Technical Description

Electronics

MANUFACTURING AND ENGINEERING TECHNOLOGY

TD16 v6.0 — WSC2017

worldskills

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:

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Stefan Praschl
Chair of the Competitions Committee

Michael Fung
Vice Chair of the Competitions Committee

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).

The electronics industry is very diverse and has evolved into several specialisms. Some Engineering Technicians/Technologists will work across many aspects of electronics, but increasing specialization and technical developments means that specialist Engineering Technician/Technologist are widely employed.

The key areas of specialism which can be seen as careers in their own right include the assembly and wiring of electronic products; the designing of prototype circuits to specifications and/or to solve specified technical problems; the installation and commissioning of equipment including the provision of customer support; service and maintenance which includes service at customer/repair/service-depot locations and remotely; and monitoring and testing to specifications: circuits, sub-assemblies and systems. Approving: circuits, sub-assemblies, systems as fit-for-purpose or meeting government regulations.

Electronics Engineering Technician/Technologists also rely on Schematic Capture and Layout software to create/verify/simulate schematic circuits and printed circuit boards. This is a specialised occupation in its own right, and also involves the creation of production documents such as Bills of Material, Gerber Files and Excellon drill files, and other automated equipment files.

Electronics specialists work in a wide range of industries supported by highly technical specialist equipment. Almost every aspect of today's world relies on, or directly uses, electronics technology. It can be said that all technologies today use Electronics in one form or another.

Electronics Engineering Technician/Technologists must work with a high degree of accuracy and precision, conforming to detailed specifications and international quality standards and demonstrating extensive technical ability. Due to the constant developments in technology, the electronics Engineering Technician/Technologist needs to be proactive in ensuring that his/her skills and knowledge are up-to-date and meet industry standards and expectations.

The Engineering Technician/Technologist may work directly with clients and will therefore need to demonstrate excellent customer service and communication skills and work effectively to time schedules. When working with clients, the Engineering Technician/Technologist may have to explain elements of complex electronics principles to assist the client to use equipment correctly. Often the nature of the establishment in which the electronics Engineering Technician/Technologist works will require them to respect confidentiality in relation to highly commercially sensitive information and to demonstrate integrity, honesty and a strong ethical sense.

The electronics specialist will work with a wide range of tools. These tools are often specialised, and include measurement test equipment. Computers and specialist software development tools are used to create programs for embedded systems, programmable devices and desktop systems. In addition, tasks will also require the use of specialist hand tools for the assembly and maintenance and rework of circuits. Surface mounted technology (SMT) is the dominant technology.

Industry also relies on Engineering Technician/Technologists to implement software solutions used to address manufacturing requirements. Engineering Technician/Technologists may also setup, configure and tune automated assemblies, circuits, systems and processes.

Embedding microcontroller units (MCUs) into systems forms the basis for Embedded Systems Engineering and is another electronics specialism. Embedded System design involves interfacing MCUs to the outside world via sensors/communication interfaces. It also involves the writing of quality software to perform required tasks.

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 – Competition Rules
- WSI – WorldSkills Standards Specification framework
- WSI – WorldSkills Assessment Strategy WSI Online resources as indicated in this document
- WorldSkills Health, Safety, and Environment Policy and Regulations

2 THE WORLDSKILLS STANDARDS SPECIFICATION (WSSS)

2.1 GENERAL NOTES ON THE WSSS

The WSSS specifies the knowledge, understanding, and specific skills that underpin international best practice in technical and vocational performance. It should reflect a shared global understanding of what the associated work role(s) or occupation(s) represent for industry and business (www.worldskills.org/WSSS).

The skill competition is intended to reflect international best practice as described by the WSSS, and to the extent that it is able to. The Standards Specification 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 not be separate tests of knowledge and understanding.

The Standards Specification 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 Specification. The sum of all the percentage marks is 100.

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

The Marking Scheme and Test Project will follow the allocation of marks within the Standards Specification to the extent practically possible. A variation of five percent is allowed, provided that this does not distort the weightings assigned by the Standards Specification.

