worldskills Europe

Technical Description

Electronics Prototyping

1 Introduction

1.1 Name and description of the skill competition

1.1.1 The name of the skill competition is

Electronics Prototyping

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 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.

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: aerospace/ aeronautics, the military, robotics, audio/TV/entertainment, laboratories and hospitals, higher education research laboratories, communications and telecommunications, power, transport, security, manufacturing including instrumentation.

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 content, relevance and significance of this document

This document incorporates a Role Description and Occupational Standards which follow the principles and some or all of the content of the WorldSkills Occupational Standards. In doing so WSE acknowledges WorldSkills International's (WSI's) copyright. WSE also acknowledges WSI's intellectual property rights regarding 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:

- WSE – Competition Rules
- WSI – WorldSkills Occupational Standard framework
- WSE – WorldSkills Europe Assessment Strategy
- WSE – Online resources as referenced in this document
- WSE – Code of Ethics and Conduct
- Host Country – Health and Safety regulations

2 The Occupational Standards

2.1 General notes regarding WSOS / WSEOS

Where appropriate WSE has utilised some, or all, of the WorldSkills International Occupational Standards (WSOS) for those Skills Competitions that naturally align between the two international competitions. Where the Skill is exclusive to the EuroSkills Competition, WorldSkills Europe has developed its own Occupational Standards (WSEOS) using the same principles and framework to that used for the development of the WSOS. For the purposes of this document the use of the words “Occupational Standards” will refer to both WSOS and WSEOS.

The Occupational Standards 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. Helpfully, for the global consultation on the WSOS in 2014-2021, around 50 percent of responses came from European industry and business.

Each Skill Competition is intended to reflect international best practice as described by the Occupational Standards, and to the extent that it is able to. The Occupational Standards 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 Occupational Standards are 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 Occupational Standards. 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 Occupational Standards. They will reflect the Occupational Standards 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 Occupational Standards to the extent practically possible. A variation of five percent is allowed, provided that this does not distort the weightings assigned by the Occupational Standards.

2.2 Occupational Standards

Section		Relative importance (%)
1	**Work organization and self-management**	5
	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	

Section		Relative importance (%)
	• Effective working under pressure • Best practices in relation to skills • Health and safety legislation and best practice in relation to the skill • Various electronics specialisms within specific industries • Different international languages and symbols and the interpretation of expressions between English and international languages, electronic symbols and units of measurement • The importance of continuous personal development • The application of electronic principles	
	The individual shall be able to: • Work professionally in relation to the environment and others • 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 recognize 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 • 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	**Communication and interpersonal skills**	**5**
	The individual needs to know and understand: • 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. • 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 individual shall be able to: • Work with colleagues and teams both in the local environment and remotely • Present ideas to teams and clients	

Section		Relative importance (%)
	• Communicate effectively with customers • Train others on the use of installations • 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.	
3	**Application of electronics principles in practice**	**15**
	The individual needs to know and understand: • The various electronics specialisms within specific industries • Commonly used 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. • Generator 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	

Section		Relative importance (%)
	• 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 • 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	
4	**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 • Design the PCB layout using CAD program according to the requirements • Use the ready-made 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	

Section		Relative importance (%)
	• Implement rework and repair mistakes in design to industry standards	
5	**Embedded systems programming**	**20**
	The individual needs to know and understand: • Embedded Systems • Algorithms and data structures • 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)	
	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	
6	**Fault finding and repair**	**15**
	The individual needs to know and understand: • The application of electronic principles	

Section		Relative importance (%)
	• 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 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	
7	**Assembly and measurement**	**20**

Section		Relative importance (%)
	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 approach & principles

3.1 General guidance

Note: this Section and Section 4 summarize a great deal of new information and guidance regarding assessment. Please refer to the Competition Rules for greater detail.

The Competition Committee (CC) establishes the principles and techniques to which assessment at the EuroSkills Competition must conform.

Expert assessment practice lies at the heart of the EuroSkills 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 EuroSkills Competition: the Marking Scheme, Test Project, and Competition Information System (CIS).

Assessment at the EuroSkills Competition falls into two broad types: measurement and judgement. All assessments will be governed by explicit benchmarks, referenced to best practice in industry and business.

The Marking Scheme must include these benchmarks and follow the weightings within the Occupational Standards. The Test Project is the assessment vehicle for the Skill Competition, and also follows the Occupational Standards. 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 Technical Description and the principles for assessment as set out in the WSE Assessment Strategy. They will be agreed by the Experts and submitted to WSE for approval together, in order to demonstrate their quality and conformity with the Occupational Standards.

