Competence matrix for the sector electronics / electrical engineering

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Flensburg, June 2009

Education and Culture DG
Lifelong Learning Programme
VQTS II – Vocational Qualification Transfer System
Leonardo da Vinci – LLP-LdV-TOI-2007-AT-0017

Translation by Georg Reuters, Eckener Schule Flensburg

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Bundesministerium für Unterricht, Kunst und Kultur

Univerza v Ljubljani

Kunsill Malti għall-Kwalifiki
Malta Qualifications Council

Erstelldatum 16.06.2009 14:32:00

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1. Constitutive considerations about the composition, structure and function of the competence matrix for the sector electronics/ electrical engineering

1.1. The definition of competences with regard to core work tasks

The considerations for composition, structure and function of the competence matrix follow the results of VQTS I (cf. Luomi-Messerer/Markowitsch 2006). So competences are described relating to core work tasks (competence areas). Correspondingly, competences are formulated in the matrix structure, which describe the stage of development of the working and training person with reference to core work tasks (stages or steps of the competence development).

The difficulties with the description of task-related competences become clear by finding answers to the following questions:

1. What is the domain of the competence matrix?
2. What are the core work tasks for the target groups to be identified in the working world?
3. Which are the "paradigmatic" work tasks which define the competence development of the working and learning person?
4. Which are the occupational competences which have to be named for the description of the competence matrix? It is also essential to define, which professional profiles are part of the scope of the competence matrix. With regard to the applicability to the transition from VET to HE (practice oriented higher education) this is of decisive importance, because the domain itself, the core work tasks and the competence development for mastering these tasks may vary according to the context defined.

At first it is decisive that a competence concept is started out from which does not only cover the disposition for a competent behaviour but also includes the apparentness of the professional competence itself. Competence is meant as expertise, which also gets apparent as a performance in the actions of a person (cf. Spöttl/Becker 2004). The description of a professional competence should also therefore name the professional action itself.

Within the VET discussion the concept "domain" is often understood as an occupational field or the domain is even equated with the profession. However, since there is no uniform job classification in Europe and obviously even in the German-speaking countries difficulties increase to allocate professions to occupational fields (IT professions, mechatronics), it becomes necessary to define a common criterion for congenial tasks and congenial competences which are related to these tasks. This is necessary to ensure that in the context of defining task-related competences these refer to professional actions which are comparable. The domain concept is suitable for it in its original sense: As *an area in which somebody is able to act competently.* Generally this term is understood as a "dominion" in which somebody is acting "*grandly"* and thereby expressing that a professionalized behaviour matters. So it is "firstly all about the person, secondly about the professional behaviour and thirdly about the action object" (Becker/Spöttl 2008, p. 57) and about the relation between these aspects which is ultimately established by characteristic work tasks (core tasks) (cf. Illustration *1:* Illustration *1:*