2.2 WORLDSKILLS STANDARDS SPECIFICATION

SECTION		RELATIVE IMPORTANCE (%)
1	**Work organization and management**	**15**
	The individual needs to know and understand: • Creativity in the design of circuits, PCB layout, and programming • Critical thinking in the design of circuits, PCB, fault-finding and programming • Honesty and integrity • Self-motivation • Problem-solving • Effective working under pressure • Health and safety legislation • Best practices in relation to skills • The importance of continuing personal development • Company cultures and procedures and potential variations dependent on national practice	
	The individual shall be able to: • Work professionally in relation to the environment and others • Work with colleagues and teams both in the local environment and remotely • Present ideas to teams and clients • Exercise care in the workplace for personal and other's safety • Take appropriate preventative action to minimize accidents and their impact • Proactively engage in continuing professional development • Develop effective record keeping practices to facilitate traceability for future development and maintenance and to comply with international standards • Interpret and recognise international symbols, diagrams and languages used by other International Standards Institutes Source and purchase components and test equipment to meet specifications and be cost effective • Write reports and record data about testing techniques, laboratory equipment and specifications to assist engineers • Communicate effectively with customers • Train others on the use of installations • Keep up to date with changes in technology • Act professionally on clients' premises • Initiate records for on-going maintenance policy • Establish maintenance contracts where appropriate	

2	Application of electronics in practice	10
	The individual needs to know and understand: • The various electronics specialisms within specific industries • Commonly used and International industry standard symbols • Commonly used units of distance measurement (mils and mm) • The business environment of the client • materials and tools of the electronics industry in ordinary servicing, installation and repair tasks (Electronic Circuit Component Specifications • Analogue and digital logic circuit and sensor circuit • AC and DC technology • Power • Wire and cables • Connectors • Displays • Circuit Design • Analysis, of electrical circuits, electronic circuits, digital logic circuits and sensor circuits • Inductive and capacitive reactance • Capacitor and inductor characteristic charging and discharging behaviour • Capacitor selection and suitability to application • Passive and Active Filters • Oscillators (RC, Crystal, PLL) • Multistage Circuits • Basic amplifier circuits (AC, DC and power amplifiers) • Basic Op Amp circuits • Practical Operational Amplifier considerations. PID Control and servo systems • Generators and pulse shapers • Generators for sine wave voltage: RC, quartz, LC oscillators, Wien bridge generator, phase generator • Pulse shaper: Schmitt trigger, differentiator and integrator • Race Conditions • Truth tables, timing diagrams, karnaugh mapping, boolean algebra, combinational logic, combinational logic applications • Number systems • Properties of basic gates AND, OR, NOT, NAND, NOR, EXCLUSIVE OR EXCLUSIVE NOR • Procedures for substituting basic NAND or NOR gates for basic gates • Methods for creating digital logic to perform specified operations • Digital logic equation/functions from given circuits. • Industry standard waveform measurement characteristics Combinational and sequential logic circuits. • EMI Shielding techniques • Electrostatic Discharge (ESD) best practices	

	The individual shall be able to:
	• Identify and analyse the appropriate principle for the task
	• Apply cognitive skills as appropriate to the task
	• Use computers as a tool to perform
	  • circuit design, PCB Layout and Simulation
	  • programming of embedded devices
	  • test and measurement of components and circuit operation to given specifications
	  • The control of circuit boards and production machinery
	• Create communication links typically used in embedded systems.
	• Interface MCUs to external devices.
	• Read and interpret engineering drawings, wiring diagrams, schematic drawings, technical manuals and engineering instructions
	• Install equipment, components, units, upgrades or refurbished equipment into service	

3	**Prototype hardware design**	**20**
	The individual needs to know and understand: • The application of electronic principles • Specialist (PCB design) software • Design that is fit for purpose • The process of converting a design into actuality	
	The individual shall be able to: • Calculate and select component values that are fit-for-purpose • Implement heatsinking principles • Design modifications to given basic electronics blocks • Design circuits that meet specification and are fit for purpose. • Use computer circuit simulation software to test that circuit designs are fit for purpose. Discuss and interpret design briefs and specifications • Draw schematic circuits using schematic capture and PCB layout software • Use the 3D capabilities of PCB Layout software. • Lay out PCBs using industry best practices • Generate fit-for-purpose PCB manufacturing data. • Assemble components onto PCBs to create functional circuits • Test prototypes and adjust as required • Implement rework and repair mistakes in design to industry standards	