Prior to submission for approval to WSE, the Marking Scheme and Test Project will be reviewed by the WSE 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 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
		A	B	C	D	E	F	G	H			
STANDARDS SPECIFICATION SECTION	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 Assessment overview

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

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

- Chief Expert allocates Expert marking groups for each module. The number of groups depends on the number of participating countries.
- Chief Expert nominates an assessment team leader for each module. The assessment team leader is responsible for the recording of results.
- Ideally one Expert in each group has experience in EuroSkills or WorldSkills Competition.

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.

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.

4.10 Skill Assessment Procedures - Mark distribution

This section defines the assessment criteria and the number of marks (judgement and measurement) awarded. The total number of marks for all assessment criteria must be 100. The table below is advisory only for the development of the Test Project and Marking Scheme.

Module A: Hardware Prototype Design – 50 marks

- A1: Development of circuit(s) - 15 marks
- A2: Design of PCB-board layout -15 marks
- A3: Assembly (IPC-A-610 F) - 10 marks
- A3: Functionality of PCB prototype to specification – 10 marks

Module B: Embedded Systems Programming – 30 marks

- B1: Basic functions of control unit - 15 marks
- B2: Full control routines - 15 marks

Module C: Fault finding Repairing, Modification and Measuring – 20 marks

Timing: model for single competitor

Time	Single competitor
5,5 h	**A: Hardware Prototype design – 5.5 h** A1: Development of circuit(s) A2: Design of PCB-board layout
6 h	**B: Embedded Systems Programming – 6 h** B1: Basic functions of control unit B2: Full control routines
6 h	**A: Hardware Prototype design – 3 h** A3: Assembly (IPC-A-610 F) **C: Fault finding, Reapeiring, Modification and Measuring– 3 h**

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 skills in each section of the Occupational Standards.

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

The Test Project will not cover areas outside the Occupational Standards, or affect the balance of marks within the Occupational Standards other than in the circumstances indicated by Section 2.1.

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 the EuroSkills Competition's 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 Standard Specification. Section 2.1 refers.

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

The Test Project should be designed to engage the spectators.

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

Module A: Hardware Prototype Design (time totally 8.5 h)

This module involves 3 phases. Competition time for this module is 8.5 hours, phase A1: 2h, phase A2: 3.5h, phase A3: 3h.

The developer of the Test project will bring a functioning sample and all components (with extras) needed to assemble the prototype. The Competitor will have a selection of components to choose from in their design. All specific components that may be used will be identified (along with their datasheets).

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

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

The PCB design rules will be supplied during the competition. The PCB will be manufactured at the competition by the Competition Organizer during day two (C2). The Hardware Design may contain analogue, digital, and microcontroller(s), or a mixture of such components.

The board will use Surface Mount Technology and Thru Hole Technology. All surface mount components to have no more than 28 pins and no less than 0.65mm of pin-to-pin pitch. And all surface mounted passive devices shall not be smaller than 0603 footprint.

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

A1: Development of circuit(s) (time 2 h)

The competitor must design a complete or partial circuit. The circuit(s) functionality must be tested through Simulation program and Competitor must create a report of simulation results. For simulation LTspice is used unless otherwise agreed on the forum.

All necessary components must be found in the library of the simulation program. The task may have components that are not found in the program's standard library, but TP Designer must ensure that the required component is already installed in the library.

Time to complete is 2 h.

A2: Design of PCB-board layout (time 3.5 h)

Competitor is given a ready-made project which include schematic and 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. Competitor's task is is to design a double-sided Printed Circuit Board (PCB). The Competitor must prepare manufacturing documents: Gerbers, drills files, pdfs, Bills of Material (BOM), etc. The Competitor may use European 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.

A3: Assembly (time 3 h)

The Competitors must assemble PCB in accordance with the Acceptability of Electronic Assemblies (IPC-A-610 F).

All functions of the PCB should work in accordance with specification in the Test project.

Module B: Embedded Systems Programming (time totally 6 h)

The Competitor must write C code for an embedded system.

The embedded MCU will be an ARM Cortex M0+: STM32L0

The IDE program will be same for all competitors, ex. STM32Cube IDE.

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

The developer of the Test Project 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.

The program will be in C only. Interrupts and Interrupt Service Routines (ISRs) may be used. In-line assembly is not allowed excluding very simple short delay loops if one is necessary. If the task includes a complex external component, then Test Project Designer needs to ready-made all complex part of code and included that software library to Test Project template. This software library must be well documented.

The developer of the Test project will bring a functioning sample and all components (with extras) needed to assemble the prototype.

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

This module involves 2 phases.

B1: Basic functions of control unit

In this phase the Competitor are given a pre-compiled sample code in hex format. With this code, the competitor can check the desired operation of the program.