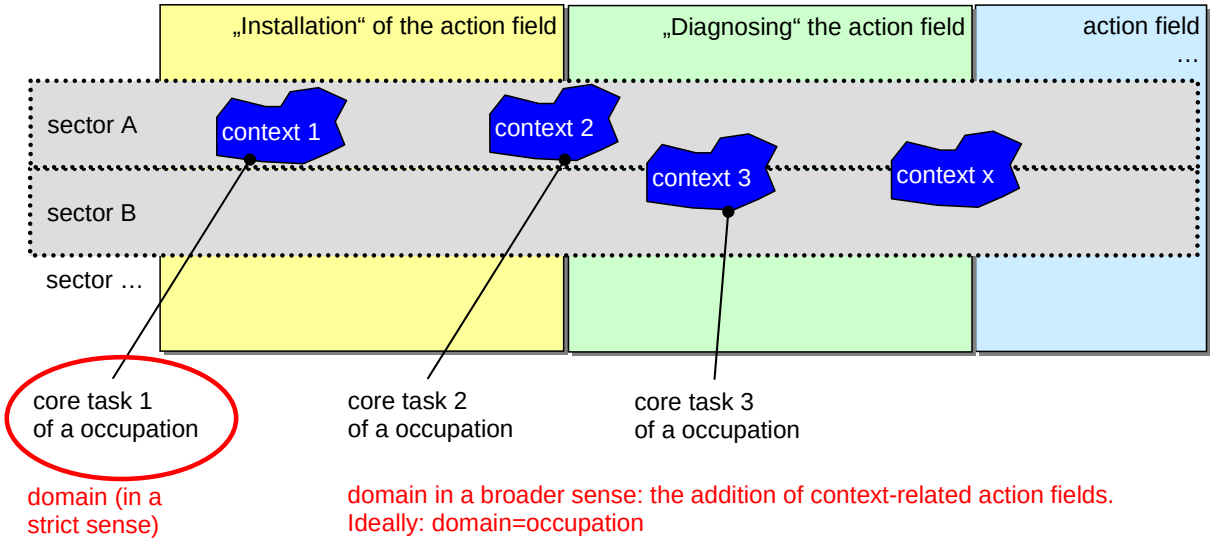

Illustration 1: Professional action areas as domains and the connection with sectors

In a first approach a domain could be understood as an action area in the sense of descriptors like

- Using and operating (of facilities, plants, systems ...)
- Mounting/dismantling
- Activation
- Maintenance/servicing/inspecting
- Installing
- Configuring / adjusting
- Measuring
- Troubleshooting / diagnosing
- Constructing
- Planning / projecting
- Simulating
- Designing and developing

In the most general sense the *domain* in our case is determined by the behaviour in the sector of "electronics/electrical engineering". This sector concept is not sufficiently precise though, because the action context remains unclear. So "installing an electrical plant" could be described abstractly as a combination of a domain-related descriptor in connection with an "object of electrical engineering". Such a competence, however, is as long meaningless as the *context* and a specification have not been described which clarify the value of the action for the practising worker (this was achieved in VQTS I by adding examples).

The *context* is indicated through

1. a value-relation, which is formed by the confrontation of the actor with the **work process** ,this relation being specified through
   - the organization of work e.g. by means of description elements of the structuring of operations or organizational structure;

- the contrast between the planned workflow (plan) and the actual execution of the task (reality), designated therefore by the relation of the working/learning person and the process (situation-relation);
- the working conditions/framework conditions so e.g. order cards, work instructions, flow charts, interface descriptions/handover logs etc.

2. a factual connection which is formed by the **objects of the expert work**, described through
   - the electronic and electrical assemblies, systems, plants, facilities;
   - the (internal and external) customer and his requirements towards the expert work (also social demands);
   - electrical and electronic tools.

So for every description of occupational competences the following determinants have to be identified:

1. the sector
2. the domain
3. the context (value-relation: work process; factual connection: work object)
4. the occupational tasks including the professional specifications described by examples

The competence development model by Dreyfus/Dreyfus (1986) will be taken to describe the competences on different stages of development with reference to the work tasks (cf. Markowitsch et.al. 2008)

1.2. Considerations about the establishment of the scope of the competence matrix

In order to get a starting point for determining the scope of the competence matrix, those professional classifications from ISCO08 and the corresponding ISCED levels which reflect the professional work and VET and the transition to HE in electrical engineering/electronics were analysed and determined (see illustration 2).

