**NZQA**

**Approved**

Achievement standard: 91077 Version 3

Standard title: Demonstrate understanding of basic concepts used in the design and construction of electronic environments

Level: 1

Credits: 3

Resource title: Does the lawn need watering?

Resource reference: Digital Technologies VP-1.47 v2

Vocational pathway: Primary Industries

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| Date version published | February 2015 Version 2To support internal assessment from 2015 |
| Quality assurance status | These materials have been quality assured by NZQA. NZQA Approved number A-A-02-2015-91077-02-7345 |
| Authenticity of evidence | Assessors/educators must manage authenticity for any assessment from a public source, because learners may have access to the assessment schedule or exemplar material.Using this assessment resource without modification may mean that learners’ work is not authentic. Assessors/ educators may need to change figures, measurements or data sources or set a different context or topic to be investigated or a different text to read or perform. |

Vocational Pathway Assessment Resource

Achievement standard: 91077

Standard title: Demonstrate understanding of basic concepts used in the design and construction of electronic environments

Level: 1

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Learner instructions

# Introduction

This assessment activity requires you to demonstrate understanding of the basic electronic concepts used in the design and construction of a sensor-controlled watering system for a lawn.

You are going to be assessed on how comprehensively you demonstrate understanding of the basic concepts used in the design and construction of electronic environments.

The following instructions provide you with a way to structure your work so you can demonstrate what you have learnt and achieve success in this standard.

Assessor/educator note: It is expected that the assessor/educator will read the learner instructions and modify them if necessary to suit their learners.

# Task

You will develop a sensor-controlled watering system for a lawn which will indicate when the moisture in the lawn drops to a level that will require the lawn to be watered. It will also have a remote indication using three LEDs or a multicolour LED that shows the level of the moisture in the lawn and a short warning buzzer that buzzes for 10 seconds to warn that watering is to start. The circuit will also provide a switch that allows the water system to be manually operated.

‘Electronic environment’ refers to functional combinations of hardware and embedded software.

‘Basic concepts’ includes understanding the function of the components you use and at least five of the following:

* a circuit as a complete path
* voltage as an energy path
* current as rate of flow of charge
* conduction (limited to the macroscopic behaviour of conductors, insulators, and semiconductors)
* circuit subsystems
* symbolic conventions and schematics
* hardware (for example components and combinations of components)
* embedded systems as software subject to hardware constraints.

You are required to design and construct a sensor-controlled watering system for a lawn.

## Specifications

Specifications must be agreed with the assessor/educator prior to the implementation of the interfacing procedures.

Specifications for the sensor-controlled watering system include:

* a system that indicates when the moisture in the lawn drops to a level that will require it to be watered, for example 20%, 30%, and 50% soil dampness at 75 mm
* a remote indicator, using three LEDs or a multicolour LED, that shows the level of the moisture in the lawn at three stages:
	+ watering needed (0-15%)
	+ moisture level normal (16-30%)
	+ moisture level too high (over 30%)
* sensors suitable for detecting the amount of moisture in the ground
* sensors calibrated to start the sprinklers when there is less than 15% moisture at 75 mm below the surface, and to stop when 30% moisture is measured
* a short warning buzzer that buzzes for 10 seconds to warn that watering is about to start
* a circuit that provides a switch so the watering system can be manually operated
* an override switch so a person can manually start the sprinklers
* a device that will start a pump when watering is needed.

To calibrate the sensor read the values with the sensor dry (0%) and the sensor in water (50%) then calculate the values needed for the indication.

The system will be a microcontroller-based circuit, using the following components:

* microcontroller, for example PIC, PICAXE, AVR, Basic Stamp
* LED and a buzzer as indicators
* switch for manual override control
* thermistor in a voltage divider sub-circuit
* motor driving a pump driven by a suitable transistor amplifier sub-circuit to spray the lawn with water. Note: For the purposes of this assessment this can be simulated with a motor only.

A suitable platform for this work would be an electronic breadboard and you may also need fixed or variable resistors, diodes and capacitors.

## Steps for construction

Use these five steps to design and construct your sensor-controlled watering system and support your work with documented evidence:

1. Use a breadboard to connect three LEDs to a microcontroller with three different resistor values. Program the microcontroller to control the LEDs, and describe and explain the effects of different resistor values. Determine a correct value of resistance for your circuit and explain your choice in terms of current and voltage requirements for an LED. Show your calculations for the currents and voltages in each LED sub-circuit.
2. Connect a transistor amplifier circuit to your microcontroller and attach a small motor to this. Explain why a transistor is required and how it affects the current and voltage in the relay sub-circuit.
3. Connect a switch to your microcontroller and write a simple program that changes the state of the motor every time the switch is pressed. Describe the purpose of the resistor in the circuit and explain its effect on the microcontroller input.
4. Connect a moisture detection circuit to your microcontroller and use this to show the effect of moisture on your motor:
	1. when the sensor is dry
	2. when the sensor is fully wet
	3. at 20%, 30%, and 50% soil dampness at 75 mm (see Specifications).
5. Modify the program so that either the thermistor or the switch controls the motor LED and buzzer.

