## 1. Year Groups

# Years 5/6

## 2. Aspect of D&T

# Electrical systems

**Focus**

# More complex switches and circuits

## 3. Key learning in design and technology

**Prior learning**

- Understanding of the essential characteristics of a series circuit and experience of creating a battery-powered, functional, electrical product.
- Initial experience of using computer control software and an interface box or a standalone box, e.g. writing and modifying a program to make a light flash on and off.

**Designing**

- Use research to develop a design specification for a functional product that responds automatically to changes in the environment. Take account of constraints including time, resources and cost.
- Generate and develop innovative ideas and share and clarify these through discussion.
- Communicate ideas through annotated sketches, pictorial representations of electrical circuits or circuit diagrams.

**Making**

- Formulate a step-by-step plan to guide making, listing tools, equipment, materials and components.
- Competently select and accurately assemble materials, and securely connect electrical components to produce a reliable, functional product.
- Create and modify a computer control program to enable an electrical product to work automatically in response to changes in the environment.

**Evaluating**

- Continually evaluate and modify the working features of the product to match the initial design specification.
- Test the system to demonstrate its effectiveness for the intended user and purpose.
- Investigate famous inventors who developed ground-breaking electrical systems and components.

**Technical knowledge and understanding**

- Understand and use electrical systems in their products.
- Apply their understanding of computing to program, monitor and control their products.
- Know and use technical vocabulary relevant to the project.

## 4. What could children design, make and evaluate?

vehicle alarm  security lighting system
alarm for valuable artefact
automatic nightlight  electrical board game
alarm for school shed  other – specify

## 5. Intended users

vehicle owner  themselves
school community  school administrator
younger children  siblings  parents
museum curator  other – specify

## 6. Purpose of products

safety  protection  security  detection
warning  comfort  illumination  entertainment
other – specify

## 7. Links to topics/themes

Our School  Toys and Games
Keep Safe  Ourselves
Culture and Leisure  Travel  Homes
Buildings  other – specify

## 8. Possible contexts

home  school  community  culture
leisure  enterprise  business
other – specify

## 9. Project title

Design, make and evaluate a _____ (product) for _____ (user) for _____ (purpose).

To be completed by the teacher. Use the project title to set the scene for children's learning prior to activities in 10, 12 and 14.

## 10. Investigative and Evaluative Activities (IEAs)

- Using research, discuss a range of relevant products that respond to changes in the environment using a computer control program such as automatic nightlights, alarm systems, security lighting e.g. *Who have the products been designed for and for what purpose? How and why is a computer control program used to operate the products? What input devices, e.g. switches, and output devices, e.g. bulbs, have been used?*
- Investigate electrical sensors such as light dependent resistors (LDRs) and a range of switches such as push-to-make switches, push-to-break switches, toggle switches, micro switches and reed switches. To gain an understanding of how they are operated by the user and how they work, ask the children to use each component to control a bulb in a simple circuit. Remind children about the dangers of mains electricity.
- Children could research famous inventors related to the project e.g. Thomas Edison – light bulb.

## 11. Related learning in other subjects

- **Spoken Language** – ask relevant questions, give well-structured descriptions and explanations. Build technical vocabulary.
- **Computing** – use technologies for research purposes and be discerning when evaluating digital content.
- **Science** – apply knowledge and understanding of circuits, switches, conductors and insulators.

## 12. Focused Tasks (FTs)

- Through teacher demonstration and explanation, recap measuring, marking out, cutting and joining skills with construction materials that children will need to create their electrical products.
- Demonstrate and enable children to practise methods for making secure electrical connections e.g. using automatic wire strippers, twist and tape electrical connections, screw connections and connecting blocks.
- Drawing on science understanding, ask the children to explore a range of electrical systems that could be used to control their products, including a simple series circuit where a single output device is controlled, a series circuit where two output devices are controlled by one switch and, where appropriate, parallel circuits where two output devices are controlled independently by two separate switches.
- Drawing on related computing activities, ensure that children can write computer control programs that include inputs, outputs and decision making. Test out the programs using electrical components connected to interface boxes or standalone boxes.
- Teach children how to avoid making short circuits.

## 13. Related learning in other subjects

- **Mathematics** – apply understanding and skill to carry out accurate measuring using standard units i.e. cm/mm.
- **Science** – apply knowledge and understanding of circuits, switches, conductors and insulators.
- **Computing** – design, write and debug programs that accomplish specific goals, including controlling physical systems. Use sequence, selection, and repetition in programs. Work with variables and various forms of input and output.

