Level 2 - Unit 3 - Smart Electronics

Overview

Smart Electronics at Level 2 requires the candidate to demonstrate skill and understanding with basic electronics and circuits. They should be comfortable working with circuit diagrams and the various components associated with creating electronics and be able to describe their use and capabilities. They should also understand some of the differences between analogue and digital technologies. They should be able to apply this knowledge to moderately complex circuits and be able to program some controls and test that they work effectively. They should be capable of combining their knowledge to build a mixed and functional system.

A work activity will typically be ‘straightforward or routine’ because:

The task or context will be familiar and involve few variable aspects. The techniques used will be familiar or commonly undertaken.

Example of context – Candidates might make a name plate for their bedroom door.

Assessor's guide to interpreting the criteria

General Information

RQF general description for Level 2 qualifications

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- Achievement at RQF Level 2 (EQF Level 3) reflects the ability to select and use relevant knowledge, ideas, skills and procedures to complete well-defined tasks and address straightforward problems. It includes taking responsibility for completing tasks and procedures and exercising autonomy and judgement subject to overall direction or guidance.
- Use understanding of facts, procedures and ideas to complete well-defined tasks and address straightforward problems. Interpret relevant information and ideas. Be aware of the types of information that are relevant to the area of study or work.
- Complete well-defined generally routine tasks and address straight-forward problems. Select and use relevant skills and procedures. Identify, gather and use relevant information to inform actions. Identify how effective actions have been.
- Take responsibility for completing tasks and procedures.
- Exercise autonomy and judgement subject to overall direction or guidance.

Requirements

- Standards must be confirmed by a trained Level 2 Assessor or higher
- Assessors must at a minimum record assessment judgements as entries in the online mark book on the INGOTs.org certification site.
- Routine evidence of work used for judging assessment outcomes in the candidates' records of their day to day work will be available from their e-portfolios and online work. Assessors should ensure that relevant web pages are available to their Account Manager on request by supply of the URL.
- When the candidate provides evidence of matching all the criteria to the specification, subject to the guidance below, the assessor can request the award using the link on the

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certification site. The Account Manager will request a random sample of evidence from candidates' work that verifies the assessor's judgement.
- When the Account Manager is satisfied that the evidence is sufficient to safely make an award, the candidate's success will be confirmed and the unit certificate will be printable from the web site.
- Each unit at Level 2 has recommended 40 guided learning hours based on time required to complete by an average learner.

Assessment Method

Assessors can score each of the criteria N, L, S or H. N indicates no evidence and it is the default setting. L indicates some capability but some help still required to meet the standard. S indicates that the candidate can match the criterion to its required specification in keeping with the overall level descriptor. H indicates performance that goes beyond the expected in at least some aspects. Candidates are required to achieve at least S on all the criteria to achieve the full unit award. Once the candidate has satisfied all the criteria by demonstrating practical competence in realistic contexts they achieve the unit certificate.

Expansion of the assessment criteria

1. Understand analogue circuits.

1.1 I can describe the purpose of circuit components and symbols.

Evidence: From portfolios, internal testing, assessor observations.

Additional information and guidance

The components can include power supply (AC and DC), resistor, potentiometer, switch, diode, LED, LDR, variable resistor, bulb/lamp, voltmeter, ammeter, transformer, capacitor, motor, thermistor, loudspeaker, buzzer, motor, transistor, integrated circuit, micro-controller. The Level 2 candidate should be able to describe these components [1] referring to their purpose and common properties. Make links to work in the core science curriculum and use real and practical applications as illustrations.

1.2 I can build valid circuits.

The candidate will be able to build simple circuits that will function as intended

Evidence: From portfolios, internal testing, assessor observations.

Additional information and guidance

Candidates should be able to build simple circuits [2] that will work. Using a prototyping system such as breadboards or kits for practice [3]is recommended but some soldered products as part of a larger system is mandatory eg a transistor switch and sensor to interface a controller to something drawing a lot of current like a motor. Candidates should appreciating that sinking or sourcing high current from some devices is likely to damage them so care needs to be exercised even if it is simply at this stage asking for advice. Connecting a digital meter to measure a highish voltage e.g. a battery with low internal resistance and switching it to measure current has a good chance of blowing the fuse if the digital meter is not itself protected. They might do circuit board etching using ferric chloride but using strip board is also reasonable.