4	**Embedded systems programming**	**20**
	The individual needs to know and understand: • Embedded Systems • Microcontrollers • Microcontroller Development Tools • Integrated Software Development Environments commonly used in industry • Device Programming methods. • Programming embedded systems using the C-language and industry best practices • The application of microcontroller interfacing principles • Common MCU peripherals Programming and interfaces to external peripherals Power management techniques Watch-dog timers • Interrupt handling (ISRs) and resets	
	The individual shall be able to: • Locate, correct and re-compile syntax errors • Write, compile, upload, test and debug C-code that performs to specification. • Use common C functions • Use supplied functions • Write functions to perform a specified task • Open, compile and upload pre-written code onto embedded systems. • Modify, debug, download, verify/test pre-written codes on embedded systems • Design, write, debug, download/upload and verify/test programs to solve/perform specified tasks • Use and/or write interrupt handlers (ISRs) and/or polling techniques where appropriate • Use generally accepted best practices when writing code • Use pre-written code and/or design and write code that implements power management techniques	
5	**Fault finding and repair**	**15**
	The individual needs to know and understand: • The application of electronic principles • Contexts in which the function of fault finding, testing, repair and measurement takes place. The limitations and applications of test equipment • Implications of unreliable equipment on business and preventative maintenance • Techniques used to isolate faults • Techniques used to make measurements on practical circuits • Software techniques used in troubleshooting embedded systems • How to work safely with high voltage and high currents • Effects of ESD and working safely with ESD sensitive devices	

	The individual shall be able to: • Check the functionality and calibration of test equipment. • Select the appropriate equipment to perform measurements. • Take measurements to test, set, adjust, and measure electronic components, modules, and equipment using measurement equipment that can measure and analyse voltage, currents, and waveforms. • Determine causes of operating errors and the required action to repair. • Isolate faults to the component level. • Adjust/replace/upgrade defective or improperly functioning circuitry and/or electronics components, using hand-tools and through-hole and surface mount soldering techniques • Test electronics units and components, using standard test equipment • Analyse results to evaluate performance against specification and determine the need for adjustment • Record evidence of successful repair • Collect and analyse the evidence both manually and remotely • Complete repair reports that record the nature, evidence, cause and repairs performed on faulty units • Support the development of preventative maintenance schedules • Perform preventative maintenance and calibration of equipment and systems • Use automatic test equipment • Use digital documentation • Measure specific electrical parameters with precision and/or plotting variations over time in order to determine correct circuit functionality • Determine if an electronic component meets specification • Design and implement test strategies to localize/find faults • Use computers as a tool to perform test routines, implement test strategies and collect and analyse test data • Replace components and perform rework to industry standards.	
6	**Assembly and Measurement**	**20**
	The individual needs to know and understand: • Relevant industry standards. • The application of electronic principles • The purposes and functions of components to fulfil required tasks • Typical tools used in electronic assembly • Safe working practices • ESD safe working practices • How to make, save and print accurate DSO measurements	

	The individual shall be able to: • Identify and assemble and use electro-mechanical parts. • Identify and assemble common sensors. Assemble mechanical parts to form working units • Wire and form cables harnesses • Identify, assemble and use various types of parts and surface mounted device parts • Work to correct sequences and tolerances • Solder components using lead free solder to comply with industry standards • Install, test and calibrate a completed assembly to customer specifications	
	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 Specification. The Test Project is the assessment vehicle for the skill competition, and also follows the Standards Specification. The CIS enables the timely and accurate recording of marks, and has expanding supportive capacity.

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

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

4 THE MARKING SCHEME

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 standards that represent the skill. It is designed to allocate marks for each assessed aspect of performance in accordance with the weightings in the Standards Specification.

By reflecting the weightings in the Standards Specification, the Marking Scheme establishes the parameters for the design of the Test Project. Depending on the nature of the skill 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 Specification, if there is no practicable alternative.

The Marking Scheme and Test Project may be developed externally by one person, or several, or by all Experts. The detailed and final Marking Scheme and Test Project designed externally must be approved by the whole Expert Jury prior to submission for independent quality assurance. The exception to this process is for those skill competitions which use an external designer for the development of the Marking Scheme and Test Project where the final versions of the Marking Scheme and Test Project are quality approved and quality assured by the Skill Competition Manager.