Competitor is given a project file in which all microcontroller initializations have been completed. The source code of the project may contain ready-made functions that the competitor needs to change. Typically, the competitor has to perform basic/HW-related functions that are needed in the programming of the next step.

B2: Full control routines

In this phase the Competitor are given a pre-compiled sample code in hex format. With this code, the competitor can check the desired operation of the final program. Competitor is given a project file in which all tasks from the previous step have been completed. In this part, the competitor has to make the final program.

The programming task (B1 and/or B2) can also include measurement tasks with an oscilloscope or a multimeter.

Module C: Fault finding, modification and measuring (time totally 3 h)

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 0603 footprint. All 0603 component footprints must be suitable for hand soldering (Class 1).

The Independent supplier will supply at least one working example project and will bring all components (with extras) and assembled boards needed to the Test project. Each board will have a few faults (except of working example project). Faults must be such that can happen. They can also be simple product development defects that can be fixed with available tools and components. The competitor does not have to find these defects, they are described in the TP document. Competitors may need to make possible modifications to the Board and repair defects.

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.

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.

Task unit can be additional card for basic task unit and add to it some new functions or can be independent part.

The Competitors are expected to work with conventional measuring and testing equipment to test, set, adjust, and measure electronic components, modules and equipment that are based in DC, AC, digital and analogue electronics. Measurements can be either direct (just read the value from the instrument) or indirect (involving both reading and some simple calculation).

The Competitor must demonstrate the operation of the device with measurement results. The Competitors must replace faulty components in accordance to Rework standard (IPC-7711A/ 7721A).

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. If the TP needs some simple tool that is not in the IL, the TP designer can deliver it with the TP. For example, a very small screwdriver.

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 WSE. Use the Word template for text documents and DWG template for drawings. Please contact jordy.degroot@worldskillseurope.org for guidance.

If the Test Project is designed by an Independent Test Project designer, then the Test Project must be designed in accordance with the WSE Independent Test Project Guide v1.1.

If your Skill wishes to have an Independent Test Project designer, you must ensure that WorldSkills Europe is made aware of this, so that it can be assured that there is proper funding in place, or that the Independent Test Project designer is aware that he/she will do this task free of charge.

5.4.1 Who develops the Test Projects or modules

The Test Project / modules are developed under the supervision of:

- The tasks of all modules must be secret.
- Test Projects modules must be made by an Independent Test Project designer.

5.4.2 How and where is the Test Projects or modules developed

The Test Project or modules are developed in the following manner:

- The Test Project is developed by an Independent Test Project designer

5.4.3 When is the Test Project developed

The Test Project is developed according to the following timeline:

TIME	ACTIVITY
At the previous Competition	not applicable
3 months prior to the Competition	In the period of six months and three months before the competition the external developer will develop a Test Project.
At the Competition	It is to be hoped that the TP designer or his/her representative should come to the competition for the presentation of the TP and coach the Judges.

5.5 Test Project validation

The Test Project will be validated in accordance with WorldSkills Europe's procedures.

A professional person will validate the Test Project and will ensure that the Test Project can be completed within the material, equipment, knowledge, and time constraints of Competitors.

A professional person can be past or present independent WorldSkills or WorldSkills Europe Expert.

5.6 Test Project selection

- Test Project is designed by an Independent Test Project designer, therefore there is no selection process

5.7 Test Project circulation

Please note that if a Test Project is known by the Chief- and/or Deputy Chief Experts, and/or any of the other Experts, it must be shared via the forums before the start of the Competition. This also means that this Test Project is subject to a 30% change before the start of the Competition.

The Test Project is circulated via the website as follows:

- Not circulated

5.8 Test Project coordination (preparation for competition)

Coordination of the Test Project will be undertaken by:

- Chief Expert and Deputy Chief Expert

5.9 Test Project change at the competition

If, during the competition a technical problem with the project is discovered the CE and DCE will determine a workable solution to the problem and make adjustments to the task as needed. The CE and DCE will consult with the Test Project designer and Assessment Team Leader when determining the workable solution.

5.10 Material or manufacturer specifications

Specific material and/or manufacturer specifications required to allow the Competitors to complete the Test Project will be supplied by the Host Organization and are available via the forums. 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.

Not applicable.

5.11 Software specifications

- Autodesk Fusion 360 Electronics
- LTspice (unless otherwise agreed on the forum)

- STM32CubeIDE (advanced C/C++ development platform with peripheral configuration)
- STM32CubeProgrammer (STM32CubeProg)

6 Skill management and communication

6.1 Discussion forum

Prior to the EuroSkills Competition, all discussion, communication, collaboration, and decision making regarding the Skill Competition must take place on the skill specific Discussion Forum, which can be reached via www.worldskillseurope.org. Skill related decisions and communication are only valid if they take place on the forum. The Chief Expert (or an Expert nominated by the Chief Expert) 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 WorldSkills Europe website www.worldskillseurope.org. Please contact jordy.degroot@worldskillseurope.org for guidance.