1.3 I can set up and debug a physical analogue circuit for a purpose

The candidate should be able to set up simple working circuits and test them.

Evidence: From portfolios, internal testing, assessor observations.

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Additional information and guidance

Candidates will need practice setting up circuits to learn the effects of combining different components and systematically checking connections to find faults and check working. They need to appreciate that short circuits can generate heat very quickly and that mismatching components can damage them. They should be taught to solder and techniques for achieving neat joints. At Level 2 they will be becoming largely self-sufficient and trusted to work safely using common components such as resistors, bulbs, motors, simple sensors and transistors. Attention to safety [4] should be appreciated at all times.

1.4 I can explain the difference between analogue and digital products.

The candidate should know the meaning of the terms analogue and digital and they should be able to explain some simple examples.

Evidence: From portfolios, internal testing and/or assessor observations.

Additional information and guidance

Candidates should understand that analogue signals are continuous whereas digital data representing a continuous signal is made of separate or discrete numbers. A variable resistor in a circuit is a good example of an analogue device and a switch is a good example of a digital device. Level 2 candidates should be able to describe an analogue watch, for example, as an analogue device because the hands move continuously whereas a digital watch or clock changes in steps of e.g. 1 second or 100th of a second not every division in between. Alternating current in a circuit is analogue, variations in temperature, pressure, brightness, and position in nature and so most sensors are analogue. Most digital devices are dependent on buttons or switches, e.g. a numeric number pad on a telephone where there are discrete buttons to press. Analogue systems are not less accurate than digital, they are more accurate in that in principle they can measure every point in their range. The problem is they might not in practical terms have the precision to pick out points close together as distinct from one another and they also lack any means of clearing out noise from the main signal. Digital systems can enable the signal to be processed removing any unwanted components or indeed adding desirable information so they are much more versatile.

2. Understand digital control.

2.1 I can describe the purpose of digital circuit components.

The candidate can describe the purpose of switches, logic gates and micro-controllers as digital devices.

Evidence: From portfolios, internal testing and/or assessor observations.

Additional information and guidance

At Level 2 candidates should be able to describe simple switches, relays, transistor switch, AND, NAND, NOT, OR, EOR and NOR gates. It is enough to be able to identify the circuit symbols and describe the purpose of the component. In the case of micro-controllers, include any device e.g. a Raspberry PI that can perform Smart functions in software and interface with external circuits to control things.

2.2 I can create program elements that control physical components.

The candidate should be able to write code to control a physical component.

Evidence: Internal testing, assessor observations.

Additional information and guidance

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In general commented code in any language is reasonable. The code should include at least some conditionality eg IF THEN . For products to be "Smart" requires some form of decision making which implies input from a sensor and output to a physical device.

2.3 I can explain bugs in a control program to get it working.

Candidates should be able to find simple faults in code controlling devices and explain how to fix them.

Evidence: Portfolios, assessor observations.

Additional information and guidance

Any control programming language can be used. Any questions set in the grading exam will use a generic pseudocode with sufficiently clear structure to work out what is happening without a knowledge of the specific syntax. Level 2 candidates should be able to not only identify the fault but explain what action should be taken to fix it.

2.4 I can use logic to control actions.

Candidates should use a range of logic for control in circuits.

Evidence: Portfolios, assessor observations.

Additional information and guidance

Two switches in series makes an AND gate because the circuit will only work if switch one AND switch 2 are closed. Using a relay to open a switch is a NOT gate because switching the relay on causes it to open the switch which then breaks the second circuit. The second circuit only works if the relay is not switched on. If there are two wires connecting a device to a power source a switch in both wires means either of them being switched on will switch the device on. This is an OR gate because either switch one OR switch two will switch on the device. Level 2 candidates should build on these ideas to become familiar with logic gates [5] and get some practical hands on experience with them. They should appreciate that using software is quicker and more versatile than "hard wiring" logic gates but it requires a more expensive general purpose device to run the software. This might not be justified if the logic is dedicated to a single simple task. For rapid prototyping using a micro-controller or computer might be much quicker and more convenient but for mass production it could be too expensive. In summary, they should get hands on experience of using control logic but the exact method is left to the centre. Nevertheless they need familiarity with a range of ways of doing it.

3. Combine analogue and digital systems.

3.1 I can describe the process of analogue to digital conversion.

Candidates should be able to describe how sampling an analogue signal can produce digital data.

Evidence: Portfolios, assessor observations.