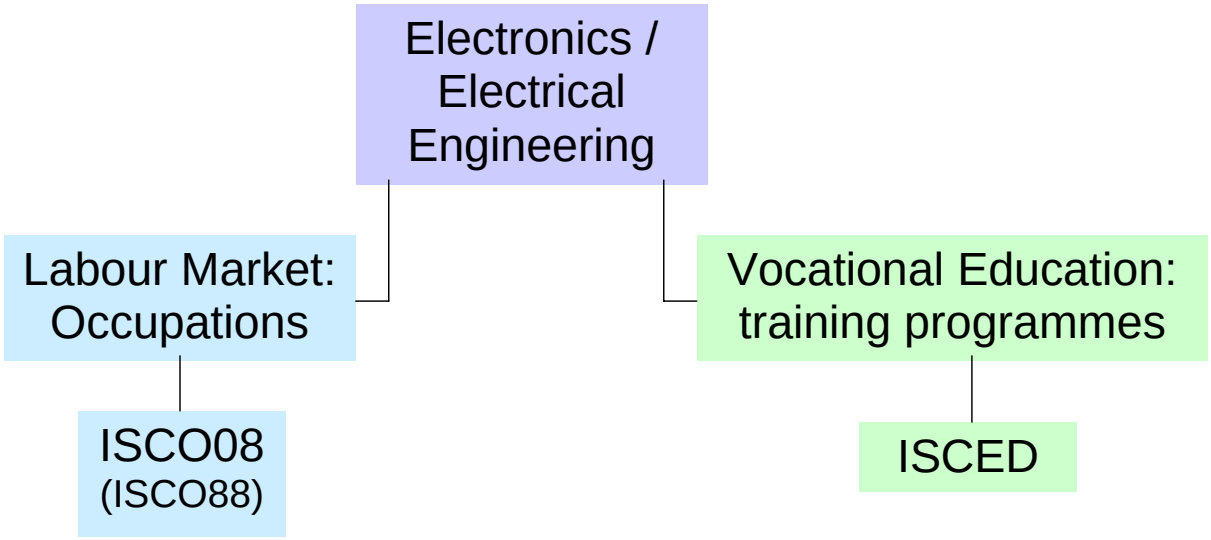

Illustration 2: Labour market relevant and education relevant classification systems for the delimitation of the scope of the competence matrix

On the basis of the old ISCO88 the following areas can be classified as relevant for a rough delimitation, in which the tertiary sector is taken into account only partly (in the transition phase) and the tier of "jobs" (ISCO Group 8) remains widely discounted:

Tertiary HE (ISCED 5A/5B)

Electrical Engineers (ISCO 2143)

Electronic Engineers (ISCO 2144)

2143 0-23.05 Engineer, electrical
2143 0-23.90 Engineer, electrical illumination
2143 0-23.90 Engineer, electrical systems
2143 0-23.30 Engineer, electrical/electric power distribution
2143 0-23.20 Engineer, electrical/electric power generation
2143 0-23.30 Engineer, electrical/electric power transmission
2143 0-23.90 Engineer, electrical/electric traction
2143 0-23.90 Engineer, electrical/electromechanical equipment
2143 0-23.05 Engineer, electrical/high voltage
2144 0-23.10 Engineer, electronics
2144 0-23.90 Engineer, electronics/computer hardware design
2144 0-23.90 Engineer, electronics/information engineering
2144 0-23.90 Engineer, electronics/instrumentation
2144 0-23.90 Engineer, electronics/semiconductors

Post Secondary / Further Education (ISCED 4A/4B)

Electrical engineering technicians (ISCO 3113)

Electronics engineering technicians (ISCO 3114)

Secondary Education (ISCED 3A/3B/3C)

Electrotechnology trades workers (ISCO 74)
(ISCO 08: Electrical and electronic trades workers)

- Electrical equipment installers and repairers (ISCO 741)
  (ISCO88: Electrical and Electronic Equipment Mechanics and Fitters / ISCO 724)
- Building and related electricians (ISCO 7411 / ISCO88: 7137)
- Electrical mechanics and fitters (ISCO 7412 / ISCO88: 7241)
- Electrical line installers and repairers (ISCO 7413)

7137 8-55.10 Electrician
7241 8-55.30 Electrician, aircraft
7137 8-55.20 Electrician, building
7137 8-55.60 Electrician, building maintenance
7137 8-55.70 Electrician, building repairs
7137 8-55.20 Electrician, building/electrical installation
7137 8-55.60 Electrician, building/electrical maintenance
7241 8-55.40 Electrician, locomotive
7137 8-55.90 Electrician, mine
7241 8-55.40 Electrician, motor vehicle
7137 8-55.90 Electrician, neon-lighting
7241 8-55.35 Electrician, ship
7137 8-55.50 Electrician, stage and studio
7137 8-55.50 Electrician, theatre