## 14. Design, Make and Evaluate Assignment (DMEA)

- Develop an authentic and meaningful design brief with the children.
- Ask the children generate innovative ideas by drawing on research and develop a design specification for their product, carefully considering the purpose and needs of the intended user.
- Communicate ideas through annotated sketches, pictorial representations of electrical circuits or circuit diagrams. Drawings should indicate the design decisions made, including the location of the electrical components and how they work as a system with an input, process and output.
- Produce detailed step-by-step plans and lists of tools, equipment and materials needed. If appropriate, allocate tasks within a team.
- Make high quality products, applying knowledge, understanding and skills from IEAs and FTs. Create and modify a computer control program to enable the product to work automatically in response to changes in the environment.
- Critically evaluate throughout and the final product, comparing it to the original design specification. Test the system to demonstrate its effectiveness for the intended user and purpose.

## 15. Related learning in other subjects

- **Mathematics** – apply understanding and skill to carry out accurate measuring using standard units i.e. cm/mm.
- **Science** – apply knowledge and understanding of circuits, switches, conductors and insulators.
- **Computing** – design, write and debug programs that accomplish specific goals, including controlling physical systems. Use sequence, selection, and repetition in programs. Work with variables and various forms of input and output.

## 16. Possible resources

zinc carbon or zinc chloride batteries, crocodile leads, bulbs, bulb holders, buzzers, light emitting diodes (LEDs), micro switches, reed switches and magnets, light dependent resistors (LDRs), wire, automatic wire strippers, masking tape, construction materials and tools as required

computer control software and interface boxes or standalone boxes, connecting leads

## 17. Key vocabulary

series circuit, parallel circuit, names of switches and components, input device, output device, system, monitor, control, program, flowchart

function, innovative, design specification, design brief, user, purpose

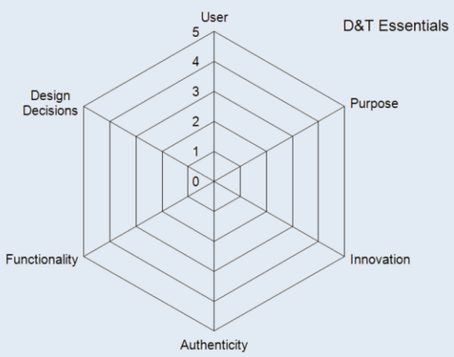
## 18. Key competencies

problem-solving  teamwork  negotiation
consumer awareness  organisation  motivation
persuasion  leadership  perseverance
other – specify

## 19. Health and safety

Pupils should be taught to work safely, using tools, equipment, materials, components and techniques appropriate to the task. Risk assessments should be carried out prior to undertaking this project.

## 20. Overall potential of project

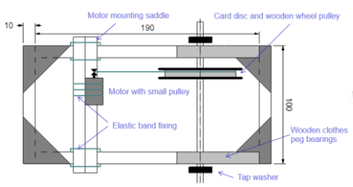


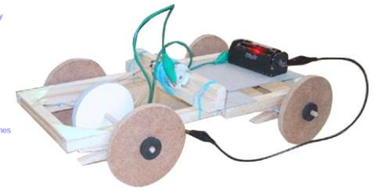
**Years 5/6**

# Electrical Systems

**More complex switches and circuits**

## Instant CPD



## Tips for teachers

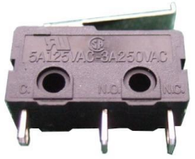
- ✓ To ensure progression from Y3/4, children need to develop an understanding of 'monitoring' as well as control and the idea of 'input' as well as 'output'.
- ✓ This project should be undertaken soon after electricity is covered in science and programming, monitoring and control are undertaken in computing.
- ✓ Create a selection of images of existing products e.g. burglar alarm and outdoor security lighting, that use monitoring and control.
- ✓ Discuss the difference between products that rely upon timed events, such as traffic lights, and those that depend upon monitoring to make something happen such as a security alarm.
- ✓ Some children will be ready to use parallel circuits in their electrical systems and this enables two or more sensors or switches to be incorporated in their products.
- ✓ Have a 'working' circuit set up so that children can test suspect components.
- ✓ Some components e.g. buzzers and light emitting diodes (LEDs) need to be connected the right way round in a circuit, ensuring positive and negative match the poles of the battery.
- ✓ Make sure electrical components and batteries match e.g. 1.5v bulb with a 1.5v battery.
- ✓ Do not use rechargeable batteries.
- ✓ CLEAPS recommend zinc carbon and zinc chloride batteries for Primary schools, not rechargeable, lithium of alkaline as these can overheat if short circuited. Button batteries are not recommended for younger children.
- ✓ Use non-mercury tilt switches.