Additional information and guidance

A good example making a digital thermometer. Putting a thermistor in melting ice and then into water and heating it up to boiling point will produce a continually changing resistance as the device warms up. This in turn varies the voltage across the device. If we sample the value of the voltage in the melting ice it corresponds to zero degrees and in the boiling water 100 degrees. Divide the interval into 100 parts and they have a working thermometer (link to science as they are likely to have put a scale on a thermometer in a similar way) This is an analogue scale because it changes

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continually. If we now take measurements of the voltage at say 100 points along the scale and store the numbers we have a digital scale with 100 points. Sample 255 points and we can better precision. 64000 points better still and so on. This is a digital thermometer but the same principle applies to any measuring device. The greater the number of samples along the scale the more precise the measurements. The device that does the sampling is called an analogue to digital converter ADC. It converts changing voltages into digital data. This could be the voltage from a microphone which is then converting an analogue sound wave into digital audio. The number of samples depends on the ADC resolution. 8 bit can sample 255 levels, 12 bit, 2048 16 bit about 65,535 and 32 bit about 4.3 billion. The other key factor in changing signals like sound waves is the sample rate. A slow sample rate won't matter measuring temperature which changes slowly, but a sound wave can change 20,000 times a second. To sample its shape in 2048 levels would need a 12 bit ADC and to get a lot of samples in one 20,000th of a second would need a sample rate a lot faster than 20,000 a second. Once the digital data has been sampled it can be transferred to computer memory and then software can operate on the data. The opposite of ADC is DAC Digital to analogue conversion. This is reconstructing the analogue signal from the digital data. The DAC device works like the ADC but in reverse. A DAC can reconstruct a sound wave from data. These devices are so fast now that you can sample live music through the ADC, process it in software and convert it back to the sound wave without anyone noticing. This is called real time processing. Level 2 candidates might or might not need ADC/DAC in their projects but they should be taught about the principles. There is a clear need here to be familiar with the National Curriculum Science requirements for the end of KS3 as Level 2 work should reinforce and build on it.

3.2 I can build a Smart system.

The candidate should be able to build a working Smart system that incorporates electronic control largely self-sufficiently.

Additional information and guidance

Level 2 Candidates will be becoming more self-sufficient. If they can self-sufficiently build practical electronic controlling circuits that integrate with wider projects with occasional prompts and advice they are at level 2.

3.3 I can explain how to use a program to control a physical system.

Candidates can explain how to use a program to control physical systems relevant to their project(s).

Evidence: Portfolios, assessor observations.

Additional information and guidance

If they can originate programs largely self-sufficiently, debug them and explain them it is a good indication of Level 2 work. Relate this work to National Curriculum Computing in KS3 and KS4.

3.4 I can combine Smart technology in a design to improve the user experience.

Candidates can use an electronic component or components in their project(s) in order to provide a degree of functionality or user experience that would not otherwise be possible.

Evidence: Portfolios, assessor observations.

Additional information and guidance

An example might be to build an interactive LED display into a model of an eco-house control panel that tells you the amount of energy a house is consuming. Another example might be a window display that contains moving components controlled by simple motors. Another example might be to build temperature and light sensing into a model of an eco-house so that temperatures and light levels could be automated to save energy. The exact methods are less important than making the product responsive to the purpose of the project by using a control and/or processing aspect related

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to digital electronics. It is likely that substantial practice with learning about digital electronics projects will be needed before integrating electronics into wider project briefs that include manufacturing outside the electronics field. At Level 2 they will need some prompts and support but they will be largely self-sufficient.

Moderation/verification

The assessor should keep a record of assessment judgements made for each candidate and make notes of any significant issues for any candidate. They must be prepared to enter into dialogue with their Account Manager and provide their assessment records to the Account Manager through the online mark book. They should be prepared to provide evidence as a basis for their judgements through reference to candidate e-portfolios and any other sources eg through signed witness statements associated with the criteria matching marks in the online mark book or internal controlled testing. Before authorizing certification, the Account Manager must be satisfied that the assessors judgements are sound.

Links
[1] http://www.circuitstoday.com/electronic-circuit-symbols
[2] https://www.circuitlab.com/
[3] https://www.kitronik.co.uk/project-kits.html
[4] http://www.bbc.co.uk/schools/gcsebitesize/design/electronics/manufacturing_processesrev7.shtml
[5] https://academo.org/engineering/electronics/

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