7241 8-55.40 Electrician, tram
7241 8-55.40 Electrician, vehicle

7241 8-51.10 Fitter, electrical
7241 8-51.40 Fitter, electrical/control apparatus
7241 8-51.60 Fitter, electrical/elevator and related equipment
7241 8-51.20 Fitter, electrical/generator
7241 8-51.50 Fitter, electrical/instruments
7241 8-51.20 Fitter, electrical/magneto
7241 8-51.20 Fitter, electrical/motor
7241 8-51.90 Fitter, electrical/refrigeration and air-conditioning
7241 8-51.40 Fitter, electrical/rheostat
7241 8-51.90 Fitter, electrical/signalling equipment
7241 8-51.40 Fitter, electrical/switchgear
7241 8-51.30 Fitter, electrical/transformer
7242 8-52.10 Fitter, electronics
7242 8-52.20 Fitter, electronics/audio-visual equipment
7242 8-52.40 Fitter, electronics/computer equipment
7242 8-52.40 Fitter, electronics/data-processing equipment
7242 8-52.50 Fitter, electronics/industrial equipment
7242 8-52.90 Fitter, electronics/instruments
7242 8-52.30 Fitter, electronics/medical equipment
7242 8-52.90 Fitter, electronics/meteorological equipment
7242 8-52.10 Fitter, electronics/prototype
7242 8-52.20 Fitter, electronics/radar
7242 8-52.20 Fitter, electronics/radio
7242 8-52.60 Fitter, electronics/signalling equipment
7242 8-52.60 Fitter, electronics/signalling systems
7242 8-52.20 Fitter, electronics/telecommunications equipment
7242 8-52.20 Fitter, electronics/television

Secondary Education (ISCED 3A/3B/3C)

Electronics and telecommunications installers and repairers (ISCO 742)

- Electronics mechanics and servicers (ISCO 7421)

Without consideration

ISCED 2C

Electrical equipment assemblers (ISCO 8212/ISCO88: 8282)

Electronic equipment assemblers (ISCO 8213/ISCO88: 8283)

8282 Electrical-equipment assemblers
8283 Electronic-equipment assemblers

With a vague correspondence (cf. ILO 1990, p. 2; http://www.ilo.org/public/english/bureau/stat/isco/isco88/publ2.htm):

ISCO Skill Level	ISCED Categories
First skill level	ISCED category 1, comprising primary education which generally begins at ages 5-7 years and lasts about 5 years.
Second skill level	ISCED categories 2 and 3, comprising the first and second stages of secondary education. The first stage begins at the age of 11 or 12 and lasts about three years, while the second stage begins at the age of 14 of 15 and also lasts about three years. A period of on-the-job training or experience may be necessary, sometimes formalised in apprenticeships. This period may supplement the formal training or may replace it partly or, in some cases, wholly.
Third skill level	ISCED category 5 (category 4 has been deliberately left without content) comprising education which begins at the age of 17 or 18, last about four year, and leads to an award not equivalent to a first university degree.
Fourth skill level	ISCED categories 6 and 7, comprising education which begins at the age of 17 or 18, lasts about three, four or more year, and lead to a university or postgraduate university degree or the equivalent.

The above mentioned rough delimitation already conveys the difficulty naming occupational competences with sufficient depth of focus for the full breadth of the fields of application. The classification according to technical objects of the electrical engineering (aircraft, building, stage and studio,...) and taxonomically structured activity fields (fit, assembler, technician, engineer) which indicate standards at the same time, does not meet the requirements of a competence description, however provides starting-points for solving the delimitation difficulties.

1.3. Principles for drawing up the draft of competence areas and competence descriptions

The following principles for the outline of the competence matrix were agreed on between the project partners (cf. Luomi-Messerer/Markowitsch 2006):

- Competences will be developed in the professional context and not primarily derived from sources in the educational system, which are marked by country-specific characteristics and mainly by educational paths dependent on the educational system.
- The project partners collect available competence descriptions, which have been gathered empirically in other research projects and can be used for the arranging of the competence matrix. This is necessary because extensive empirical research is not possible in the context of the project. The outline of the competence matrix must therefore be based on secondary analyses.
- An outline of the competence matrix - prepared from the secondary sources – will be evaluated and developed further by means of an expert technician workshop.