In addition, Experts are encouraged to submit their Marking Schemes and Test Projects for comment and provisional approval well in advance of completion, in order to avoid disappointment or setbacks at a late stage. They are also advised to work with the Skill Advisors at this intermediate stage, in order to take full advantage of the possibilities of the CIS.

In all cases the complete and approved Marking Scheme must be entered into the CIS at least eight weeks prior to the Competition using the CIS standard spreadsheet or other agreed methods. The Skill Competition Manager is responsible for this process.

4.2 ASSESSMENT CRITERIA

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

Assessment Criteria are created by the person(s) developing the Marking Scheme, who are free to define 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 Mark Summary Form generated by the CIS will comprise a list of the Assessment Criteria.

The marks allocated to each criterion will be calculated by the CIS. These will be the cumulative sum of marks given to each A 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) has a specified day on which it will be marked.

Each marking form (Sub Criterion) contains Aspects to be assessed and marked by measurement or judgement. Some Sub Criteria have Aspects marked by both measurement and judgement, in which case there is a marking form for each.

4.4 ASPECTS

Each Aspect defines, in detail, a single item to be assessed and marked together with the marks, or instructions for how the marks are to be awarded. Aspects are assessed either by measurement or judgement, and appear on the appropriate marking form.

The marking form lists, in detail, every Aspect to be marked together with the mark allocated to it and a reference to the section of the skill as set out in the Standards Specification.

The sum of the marks allocated to each Aspect must fall within the range of marks specified for that section of the skill in the Standards Specification. 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)

		CRITERIA								TOTAL MARKS PER SECTION	WSSS MARKS PER SECTION	VARIANCE
STANDARDS SPECIFICATION SECTION		A	B	C	D	E	F	G	H			
	1			2.75	1.00	1.25	0.25	1.00		6.25	6.00	0.25
	2		4.25			2.00		0.50	1.00	7.75	6.00	1.75
	3	11.00	9.75							20.75	22.00	1.25
	4			10.25	11.00					21.25	22.00	0.75
	5					9.50	10.00	1.50		21.00	22.00	1.00
	6					2.00		7.00	14.00	23.00	22.00	1.00
TOTAL MARKS		11.00	14.00	13.00	12.00	14.75	10.25	10.00	15.00	100.00	100.00	6.00

4.5 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
- 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, with a fourth acting as a judge where required to prevent compatriot assessment.

4.6 ASSESSMENT AND MARKING USING MEASUREMENT

Three Experts will be used to assess each aspect. 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.

4.7 THE USE OF MEASUREMENT AND JUDGEMENT

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

4.8 COMPLETION OF SKILL ASSESSMENT SPECIFICATION

(a) Hardware Prototype Design module - 30 marks
  (i) Phase 1: Development of circuit(s) - 5 marks
  (ii) Phase 2: Design of PCB-board layout and production of Gerber files -15 marks
  (iii) Phase 3: Production and assembly of PCB – 5 marks
  (iv) Functionality of PCB prototype to specification- 5 marks

(b) Embedded Systems Programming Module - 25 marks
  (i) Functionality - 20 marks
  (ii) Following Best Practices as described in "Trade 16: World Skills Coding Standard" which will be posted on the Expert's forum. – 5 marks

(c) Fault Finding and Repair Module - 25 marks
  (i) Finding faults and evidence - 15 marks
  (ii) Repairing to Rework standard (IPC-7711A/7721A) – 5 marks
  (iii) Fault analysis and improvements to design to prevent future failure – 5 marks

(d) Assembly and Measurement Module - 20 marks
  (i) Functionality - 10 marks;
  (ii) Assembled quality according IPC-A-610 F - 5 marks
  (iii) Measurement Correctness and Quality. - 5 marks.

4.9 SKILL ASSESSMENT PROCEDURES

Groups will be formed of experts for each of the four modules to be assessed.

- Chief Expert allocates four to five Experts for each module.
- Chief Expert nominates an assessment team leader for each module. The assessment team leader is responsible for the recording of results and does not normally perform the marking function.
- Ideally one Expert in each group is fluent in the English language.

The project provider 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). All assessments are done when the last module's assessment is completed.

Only the Expert marking group for a specific module assesses the module. All other Experts may leave the Competition site if they are not involved in assessment. Modules are assessed in the Expert room.