## Useful resources at www.data.org.uk

- Torches, Lamps and Lanterns
- Alarming Vehicles
- Designing and making alarm circuits using inputs with computer control

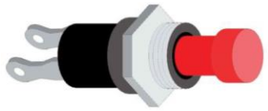
# Switches and sensors

Latching switch

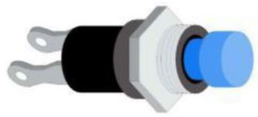



Micro-switch

Light-dependent resistor (LDR)



**Push-to-make switch**
When you push, the electricity flows through the circuit, but when you release it the circuit is broken and the switch is off.



**Push-to-break switch**
The switch is off while the button is pushed, but returns to its 'on' position when button is released.

**Reed switch**
Activated by a magnet which closes the contacts.

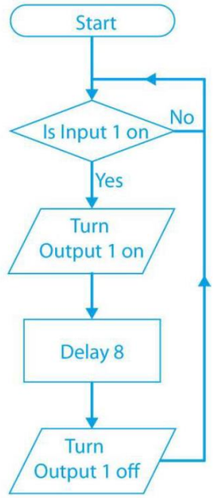
**Tilt switch**
When tilted a ball bearing bridges the contacts inside, completing the circuit.

- Micro-switch – a switch that can operate as push-to-break switch or a push-to-make switch.
- Push-to-break switch – a switch turned off by pressing it.
- Push-to-make switch – a switch turned on by pressing it.
- Reed switch – a switch operated by a magnet.
- Tilt switch – a switch that works when tilted at an angle.
- Toggle switch – a switch operated when a lever is pressed.
- Light dependent resistor (LDR) – a sensor that operates when light is shined on it.

Standalone control box

Interface control box


Example control program




- Children need to learn how to write a sequence of instructions where a decision is made e.g. when a switch is pressed a buzzer is activated.
- They use a 'control language' or create a flowchart to produce a series of instructions.
- Children's computing knowledge and skills need to focus on using input and output devices connected to a standalone box or interface box.
- They use their learning in computing to control and monitor products they have designed and made e.g. alarm system.

## Designing, making and evaluating an alarm to protect a valuable artefact

An iterative process is the relationship between a pupil's ideas and how they are communicated and clarified through activity. This is an example of how the iterative design and make process *might* be experienced by an individual pupil during this project:

| THOUGHT | ACTION |
|---|---|
| What will my alarm be for? What will it protect? Who will control it? What components will it need? | Developing innovative ideas through discussion and annotated sketches, generating a design specification. |
| Which switches or sensors should I use? What output devices should I use? | Discussing ideas, modelling possible electrical circuits. Recording design ideas pictorially or using circuit diagrams. |
| What tools and components will I need? What sequence of steps will I use? | Developing a step-by-step plan. |
| How can computer control improve my alarm system? | Writing and testing programs and connecting to a control box. |
| More thoughts… appraising, reflecting, refining. | More actions… assembling, testing, modifying. |
| Will the alarm achieve its purpose? | Evaluating the alarm against the original design specification. |

## Glossary

- **Modelling** – to realise and manipulate ideas in a tangible form.
- **Open switch** – when a switch is positioned such that electricity cannot flow through it.
- **Closed switch** – when a switch is positioned such that electricity can flow through it.
- **Normally open** – the term used to describe when a switch is in the off position, i.e. the switch is open and no electricity can flow when the button on not pressed.
- **Normally closed** – the term used to describe when a switch is in the on position i.e. the switch is closed and electricity can flow when the button is not pressed
- **Computer control input** – when a switch, such as a micro switch, sends a signal to a computer control box to activate a sequence of events such as a buzzer or light being used to attract attention or alert people.
- **Output devices** – components that produce an outcome e.g. bulbs and buzzers.
- **Input devices** – components that are used to control an electrical circuit e.g. switches or sensors.