1.4. Methods of developing a competence matrix

The competence matrix was developed by means of a synthesis method in the context of which work process studies and competence analyses on hand were

evaluated in the occupational field electrical engineering/electronics. The competence descriptions of the partner countries (where on hand) were evaluated. These competence descriptions were mostly taken from curricula and job descriptions. Special care was taken that no country-specific curricular singularities became part of the competence matrix because this would prioritize a certain competence development determined by institutional and legal framework conditions in a specific professional educational system. This would endanger the mutual acceptance of the descriptions. Yet the avoidance of country-specific singularities will also allow to portray the competence profiles of training measures from various countries. Additionally, experts from the sector electrical engineering were consulted for the evaluation of the descriptions who have checked the sector, domain, context and also the professional reference of the descriptions.

The following secondary sources were analysed and used for the outline of the competence matrix:

- Collected information of the VQTS II partners about curricula, certificate supplements, job descriptions, sector-related competence descriptions on hand and approaches for national qualifications frameworks and particularly the outline for a competence matrix from Malta,
- Research results from the following projects:
  - pilot project business- and work process-oriented vocational training (GAB, cf. http://www.gab.uni-bremen.de/), esp. research related to the electronics engineer.
  - profession-scientific analyses of the fields of action of the electrician by Thomas Hägele (cf. Hägele 2002).
  - Leonardo da Vinci project AMOR (Approach for the matching process of outcome-based curricula to the EQF in vocational education) in which curricula from the electrical engineering industry were related to the European qualification framework (EQR), and to this work situations for the professional profiles "electronics technician field of study energy and building technology (cf. http://www.amor-project.eu) from Germany and the qualification "electrician" from Luxembourg.
  - Occupational field analyses by Falk Howe (cf. Howe 2004).
  - Leonardo da Vinci project EuQuaSit (European Qualification Strategies in Information and Communications Technology; http://www.euquasit.net/).
- Analysis of "job descriptions" from the industry and the skilled crafts primarily from the English-speaking countries.
- Considerations for the competence measuring from the project KOMET: Occupational competences and professional identity of trainees in the electrical trades: A large-scale examination at technical colleges in Hesse and Bremen.

The breadth of the electrical and electronic applications and fields of application (building installation and automation, energy supply, -processing and -distribution, industrial production/automation engineering, household and consumer electronics, audio and video applications/event technology, process control, process supervision

and process visualization, microelectronics/computer technology, data transmission and communication technology, radio engineering etc.) require certain compromises regarding the context in the development of the competence matrix.

All core work tasks include key competences, such as social and communicative competences. Also the acceptance of responsibility and quality awareness are integrated in all the listed occupational competences. Without these competences the work tasks cannot be executed in a manner indicating professional ability.

The stages of development depicted in the matrix cannot be immediately assigned to the standards of the European qualification framework (EQF). Yet the fact that the matrix contains integral professional qualifications above the second ISCO-skill level and competences, which are not considered from school and university careers of the ISCED standard 2C provide a frame of orientation for a classification of the levels. At the same time, neither competences on a level, which presuppose a completed (esp. second and/or third) studies cycle (EQR standard 7 and 8) are contained; yet parts of a first studies cycle (EQR standard 6) can be object of the competence descriptions. Ergo the competence matrix describes competences on all standards of professional qualifications including the transition of the vocational training on secondary level (basic vocational training) to the academic education (EQR level 5).

2. The VQTS competence matrix for the sector electronics / electrical engineering

The greatest difficulties in denominating context- and task-related competences in the chosen sector are caused by

a) the complexity of the sub-sectors and

b) the variety of strictly work-related tasks in the area of the qualifications which presuppose a vocational training in comparison with the tasks which are worked upon in the university sector.

The complexity of the sub-sectors is taken into account by the orientation of the description towards the core sectors (facility management, industrial plants, machines and propulsion systems, automation systems). Most of "electricians /electronics technicians“ work there while competence descriptions for tasks of special sectors (medical engineering, radio engineering etc.) can be attained by the addition of suitable examples in the matrix.

Since the "overlapping" with the university area is carried out from a task- and working world-related perspective, on the higher stages of competence development rather more demanding application-oriented competences are listed than academic tasks oriented towards research and development.