The information includes:

- Competition Rules
- Technical Descriptions
- Test Projects
- Infrastructure List
- EuroSkills Health, Safety, and Environment Policy and Regulations
- Other Competition-related information

6.3 Test Projects and Marking Schemes

Circulated Test Projects will be available at the WorldSkills Europe website from www.worldskillseurope.org. Please contact jordy.degroot@worldskillseurope.org for guidance.

6.4 Day-To-Day management

The day-to-day management of the Skill Competition during the EuroSkills Competition is defined in the Skill Management Plan that is created by the Skill Management Team led by the Chief Expert. The Skill Management Team comprises the Jury President, Chief Expert and Deputy Chief Expert. The Skill Management Plan is progressively developed in the six months prior to the Competition and finalized at the Competition by agreement of the Experts. The Skill Management Plan can be viewed at www.worldskillseurope.org. Please contact jordy.degroot@worldskillseurope.org for guidance.

7 Skill specific safety requirements

7.1 Requirements

Refer to Host Country/Region Health and Safety documentation for Host Country/Region regulations. This document will be shared via the forums. One overall Health and Safety document will be published, as well as Skill specific safety requirements.

8 Materials and equipment

8.1 Infrastructure List

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

The Infrastructure Lists will be available at the WorldSkills Europe website from www.worldskillseurope.org. Please contact jordy.degroot@worldskillseurope.org for guidance.

The Infrastructure List specifies the items and quantities requested by the Experts for the next Competition. The Host Organization will progressively update the Infrastructure List specifying the actual quantity, type, brand, and model of the items.

At each Competition, the Experts must advise the Competition Manager 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.

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

WorldSkills Europe aims to minimize the sending of toolboxes as much as possible. We therefor ask you to keep this in mind when writing the section below. Please be advised that competitors should bring as little as possible and what they do bring **MUST** be true hand tools. Only items are allowed that would significantly affect their ability to perform the task and deliver the Test Project to a high standard.

Competitors and Experts do not bring a toolbox or tools (except those listed in section 8.3) 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

Competitors may bring personal items such as prescription safety glasses, ear protection, headphones, and an approved music player.

Competitors may bring personal small hand tools such as tweezers, side cutters and pliers. These will be agreed in more detail at the Forum (which ones and the quantities).

Competitors can use own unprogrammable keyboard. Competitors' own keyboards are checked before the start of the competition.

8.4 Materials, equipment and tools supplied by the Experts

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

8.5 Materials, equipment and tools prohibited in the Skill area

Competitors and Experts are not allowed to bring personal laptops, tablets, mobile phones, personal photo and video devices or any other portable memory devices into the workshop area the during the Test Project execution.

Experts can use a mobile phone or laptop in the expert room without disturbing others.

They are only allowed to use memory sticks provided by the Competition Organizer. Competition memory devices or any other portable memory devices must not be taken outside the workshop.

8.6 Workshop Layout

Workshop layouts from previous competitions are available by contacting the Competition and IT Coordinator at: jordy.degroot@worldskillseurope.org. New Workshop Layouts will be communicated via the forums when completed.

Please be advised that you will have the opportunity to discuss your Workshop Layout proposal with the Host Organization during the Skills Development Workshop (SDW) and the Competition Preparation Meetings (CPM).

For workshop layout development, please refer to the forums.

9 Skill-specific rules

9.1 Introduction

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 Personal laptops – USB – memory sticks – mobile phones

Laptops, USB drives and mobile phones are forbidden for competitors during the Test Project execution.

9.3 Personal photo cameras – video taking devices

Photo cameras and video taking devices are forbidden for competitors during the Test Project execution. They can be used by Experts after permission of the Chief Expert.

9.4 Communication between compatriot experts and competitors

If the competitor must communicate with compatriot expert or vice versa, another expert must ensure that the compatriot expert does not pass on any confidential information or advice related to the Test Project.

9.5 Other

- 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 are ESD safe.

10 Visitor and media engagement

10.1 Engagement

Following is a list of possible ways to maximize visitor and media engagement, within the remit of the Competition Rules:

- 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 will install a mini working electronic production line close to the competition area.

11 Sustainability

11.1 Sustainability

This Skill Competition will focus on the sustainable practices below:

- Recycling
- Use datasheets in PDF form
- Use of ‘green’ materials – e.g., lead-free solder is used
- Use of components available from global suppliers
- Ensure that all items on IL are used
- Use of completed Test Projects after Competition.