5 THE TEST PROJECT

5.1 GENERAL NOTES

Sections 2,3 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 skills in each section of the WSSS.

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

The Test Project will not cover areas outside the Standards Specification, or affect the balance of marks within the Standards Specification other than in the circumstances indicated by Section 2.

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.

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 Specification. Section 2.1 refers.

5.2 FORMAT/STRUCTURE OF THE TEST PROJECT

The format of the Test Project may be a series of standalone or integrated modules.

5.3 TEST PROJECT DESIGN REQUIREMENTS

All modules will be provided by an independent provider.

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

Assembly Module

The recommended ratio of component assembly, wiring and mechanical assembly is approximately 75%, 15% and 10% respectively.

All surface mount components to have no more than 20 pins and no less than 0.65mm of pin to pin pitch. And all surface mounted passive devices shall not be smaller than 0805 foot-print.

A working demonstration module will be supplied together with spare replacement components All electronic parts brought to the competition should be in antistatic bags.

In the event that special assembly tools are required to complete the assembly. The supplier must inform the Skills Competition Manager (SCM) so that they can be added to the IL. Notification should be given before the Competition Preparation Week approximately eight months before the competition.

Fault Finding and Repair Module

The fault-finding task will use the project disclosed on the expert forum.

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 0.65 mm of pin pitch. And all surface mounted passive devices shall not be smaller than 0805 foot-print.

The Independent supplier will supply at least one working project. The independent supplier will demonstrate a functioning project to experts and competitors at the competition.

Replacement components for every component in the project will be available during the competition.

All boards will be pre-built before the Competition. Each board will have a minimum of five faults.

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.

Hardware Prototype Design Module

This module involves 3 phases. During Phase 1 the individual must design a complete or partial circuit. The circuit(s) must be tested through simulation.

During phase 2 the individual will be given a reference schematic design. This circuit schematic will be captured by the individual and a **single-sided** Printed Circuit Board (PCB) will be designed. The individual must prepare manufacturing documents: Gerbers, drills files, pdfs, Bills of Material (BOM), etc. The individual will be given a component library that contains the schematic symbols and footprints needed to complete the PCB except for one component. The individual will be expected to create the schematic symbol and footprint for this one component. The individual may use their country's schematic drawings conventions.

During phase 3 the Prototype PCB is assembled and tested. If problems/errors in design are recognised at this stage they may be repaired.

The board will primarily use Surface Mount Technology. ICs must have 0.65 mm of pin pitch or greater. All surface mounted passive devices shall have an 0805 footprint or bigger.

Competition time for this module is 7.5 hours, phase 1: 2h, phase 2: 3.5 h, phase 3: 2 h.

The Independent supplier will bring a functioning sample and all components (with extras) needed to assemble the prototype. The individual will have a selection of components to choose from in their design. All complex components that may be used will be identified (along with their datasheets) in the Expert's forum.

Common fundamental components:

- Op amps and comparators;
- Logic gates (AND, NAND, counters, shift registers, monostables, etc.);
- Passive components (resistors, capacitors, etc.) ;
- Discrete semiconductors (transistors, diodes, zeners etc);
- Opto components (optocouplers, slotted optos, 7 segment displays, etc.);

Will not have their data sheets provided in advance.

The PCB design rules will be supplied during the competition.

The PCB will be manufactured at the competition by the Competition Organizer between day two (C2) and the afternoon of day three (C3).

The Hardware Design may contain analogue, digital, and microcontroller(s), or a mixture of such components.

Embedded Systems Programming module

This module has the individual write C code for an embedded system. The embedded MCU will be an ARM Cortex M0+: STM32L052 or STM32L053.

The IDE used will be Keil uVision5. uVision5 has an evaluation and lite version that can be used for training (http://www.keil.com).

The device Programmer will be the ST-LINK/V2 (http://www.st.com/content/st_com/en/products/development-tools/hardware-development-tools/development-tool-hardware-for-mcus/debug-hardware-for-mcus/debug-hardware-for-stm32-mcus/st-link-v2.html)

The independent supplier may prepare a custom PCB with a connector for the ST-LINK/V2. The competition organizer will supply the custom PCB and ST-LINK/V2 programmer.

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.