Der Diskussionsprozess unter den Projektakteuren des Projektes VQTS-II war von den genannten Problembereichen geprägt. Unterschiedliche Vorstellungen zur Breite des Sektors (Einbeziehen von Subsektoren), zur fachlichen Tiefe von Aufgabenstellungen (Qualifikationen von Facharbeitern, Technikern, Ingenieuren) und damit verbundenen Wissensbereichen führten zur Entwicklung einer Kompetenzmatrix, die eine Balance zwischen Abstraktion und Konkretion herstellt. Die Matrix A entstand dabei zunächst durch die in Abschnitt 1.4 beschriebenen Methoden. Die weiterentwickelte Matrix B ist Resultat des Diskussionsprozesses unter den Projektakteuren einerseits und der durchgeführten Expertenworkshops mit Vertretern aus Unternehmen andererseits auf der Basis der Matrix A.

The process of discussion of the VQTS-II project partners had reflected the mentioned problem areas. Different ideas to the breadth of the sector (sub sectors included), the depth of task formulations (qualifications of skilled workers, technicians, engineers) and concerned knowledge areas led to the development of a balanced competence matrix between abstraction and concretion. At first Matrix A was a result from the methods described in section 1.4 . The further developed Matrix B is result of the process of discussion on the one hand between the project partners and of expert workshops with representatives from enterprises on the other hand on the basis of the matrix A.

competence matrix A „Electronics/Electrical Engineering“				
Group of competences (related to core work tasks)	**steps of competence development**			
1. Planning, mounting and installing electrical and electronic systems	He/she can prepare and carry out simple electrical and electronic installations (cables, electrical outlets,connection and dispersion systems, circuit boards, modular electronic components, computer components) as well as carry out and check the necessary wirings and mountings.	He/she can plan and connect electrical and modular electronic installations (energy supply in private and business premises, incl. lighting; alternating and three-phase current; electronic systems as units) as well as select the most suitable ones for the customer from different realization variants). Differently complex solutions are compared according to customer criteria and technological criteria and used for customer advice.	He/she can plan complex electrical and electronically networked installations (systems of energy distribution, building management systems, EIB measuring arrangements, regulation and monitoring systems etc.) and fully wire them. He/she can configure, service and diagnose the functionality of the installation according to customer requirements with computer-assisted tools.	
2. inspecting and configuring electrical and electronical systems and machines in industrial appliances	He/she can carry out basic and scheduled maintenance tasks, inspections and checks at electrical equipment (industrial plants, switching and control systems, electrical machinery, computer systems). Adjusting tasks at electronic appliances can be undertaken according to predefined instructions. He/she can use the measuring and testing tools necessary for it.	He/she can carry out and document preventative maintenance works and setting tasks at industrial electric appliances and systems according to established methods of the quality assurance.	He/she can analyse and determine the availability and the condition of electrical/electronic systems. He/she can carry out examine the effect of influence factors on the reliability and performance of electrical/electronic systems and find causes of malfunctions.	He/she can develop and document maintenance and inspection methods for electrical/electronic systems on the basis of analyses of the production process (in relation to custom-designed quality assurance systems) as well as develop maintenance, inspection and quality assurance plans from this
3. installing and adjusting electrical components and electronic systems	He/she can operate and set up electrical/electronic systems following customer requirements and the operational examples of a technical documentation.	He/she can determine system test parameters for the installation of electrical and electronic systems and select and carry out test procedures for the installation and adjustment.	He/she can select, install and adjust electrical energy supply systems, propulsion systems (electrical machines) and their control and regulation – facilities as well as accompanying sensors and actuators according to a requirement analysis.	
4. designing, constructing and modifying electrical/electronic wirings/circuit boards, control circuitries and machines including their interfaces	He/she can design and build up simple electrical/electronic wirings according to customer requirements and existing standards.	He/she can make layouts for electrical/electronic wirings with the help of CAD programmes and design and fit circuit boards by means of suitable methods.	He/she can carry out necessary changes and customizations at electrical/electronic control circuitries and equipment (microcontrollers, SPS and accompanying software).	He/she can design, build up and configure electrical/electronic settings and controls including accompanying programming according to the operation requirements of electrical machines and installations.