Use the circuit below, if required.

## Completing the task

As you perform the task, make notes and gather evidence for inclusion in your portfolio. For example:

* describe what happens to the moisture-controlled detection system when you apply consistent and correct use of at least five basic concepts (for example, voltage, current, open and closed circuits, correct use of component symbols, software to control basic microcontroller circuits)
* explain your choice of basic components to build your circuit, for example resistor to limit current and/or transistor to amplify current
* explain any calculations and/or research, for example manufacturer data sheets, that you used to determine the best components for your circuit
* describe how your circuit behaves in terms of the basic concepts, for example, a voltage divider
* discuss the operation, function, and calculation of the electronic components you used in your circuit, for example:
	+ resistor values in an LED current limit sub-circuit controlled by a microcontroller
	+ voltage divider sub-circuit resistor values as inputs to a microcontroller
	+ diode between a circuit and a power source
	+ selection of a suitable transistor based upon its characteristics as an amplifier between a microcontroller and a motor.

## Presentation

Present your understandings as a portfolio, which must include:

* circuit diagrams
* layouts
* programs for each of the five steps in the task.

You may also want to include:

* annotated diagrams and photographs
* journal entries that describe your trialling and testing of circuits
* your responses to assessor/educator questions
* interview notes from a scheduled assessor/educator consultation
* test results.

This is an individual activity.

# Resources

## Useful websites:

<http://www.arduino.cc/en/>

[www.electronics-tutorials.com/basics/basic-electronics.htm](http://www.electronics-tutorials.com/basics/basic-electronics.htm)

<http://williamson-labs.com/>

[www.technologystudent.com](http://www.technologystudent.com)

Vocational Pathway Assessment Resource

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Assessor/Educator guidelines

# Introduction

The following guidelines are supplied to enable assessors/educators to carry out valid and consistent assessment using this internal assessment resource.

As with all assessment resources, education providers will need to follow their own quality control processes. Assessors/educators must manage authenticity for any assessment from a public source, because learners may have access to the assessment schedule or exemplar material. Using this assessment resource without modification may mean that learners' work is not authentic. The assessor/educator may need to change figures, measurements or data sources or set a different context or topic. Assessors/educators need to consider the local context in which learning is taking place and its relevance for learners.

Assessors/educators need to be very familiar with the outcome being assessed by the achievement standard. The achievement criteria and the explanatory notes contain information, definitions, and requirements that are crucial when interpreting the standard and assessing learners against it.

# Context/setting

This activity requires learners to demonstrate comprehensive understanding of basic concepts used in the design and construction of electronic environments, using the design and construction of an electronic sensor-controlled water system for a lawn.

The specifications need to be agreed prior to the implementation of interfacing procedures. They may be provided or developed in negotiation with the learner.

# Conditions

In this activity learners will work individually.

# Resource requirements

Electronic catalogues and supplies are available at:

[www.Surplustronics.co.nz](http://www.Surplustronics.co.nz)

[www.Activecomponents.com](http://www.Activecomponents.com)

Learners will also require:

* internet access
* materials to build their detection system
* a digital camera
* an electronic breadboard
* electronic circuit simulation software, for example:

[www.falstad.com/circuit/](http://www.falstad.com/circuit/)

[www.yenka.com](http://www.yenka.com)

* software for schematic capture, for example:

[www.cadsoft.de](http://www.cadsoft.de).

The following resources may also be useful:

* *An Introduction to Practical Electronics, Microcontrollers and Software Design* by Bill Collis (available at [www.techideas.co.nz](http://www.techideas.co.nz))
* *PICAXE Microcontroller Projects for the Evil Genius* by Ron Hackett (available at [www.amazon.com](http://www.amazon.com)).

# Additional information

Other microprocessors, such as Arduino could be used.

# Assessment schedule: Digital Technologies 91077 – Does the lawn need watering

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| Evidence/Judgements for Achievement | Evidence/Judgements for Achievement with Merit | Evidence/Judgements for Achievement with Excellence |
| The learner demonstrates understanding of basic concepts used in the design and construction of a sensor-controlled watering system by:* describing concepts of electronics in practical contexts

Basic concepts will include understanding of the function of electronic components as well as at least five of the following:* + a circuit as a complete path
	+ voltage as an energy level
	+ current as rate of flow of charge
	+ conduction (limited to the macroscopic behaviour of conductors, insulators, and semiconductors)
	+ circuit subsystems
	+ symbolic conventions and schematics
	+ hardware (for example components and combinations of components)
	+ embedded systems as software subject to hardware constraints

For example:The learner drew a completed circuit schematic with all the correct symbols and conventions.The learner was able to describe how a voltage divider works.In electronics, we talk about a circuit as a complete path. This means that electrons flow from a battery through the components and back to the battery again. Sometimes there are breaks and shorts in the path due to incorrect wiring. See my circuit diagram and photograph with notes showing a completed circuit without short circuits or disconnections.* describing the operational function of electronic components in a sensor-controlled watering system (e.g. in a transistor switch system)