The program will be in C only. Interrupts and Interrupt Service Routines (ISRs) may be used. In-line assembly is not allowed.

If the task includes a complex external component, then the datasheet and software library will be provided at C-2 months via the Expert's forum.

TIME ALLOWED 19.5 HOURS

MODULE	TIME ALLOWED	SUGGESTED DAY
Hardware Design Module	7.5 hours (2+3.5+2)	C1 and C3
Assembly and Measurement Module	4 hours	C2
Fault Finding and Repair	4 hours	C3
Embedded Systems Programming	4 hours	C4

General notes on modules

Each independent supplier of Modules will:

- Meet the Test Project design requirements;
- Supply documents that use a minimum number of words;
- Supply documents that can be translated quickly into the chosen language of the Competitor;
- Supply a small project brief;
- Supply parts lists; circuit diagrams, data sheet packs.

Project documentation will be brought to the Competition on CD/DVD or memory stick in Microsoft Word. All lines are to be double spaced underneath to allow for translation into the chosen language of the Competitors. The independent supplier is encouraged to use illustrations, diagrams and videos to reduce the amount of text that requires translation.

The independent supplier will use MS office tools or software used in the competition to create documentation. Paper copies should also be presented and where possible in three official Languages.

Where possible, circuit diagrams, photographs, line drawings, etc. will be used for all modules and project 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 tasks 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 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 Who develops the Test Project or modules

The Test Project modules are developed by an independent external company.

5.4.2 How and where is the Test Project or modules developed

Test Project/modules are developed independently under the direction of the SCM.

5.4.3 When is the Test Project developed

The Test Project is developed according to the following timeline:

TIME	ACTIVITY
At C-12 months or earlier	The circuits/system that will be used for the fault-finding task will be made known to Experts via the Expert's forum. Experts will be given the information needed to create the circuit/system.
Two (2) months before the first Competition preparation day	70% of the components used in the assembly module will be identified, along with their data sheets. If the SD task includes a complex external component, then the datasheet and software library will be provided.

5.5 TEST PROJECT VALIDATION

The SCM will validate the Test Project. Test project must meet the description in section 5.3 TEST PROJECT DESIGN REQUIREMENTS.

Time limit

The time allocated to each module is:

- Hardware Design Project – 7.5 hours;
- Embedded Systems Programming - 4 hours;
- Fault Finding, repair - 4 hours;
- Assembly and Measurement Project - 4 hours.

However, the time allotted may adjusted during the competition if it is determined necessary by the SCM.

5.6 TEST PROJECT SELECTION

The Test Projects are provided by independent suppliers under the direction of the SCM.

Test Project presentation

Test Project(s) will be presented to Experts by the independent supplier. An example will be shown working in physical form with all required functions shown to be working. Videos can support but not replace the demonstration of Test Project functionality.

5.7 TEST PROJECT CIRCULATION

The Test Project is circulated via the website as follows:

The Test Project(s) is circulated via the website as follows:

In general, no information regarding Test Project is supplied in advance. Exceptions to this include the circulation of data sheets, software libraries at C-2 months and fault finding circuit/systems at C-12 months.

5.8 TEST PROJECT COORDINATION (PREPARATION FOR COMPETITION)

Coordination of the Test Project during the competition will be undertaken by the team assigned by the CE. Each Expert Team assigned to a Test Project Module will have a leader assigned by the CE.

5.9 TEST PROJECT CHANGE AT THE COMPETITION

If, during the competition a technical problem with the project is discovered the SCM, CE, and DCE (the Skills Management Team - SMT) will determine a workable solution to the problem and adjustments to the task as needed.

The SMT will consult with the Test Project Team Leader when determining the workable solution.

5.10 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.

This lists is continuously updated by the Host Country 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 you don't miss any critical information.

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 skill specific Discussion Forum (http://forums.worldskills.org). Skill related decisions and communication are only valid if they take place on the forum. The Skill Competition Manager (or an Expert nominated by the Skill Competition Manager) will be the moderator for this Forum. Refer to 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 (I.L)
- 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 during the Competition is defined in the Skill Management Plan that is created by the Skill Management Team led by the Skill Competition Manager. The Skill Management Team comprises the Skill Competition Manager, Chief Expert, and Deputy Chief Expert. The Skill Management Plan is progressively developed in the eight months prior to the Competition and finalized at the Competition by agreement of the Experts. The Skill Management Plan can be viewed in the Expert Centre (www.worldskills.org/expertcentre).