competence matrix A „Electronics/Electrical Engineering“				
Group of competences (related to core work tasks)	**steps of competence development**			
5. developing custom-designed electrical/ electronic systems	He/she can develop and present proposals for solution for electrical/electronic system installations (e.g. lighting installations,automation systems)following customer requirements.	He/she can conceive electrical/electronic systems under consideration of customer feedbacks and future technological requirements and develop the necessary documentation to this(operational, maintenance, safety instructions) .	He/she can develop technical solutions and suitable documentations for electrical and electronic problem definitions and conceive and carry out trainings for customers based to them.	
6. Supervising and supporting work and business processes	He/she can supervise process steps in the production with suitable process tools (e.g. PPS) and carry out quality controls .	He/she can evaluate results of the process monitoring with software tools and determine quality assurance actions (work, production and time schedules).	He/she can develop controlling methods in the production (PPS) and process planning/control and supervision (CAP) and implement these with the help of software supported systems.	
7. Installing, configuring modifying and testing of application software for the programming of electrical/electronic installations	He/she can install programmes for hardware and software environments and carry out simple configuration tasks as well as updates.	He/she can select hardware and software for production systems following the business requirements and test programmes.	He/she can integrate hardware and software into existing system environments and use simulation and diagnostic programs.	He/she can combine hardware and software to networked system environments and carry out network specific checks of all signals and adapt by means of software.
8. diagnosing and repairing of electrical/electronic systems and equipment	He/she can carry out standardized test procedures and diagnostic methods using wiring diagrams and test tools and carry out simple repairs at electrical/electronic systems.	He/she can use testing and diagnostic tools as well as expert systems for the fault diagnosis at electrical/electronic systems up to the component level and carry out the necessary repairs.	He/she can select and use diagnostic methods for complex electrical/electronic systems and carry out preventative measures for the avoidance of disturbances and malfunctions in arrangement with customers.	He/she can carry out system analyses (FMEA, FTA etc.) of electrical /electronic systems, determine error types and develop suitable diagnosis and repair methods including preventative measures.

VQTS II Competence Matrix B „Electronics/Electrical Engineering“

Competence Areas (core work tasks)	steps of competence development			
1. Preparing, planning, mounting and installing electrical and/or electronic systems for buildings and industrial applications	He/She can prepare and carry out simple electrical and electronic installations (e.g. cables, electrical outlets, connection and distribution systems, modular electronic components, computer components) as well as carry out and check the necessary wirings and mountings.	He/She can plan, prepare and connect electrical and modular electronic installations. (e.g. energy supply in private and business premises, incl. lighting; alternating and three-phase current; electronic systems as units, wireless LAN, multimedia systems). He/She can advice the costumer and select the best implementation according to customer specifications.	He/She can plan complex electrical and/or electronically networked installations (e.g. systems of energy distribution, building management systems / KNX, regulation and monitoring systems, building access systems, RFID-systems etc.) and fully wire them. He/She can configure, service and diagnose the functionality of the installation according to customer requirements and for this purpose can use computer-assisted tools.	
2. inspecting, maintaining and servicing electrical and/or electronic systems and machinery	He/She can carry out basic and scheduled maintenance tasks, inspections and checks at electrical and/or electronic equipment according to maintenance schedules and predefined instructions (e.g. checking voltage tolerances, changing wearing parts in industrial plants, switching and control systems, electrical machinery, computer systems). He/She can use the measuring and testing tools necessary for it.	He/She can carry out and document preventative maintenance and alignment tasks at electrical and/or electronic industrial appliances and systems according to established methods of the quality assurance (e.g. continuous monitoring of …).	He/She can analyse and determine availability and condition of electrical and/or electronic systems. He/She can analyse influencing factors on reliability and performance of electrical/electronic systems and find causes of malfunctions (e.g. leakage current analysis, power factor correction, EMC analysis).	He/She can develop and document maintenance and inspection methods for electrical/electronic systems based on production and service process analysis as well as on quality management and customer requirements. He/She is able to develop related maintenance, inspection and quality assurance plans (e.g. optimizing MTBF of a production line, planning reserve power supply).
3. setting up, putting into operation and adjusting electrical and/or electronic systems	He/She can set up, adjust and put into operation electrical and/or electronic systems (e.g. allocating frequency channels for a TV set, basic settings of a frequency converter or a thermo relay for a motor) following customer requirements and instructions from the technical documentation.	He/She can obtain and set system test parameters for set up and operation of electrical and electronic systems and select and carry out test procedures for installation and adjustment (e.g. adjusting interfaces in multimedia system, sensitivity setting of alarm equipment, elevator control unit).	He/She can select, set up and adjust electrical and/or electronic systems and their control including accompanying sensors and actuators according to requirement analysis (e.g. energy supply systems, drive systems, electrical machinery, radio relay systems).	
4. designing, modifying and adapting wirings and circuit boards for electrical and/or electronic systems including their interfaces	He/She can modify, plan and build up simple electrical/electronic circuits according to standards and guidelines (e.g. wiring for rooms, connection diagram of basic motor circuits, simple operational amplifier applications, small programmable control units).	He/She can modify, plan and build up standard electrical/electronic appliances according to customer requirements and official regulations (e.g. fire-warning devices, layouts for electrical/electronic wirings with the help of CAD programmes, energy supply in private and business premises).	He/She can design, build up and improve electrical/electronic applications and its interfaces together with experts working in interdisciplinary teams according to emc standards and confirming test (e.g. electronic control circuits and equipment, microcontroller applications, PLC and related software).	He/She can design, build up and configure devices and facilities, units for process control systems including related programming and considering complex system requirements (e.g. controlled drive systems, process monitoring, automated production line, real time microcontroller applications for car control, GSM data transmission for monitoring and remote control).

