industry donated components;
  - Use datasheets in PDF form
- Use of “green” materials – e.g. lead-free solder is used;
- Use of components available from Global Partners;
- Ensure that all items on IL are used.

13 References for industry consultation

13.1 General notes

WorldSkills is committed to ensuring that the WorldSkills Occupational Standards fully reflect the dynamism of internationally recognized best practice in industry and business. To do this WorldSkills approaches a number of organizations across the world that can offer feedback on the draft Description of the Associated Role and WorldSkills Occupational Standards on a two-yearly cycle.

In parallel to this, WSI consults three international occupational classifications and databases:

- ISCO-08: (http://www.ilo.org/public/english/bureau/stat/isco/isco08/)
- ESCO: (https://ec.europa.eu/esco/portal/home)
- O*NET OnLine (www.onetonline.org/)

13.2 References

This WSOS appears most closely to relate to a Microelectronics Engineering Technician: http://data.europa.eu/esco/occupation/0ea36a48-a27d-4515-b61f-3cab395cf60f

and/or Electronics Engineering Technicians:
https://www.onetonline.org/link/summary/17-3023.01 .

These links can also be used to explore adjacent occupations.

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The following table indicates which organizations were approached and provided valuable feedback for the Description of the Associated Role and WorldSkills Occupational Standards in place for WorldSkills Shanghai 2026.

Organization	Contact name
CTIcontrol	Miguel Ángel Pérez Alcántara, Research and Development Director
LPKF (Tianjin) Co. Ltd	Guo Guo, DQ Application Team Leader

14 Appendix

14.1 Appendix information

Not applicable.