7 SKILL-SPECIFIC SAFETY REQUIREMENTS

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

- All individuals must have Electrostatic Discharge (ESD) awareness and use ESD straps when working with components/circuits.
- All individuals must wear eye protection while soldering or cutting component leads.
- It is recommended that shoes have closed toes and be ESD safe.

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 Competition Manager on behalf of the Experts for the next Competition. The Competition Organizer will progressively update the Infrastructure List specifying the actual quantity, type, brand, and model of the items. Items supplied by the Competition Organizer are shown in a separate column.

At each Competition, the Skill Competition Manager must review, audit, and update the Infrastructure List in partnership with the Technical Observer in preparation for the next Competition. The Skill Competition Manager must advise the Director of Skills Competitions of any requests for increases in space and/or equipment.

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 and Experts do not bring a tool box or tools to the competition as all tools and equipment are supplied by the host country.

8.3 MATERIALS, EQUIPMENT, AND TOOLS SUPPLIED BY COMPETITORS IN THEIR TOOLBOX

Not applicable.

8.4 MATERIALS, EQUIPMENT, AND TOOLS SUPPLIED BY COMPETITORS

Competitors are not permitted to bring any equipment, supplies, or tools for use in the competition except for an English translation dictionary. Competitors may also bring personal items such as prescription safety glasses, ear protection, headphones and approved music player.

8.5 MATERIALS, EQUIPMENT, AND TOOLS SUPPLIED BY EXPERTS

Experts are not permitted to bring any equipment, supplies or tools for use in the competition except for an English Translation Dictionary.

8.6 MATERIALS, EQUIPMENT, AND TOOLS SUPPLIED BY HOST COUNTRY

The host country will supply all the items on the I.L.

Computers supplied by the Host Country will use the current version of Windows capable of supporting software used in the competition. Windows will be installed and use the English language. The Host Country will install the software required for the competition and use the English language version.

A standard US layout keyboard will be used. Competitors are allowed to change keyboard language to their personal preference. Competitors will be allowed to place stickers on keys.

8.7 MATERIALS, EQUIPMENT, AND TOOLS SUPPLIED BY INDEPENDENT SUPPLIER

The independent supplier may only supply equipment and tools that are needed for their task and not on the I.L. However, independent suppliers are expected to identify all tools and equipment needed to complete their Test Project on the Infrastructure List.

