

<b>Title</b>	<b>Demonstrate and apply knowledge of a.c. motors</b>		
<b>Level</b>	<b>4</b>	<b>Credits</b>	<b>4</b>

<b>Purpose</b>	<p>This unit standard covers the principles, construction, calculations, and measurement of single-phase and three-phase alternating current (a.c.) motors. It is intended for use in the training of electricians and related trades.</p> <p>People credited with this unit standard are able to:</p> <ul style="list-style-type: none"> <li>– demonstrate knowledge of single-phase motors;</li> <li>– compare characteristics of single-phase motors;</li> <li>– demonstrate knowledge of the factors that affect the performance of three-phase induction motors;</li> <li>– perform a.c. motor calculations and verify by measurement;</li> <li>– reverse direction of rotation of induction motors; and</li> <li>– diagnose faults in electric motors.</li> </ul>
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<b>Classification</b>	Electrical Engineering > Electrical Machines
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<b>Available grade</b>	Achieved
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### Guidance Information

- 1 This unit standard has been developed for learning and assessment off-job.
- 2 Achievement of this unit standard alone does not entitle trainees to legally perform prescribed electrical work without supervision. Until registered and licensed under the Electricity Act 1992, trainees are assisting and must work under supervision when carrying out prescribed electrical work.
- 3 This unit standard and unit standards 5932, 15848, 15855, 29444, and 29480 together meet the assessment requirements of ERAC EPC 12.  
 This unit standard and unit standards, 29444, and 29483 together meet the assessment requirements of ERAC CEPC 13.  
 This unit standard and unit standards 29420, and 29444 together meet the assessment requirements of ERAC EPC 14.  
 This unit standard and unit standards 29420, 29444, and 29483 together meet the assessment requirements of ERAC EPC 15.  
 This unit standard and unit standards 29444 and 29480 meet the assessment requirements of ERAC EPC 52.  
 This unit standard and unit standards 15848, 29420, 29421, 29422, 29444, 29481, 29483, and 29557 meet the assessment requirements of ERAC EPC 54.

#### 4 Definitions

*CEPC* – Critical Essential Performance Capability.

*EPC* – Essential Performance Capability.

*ERAC* – Electrical Regulatory Authorities Council.

*EWRB* – Electrical Workers Registration Board.

*Industry practice* – those practices that competent practitioners within the industry recognise as current industry best practice.

*Specifications* – machine specifications, maintenance instructions, or bearing manufacturers' recommendations relating to removal, cleaning, testing, and fitting of bearings and seals, and the types of lubricants to be used.

*Safe and sound practice* – as it relates to the installation of electrical equipment is defined in AS/NZS 3000:2007, *Electrical Installations (known as the Australian/New Zealand Wiring Rules)*.

#### 5 Assessment

- a Candidates are to be supplied with formulae involving more than three quantities.
- b Use of a calculator during the assessment is permitted.
- c Candidates are expected to express calculated values in the relevant Systeme Internationale (SI) units, including multiples and sub-multiples (pico, nano, micro, milli, kilo, mega, etc) and be able to convert between them.
- d Candidates may refer to current legislation and Standards during assessment.
- e Demonstration of safe working practices and installation in accordance with *safe and sound practice* are essential components of assessment of this unit standard.
- f All activities and evidence presented for all outcomes and performance criteria in this unit standard must be in accordance with:
  - i legislation;
  - ii policies and procedures;
  - iii ethical codes;
  - iv Standards – may include but are not limited to those listed in Schedule 2 of the Electricity (Safety) Regulations 2010;
  - v applicable site, enterprise, and industry practice; and,
  - vi where appropriate, manufacturers' instructions, specifications, and data sheets.

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## Outcomes and performance criteria

### Outcome 1

Demonstrate knowledge of single-phase motors.

#### Performance criteria

- 1.1 With the aid of circuit diagrams describe single-phase multi-speed motors and outline the principles of operation, winding connections, starting, and speed change methods.

Range           tapped-field universal motor, two-speed split-phase motor.

- 1.2 State three different multi-speed motor applications and give reasons for choice.

- 1.3 State a typical multi-speed motor application and give reasons for the suitability of the choice.
- 1.4 Describe construction of and outline operating principles of universal motors.
- 1.5 State four typical application of universal electric motor with reasons for the suitability of the motor type to the identified application.
- 1.6 Compare five properties of single-phase motors.

## **Outcome 2**

Compare characteristics of single-phase motors.

Range motors – universal, standard split-phase induction, capacitor-start, permanently-split capacitor, capacitor start and run, shaded pole.

### **Performance criteria**

- 2.1 Sketch typical speed versus torque curve for each motor.
- 2.2 Compare four single-phase motor properties.
- 2.3 Describe electronic speed control methods for each motor.

## **Outcome 3**

Demonstrate knowledge of the factors that affect the performance of three-phase induction motors.

### **Performance criteria**

- 3.1 Describe the effects of reduced supply voltage on a three-phase induction motor.
- 3.2 Describe the effect of increasing load on efficiency and power factor in terms of increased motor current and reduced cooling.
- 3.3 State the effect of the loss of one phase for star and delta connected motors.
- 3.4 State the effect of a reversed winding on the operation of a three-phase induction motor and explain two methods of rectification.
- 3.5 Explain the effect of multiple starts.
- 3.6 Explain the effects of voltage surges.

Range effects may include but are not limited to – harmonics, lightning strikes, multi-control systems.

**Outcome 4**

Perform a.c. motor calculations and verify by measurement.

Range calculations – run current, start current, synchronous speed, rotor speed, slip speed, input power, output power, efficiency;  
motors may include but are not limited to – single-phase induction, capacitor-start split-phase, three-phase cage, three-phase slip-ring.

**Performance criteria**

- 4.1 Perform calculations in accordance with industry practice.
- 4.2 Take measurements in accordance with industry practice.
- 4.3 Compare measured and calculated values and explain variations in terms of load variations, instrument tolerance, and measurement error.

**Outcome 5**

Reverse direction of rotation of induction motors.

Range single-phase, three-phase.

**Performance criteria**

- 5.1 Install a reversing switch to control the rotation direction of a mains connected motor.
- 5.2 Install contactors to control the rotation direction of a mains connected motor.

**Outcome 6**

Diagnose faults in electric motors.

Range motor types – single-phase, three-phase.  
Evidence of two types of fault on each motor is required.

**Performance criteria**

- 6.1 Compare motor performance against specifications or records of previous performance as an aid to diagnosing motor fault.  
  
Range dynamometer or in situ connected-load tests, power factor, line current, speed, output.
- 6.2 Identify visible and audible motor defects.
- 6.3 Use logical techniques to analyse symptoms, and make electrical measurements where necessary, to locate faults and/or faulty components.

- 6.4 Assess repair viability in terms of manufacturers' recommendations, component cost and availability, cost and time to repair, cost of equivalent replacement product, and supervisor or customer instructions.
- 6.5 Document results in accordance with industry practice.

<b>Replacement information</b>	This unit standard replaced unit standard 15858.
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**This unit standard is expiring. Assessment against the standard must take place by the last date for assessment set out below.**

**Status information and last date for assessment for superseded versions**

Process	Version	Date	Last Date for Assessment
Registration	1	21 July 2016	31 December 2027
Review	2	24 March 2022	31 December 2027
Rollover and Revision	3	25 May 2023	31 December 2027

<b>Consent and Moderation Requirements (CMR) reference</b>	0003
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This CMR can be accessed at <http://www.nzqa.govt.nz/framework/search/index.do>.