Electronic components include:* + a microcontroller (one example)
	+ a cell
	+ a switch (for example SPST, SPDT, reed, relay)
	+ a resistor (for example fixed, variable, light dependent [LDR], thermistor)
	+ light-emitting diode (LED)
	+ motor
	+ voltage divider and transistor switch subsystems

For example:A resistor is required to be put in series with an LED because … Current and voltage … might …The voltage divider is used as a … into the microprocessor so that …*The above expected learner responses are indicative only and relate to just part of what is required.* | The learner demonstrates in-depth understanding of basic concepts used in the design and construction of a sensor-controlled watering system by:* describing concepts of electronics in practical contexts

Basic concepts will include understanding of the function of electronic components as well as at least five of the following:* + a circuit as a complete path
	+ voltage as an energy level
	+ current as rate of flow of charge
	+ conduction (limited to the macroscopic behaviour of conductors, insulators, and semiconductors)
	+ circuit subsystems
	+ symbolic conventions and schematics
	+ hardware (for example components and combinations of components)
	+ embedded systems as software subject to hardware constraints

For example:The learner drew a completed circuit schematic with all the correct symbols and conventions.In electronics, we talk about a circuit as a complete path. This means that electrons … through the components and back to the … Sometimes there are breaks and shorts in the path due to incorrect wiring.* explaining the behaviour of electronic circuits

For example:*I chose this resistor because a lower value would have… effect and a higher value would have… effect (explained in terms of current and voltage). The purpose of the transistor is to… between the motor and the micro because… When I made my circuit, I made sure the LED and resistor were in series, not in parallel,* OR*When I made the circuit, I realised the LED and resistor were in parallel, and I changed them to series because the current…** explaining the operational function of electronic components in a sensor-controlled watering system

Electronic components include:* + a microcontroller (one example)
	+ a cell
	+ a switch (for example SPST, SPDT, reed, relay)
	+ a resistor (for example fixed, variable, light dependent [LDR], thermistor)
	+ light-emitting diode (LED)
	+ motor
	+ voltage divider and transistor switch subsystems

For example:The learner drew a completed circuit schematic with all the correct symbols and conventions and annotated it with the values to be used in the final circuit.The learner explained the purpose of the transistor in the motor sub circuit and could explain what effect changing the value may have on the circuit.A resistor is required to be put in series with an LED because … Current and voltage … might … The learner spent some time determining the correct value of the resistor.The voltage divider is used as a … microprocessor so that … Changing the value of the resistor will …During testing the learner decided to replace the fixed resistor in the voltage divider with a variable one because …*The above expected learner responses are indicative only and relate to just part of what is required.* | The learner demonstrates comprehensive understanding of basic concepts used in the design and construction of a sensor-controlled watering system by:* describing concepts of electronics in practical contexts

Basic concepts will include understanding of the function of electronic components as well as at least five of the following:* + a circuit as a complete path
	+ voltage as an energy level
	+ current as rate of flow of charge
	+ conduction (limited to the macroscopic behaviour of conductors, insulators, and semiconductors)
	+ circuit subsystems
	+ symbolic conventions and schematics
	+ hardware (for example components and combinations of components)
	+ embedded systems as software subject to hardware constraints

For example:The learner drew a completed circuit schematic with all the correct symbols and conventions.In electronics, we talk about a circuit as a complete path. This means that electrons … through the components and back to the …. Sometimes there are breaks and shorts in the path due to incorrect wiring.* explaining the behaviour of electronic systems (e.g. the effects of voltage levels on the operation of a transistor switch sub-system)

For example:*I calculated the resistor value for my LED on my microcontroller to be… using Ohm’s law in this way (see my calculation and explanation). I wanted the LED to be bright enough for the light to be seen at a distance on a bright day. I chose the capacity of the cells for my project to be … based upon my calculations of the current demands of my circuit with … LEDs, motor…* *Here are my calculations…** discussing the operational function of electronic components in a sensor-controlled watering system (e.g. the effect of swapping the fixed resistor and the LDR in a voltage divider circuit).

Electronic components include:* + a microcontroller (one example)
	+ a cell
	+ a switch (for example SPST, SPDT, reed, relay)
	+ a resistor (for example fixed, variable, light dependent [LDR], thermistor)
	+ light-emitting diode (LED)
	+ motor
	+ voltage divider and transistor switch subsystems

For example:I tested my motor and found that it could not be run directly by my microcontroller. So I used a transistor in the circuit between the microcontroller and the relay because the microcontroller is limited to providing X current and my motor requires Y current. The transistor for my motor amplifies the current as a microcontroller cannot drive a motor directly.The microcontroller has … which can be used along with some code to control the function of the circuit. It does this by … I found some errors in the code on testing which I fixed by …I researched three transistors… Their specifications are… I chose... as the specification for my relay is… and then I knew that my chosen transistor would not overheat/explode/cease to function. The effect of swapping the transistor in the circuit is … *The above expected learner responses are indicative only and relate to just part of what is required.* |

Final grades will be decided using professional judgement based on an examination of the evidence provided against the criteria in the Achievement Standard. Judgements should be holistic, rather than based on a checklist approach.