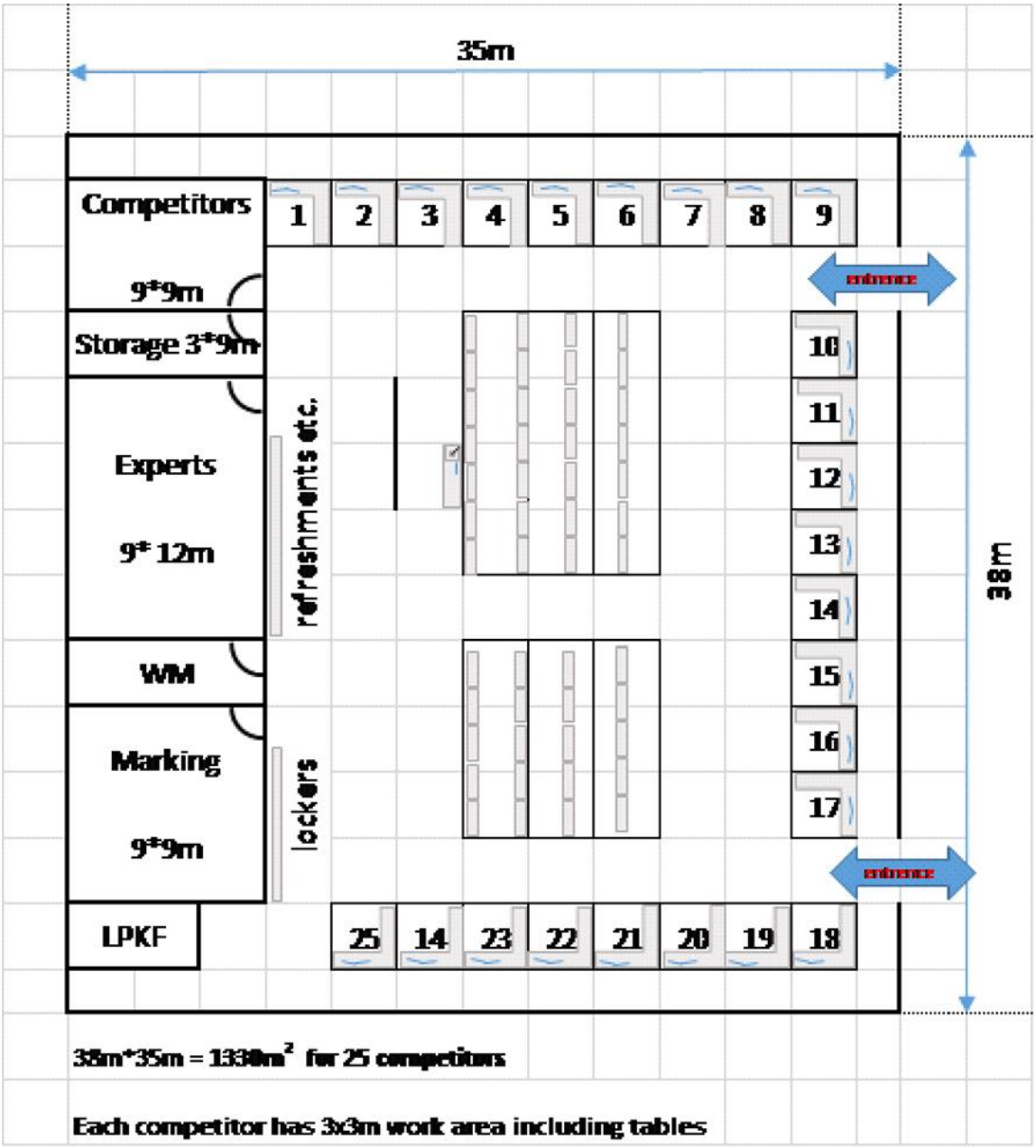
8.8 NATIVE LANGUAGE TO ENGLISH TRANSLATION DICTIONARY

Competitors may use a commonly available English to native language dictionary during the competition. They may not use custom or subject specific dictionaries. The dictionary must be in paper form, electronic dictionaries are not allowed.

8.9 PROPOSED WORKSHOP AND WORKSTATION LAYOUTS

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

Example workshop layout:



9 SKILL-SPECIFIC RULES

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 work flow, and documentation management and distribution.

TOPIC/TASK	SKILL-SPECIFIC RULE
Use of technology – USB, memory sticks	• Competitors 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 are to be submitted to the Chief Expert at the end of each day for safe keeping and must not be taken out of the workshop. • Note: The Competition Organizer may use specific software to check that the three previous rules are strictly followed.
Use of technology – personal laptops, tablets and mobile phones	• Competitors and Interpreters are not allowed to bring personal laptops, tablets or mobile phones into the workshop.
Use of technology – personal photo and video taking devices	• Competitors, Experts, and Interpreters are allowed to use personal photo and video recording devices in the workshop before the competition task begins and during the presentation of the task by the independent supplier with the exception of the Hardware Design Module that spans multiple days of the competition. • Once competition begins competitors may not use photo and video recording devices. • Photo and video recording devices may be used after the conclusion of the competition on C4. • Competitors, Experts, Interpreters, visitors should obtain the consent of those they wish to photograph.
Tools/infrastructure	• Competitors and Experts must wear ESD straps when handling PCBs and components.

10 VISITOR AND MEDIA ENGAGEMENT

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

- Try a trade;
- 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 suppliers to develop test projects that are visually interesting and exciting;
- Encourage independent supplier to allow open-ended solutions to tasks;
- Sponsor install a mini working electronic production line close to the competition area.

11 SUSTAINABILITY

This skill competition will focus on the sustainable practices below:

- Recycling. - Using project from previous competition for different task;
  - Encourage use of industry donated components;
  - Use datasheets in PDF form
- Use of 'green' materials – e.g. lead-free solder is used;
- Competition tasks---- Host country funding;
- Use of components available from global suppliers;
- Ensure that all items on IL are used;