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| **Develop a programmable counter** |
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| Investigate a decade counter circuit and compare it to a programmable counter |
| **Subject(s):** Design & Technology**Approx time:** 20 minutes |  | **Key words / Topics:** * BBC micro:bit
* decade counters
* circuit simulation
* computer aided design
* programmable systems
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| Stay safe Whether you are a scientist researching a new medicine or an engineer solving climate change, safety always comes first. An adult must always be around and supervising when doing this activity. You are responsible for: • ensuring that any equipment used for this activity is in good working condition• behaving sensibly and following any safety instructions so as not to hurt or injure yourself or others  Please note that in the absence of any negligence or other breach of duty by us, this activity is carried out at your own risk. It is important to take extra care at the stages marked with this symbol: ⚠ |
| **Suggested Learning Outcomes**  |  |  |
| * To simulate and test the operation of a decade counter circuit.
* To compare and contrast hardware based electronic counters with programmable counters.
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| **Introduction** |  |  |
| This is one of a series of resources to support the use of the BBC micro:bit in Design and Technology lessons. Some people enjoy taking part in quizzes in their spare time. Keeping an accurate score of points gained by each team, or player, is important when deciding who the overall winner is. Programmable counter systems can be used to do this quickly and easily, and reduce the likelihood of human error.In this unit of learning, learners will use the BBC micro:bit to develop a programmable counter that can be used to keep score during a quiz. |
| **Purpose of this activity**In this activity, learners will investigate a decade counter circuit. They will then compare the operation of this to their programmable counter.This could be used as an extension lesson activity with ‘Design a prototype score counter’ as the main activity. It is an ideal exercise for learners to develop their technical knowledge related to the use of decade counters in electronics, and compare their operation to similar programmable systems. |
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| **Activity** |  | **Teacher notes** |
| **1. Different counter solutions**Explain that there are different ways that the function of counting can be achieved using electronic systems. This can be done with programmable systems, such as the BBC micro:bit, but can also be done using hardware based solutions. Explain that one such solution is a decade counter circuit. This circuit is based on the 4017B integrated circuit or IC, which acts like the brain of the system.**2. Decade counter**Show the circuit diagram for a decade counter. Explain that learners will be simulating this using software and investigating how it works and what it does.Go through the main components in the circuit diagram such as the count and reset switches, resistors, IC and LED. Recap knowledge of circuit symbols as required.**3. Simulating the circuit and investigating how it works**Learners are to draw the circuit in circuit simulation software. Once done they should test the circuit by pressing the count and reset buttons. The count button should turn on each LED in sequence. The reset button should reset the counter.Learners may encounter switch bounce depending n the accuracy of the circuit simulation software used. Discuss with them what this is and how this might be avoided (Schmitt Trigger circuit etc.).**4. Comparing to programmable systems**Learners to write down how this system differs from their programmable counter. What do they think are the advantages and disadvantages of programmable counter systems against hardware based systems? |  | The IET TV video – Counting the Score <https://tv.theiet.org/?videoid=7826> can be shown as an introduction or starter for activities in this unit of work.Learners may need to recap basic circuit symbols and the use of circuit diagrams before attempting this activity. If learners have not used circuit simulation software previously they may benefit from a teacher demonstration of this.Any circuit simulation software that is available in school and that supports decade counters can be used. Popular examples are Circuit Wizard and Yenka (formerly Crocodile Technology).Teacher may need to check the circuits drawn by learners prior to them testing them, to ensure that they have been correctly drawn, and therefore the test results are accurate.If learners encounter switch bounce they could investigate this issue further and look at ways to reduce it. |
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| **Differentiation** |  |  |
| **Basic** |  | **Extension** |
| All learners should be able to draw the circuit and make basic observations on how it operates. Some learners may need guidance on the use of circuit simulation software. They may also benefit from a sheet showing the basic component symbols used in the circuit and what they represent. |  | Learners could build a decade counter circuit on breadboard or stripboard using actual components. They could then compare the operation of this to what was observed in the simulation software.They could also devise a solution to eliminate the effects of switch bounce in the circuit, such as the use of a Schmitt Trigger. |
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| **Resources** |  | **Required files** icon-docicon-pdficon-ppt |
| * Projector/Whiteboard
* Exercise books or folders
* Circuit simulation software (e.g. Circuit Wizard, Yenka etc.)
 |  | icon-ppt Decade Counter Circuits presentation |
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| **Additional websites** |  |  |
| The following websites can be used for providing additional technical information and supporting delivery to learners.* **IET TV – Counting the Score:** Supporting IET TV video - ideal for use as part of a starter or introductory activity to support this resource. <https://tv.theiet.org/?videoid=7826>
* **Technology Student – Decade Counters 1:** Introduction to decade counter circuits and their operation. <http://www.technologystudent.com/elec1/count1.htm>

**Technology Student – Decade Counters 2:** Activity sheet for displaying knowledge of decade counters and their operation. <http://www.technologystudent.com/pdfs/COUNTER1.pdf> |
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| **Related activities (to build a full lesson)** |  |  |
| **Starters**ACTIVITY: Learning more about programmable systems **Main*** ACTIVITY: Design a prototype score counter
 | **Plenary*** ACTIVITY: Decade counter circuits
* Opportunities within activity for presentations, peer/self assessment
* Reflection on Objectives and PLTS skills used
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| **The Engineering Context** |
| Electronic counting is an ideal topic for teaching about programmable components and embedded intelligence in products. These are key parts of the 2014 programme of study for Design and Technology at key stage 3. It is also an ideal vehicle for using the BBC micro:bit in the classroom and developing the product integration skills of learners. |
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| **Curriculum links** |
| **England: National Curriculum**Design & Technology * KS3 4c, 4d
 | **Northern Ireland: Curriculum**Technology & Design* KS3 Knowledge and Skills: Control – incorporate control systems, such as mechanical, electronic or computer-based, in products and understand how these can be employed to achieve desired effects.
* KS3 Knowledge and Skills: Communication - Communication – use of free-hand sketching and formal drawing techniques and ICT tools.

Learning Outcomes:* show deeper understanding by thinking critically and flexibly, solving problems and making informed decisions, using Mathematics and ICT where appropriate.
* communicate effectively in oral, visual (including graphic), written, mathematical and ICT formats showing clear awareness of audience and purpose.
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| **Scotland: Curriculum for Excellence**Technologies* TCH 3-01a, TCH 3-04a
 | **Wales: National Curriculum**Design and Technology* KS3 Skills: Designing 6
* KS3 Skills: Systems and Controls 16, 20
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| **GCSE D&T**AQA D&T* 3.1.4, 3.3.5

Edexcel D&T* 1.6.2a/c, 1.6.3c, 1.7.4, 1.17.1j, 5.2.2b/c, 5.2.2i, 5.2.3b

Eduqas D&T* 2.1 Core: 5, 6
* 2.1 Systems: 1
* 2.2 Core: 8

OCR D&T6.4a ii, 6.4b i, 6.4c, 7.4a | **GCSE Engineering**AQA Engineering3.3.2, 3.3.3, 3.4.1, 3.4.2 |
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| **Assessment opportunities** |
| Assess the written responses of learners and quality of technical knowledge and vocabulary shown. Opportunity for learners to peer assess each other’s responses. |
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| **Person, learning and thinking skills (PLTS)** |
| * Independent enquirer
* Self-manager
* Effective participator
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| **The Engineering Context**  |

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