VQTS II Competence Matrix B „Electronics/Electrical Engineering“

Competence Areas (core work tasks)	steps of competence development			
5. developing custom designed electrical and/or electronic projects	He/She can develop and propose solutions for simple electrical/electronic system based on customer requirements (e.g. lighting installations, power supply unit, basic automation and control systems).	He/She can design electrical/electronic systems (e.g. PLC program for industrial applications, microcontroller application, ensuring expansion capability) and provide the necessary documentation (operational, maintenance, safety instructions, function, integration and acceptance tests)	He/She can develop technical solutions for electrical and/or electronic systems and applications (e.g. microcontroller board for heating and air condition, RFID access system, new production line...) and provide appropriate documentation and customer training.	
6. Supervising and supporting work and business processes including quality management	He/She can check process steps in the production with suitable process tools (e.g. PPS, ERP, MRP) and carry out quality controls.	He/She can evaluate results of the process monitoring with software tools and determine quality assurance actions (work, production and time schedules).	He/She can develop controlling methods in the production (PPS, MRP, ERP) and process planning/control and supervision (CAP) and implement these with the help of software supported systems.	
7. Installing, configuring modifying and testing of application software for setup and operation of electrical and/or electronic systems	He/She can install programmes for hardware and software environments and carry out simple configuration tasks as well as updates (e.g. starter software, graphical programming for measurement and automation).	He/She can select hardware and software for production systems following the business requirements and test programmes.	He/She can integrate hardware and software into existing system environments and use simulation and diagnostic programs (e.g. .	He/She can combine hardware and software to networked system environments and carry out network specific checks of all signals and adapt by means of software (e.g. OPC-Server, process control system).
8. diagnosing and repairing of electrical/electronic systems and equipment	He/She can carry out standardized test procedures and diagnostic methods using wiring diagrams and test tools and carry out simple repairs at electrical/electronic systems (e.g. power measurement, level measurement).	He/She can use testing and diagnostic tools as well as expert systems for the fault diagnosis at electrical/electronic systems up to the component level and carry out the necessary repairs (e.g. software control test, spectrum analyzer).	He/She can select and use diagnostic methods for complex electrical/electronic systems and carry out preventative measures for the avoidance of disturbances and malfunctions in arrangement with customers (e.g. detection of bit error rate, overvoltage protection analyse).	He/She can carry out system analyses (FMEA, FTA etc.) of electrical /electronic systems, determine error types and develop suitable diagnosis and repair methods including preventative measures.

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