Title	Demonstrate knowledge of radio theory and installation practice		
Level	4	Credits	15

Purpose	This unit standard is intended for service technicians and servicepersons who install, diagnose and repair mobile and re-locatable wireless systems, associated hardware, and services. People credited with this unit standard are able to: – demonstrate knowledge of radio waves and the electromagnetic spectrum; – describe the properties and behaviour of transmission lines and antenna systems; -- demonstrate knowledge of modulation and encoding; – demonstrate knowledge of radio frequency signal reception; – demonstrate knowledge of radio interference; and – demonstrate knowledge of modern communication systems.

Classification	Electrical Engineering > Electrotechnology

Available grade	Achieved

Guidance Information

1 Recommended unit standard for entry:
Unit 27912, *Demonstrate knowledge of electrical principles in an electrotechnology or telecommunications environment*.

2 References
AS/NZS 4509.1:2009 *Stand-alone power systems Part 1: Safety and installation,* available from https://www.standards.govt.nz;
AS/NZS 4509.2:2010 *Stand-alone power systems Part 1: System design,* available from https://www.standards.govt.nz;
AS/NZS 5033:2014 *Installation and safety requirements for photovoltaic (PV) arrays*, available from https://www.standards.govt.nz;
AS/NZS 5070.1.2008 *Siting and operation of radiocommunications facilities – Guidelines for fixed, mobile and broadcasting services*;
Compliance Standards for EMC and Radio, available from https://www.rsm.govt.nz;
Electricity Act 1992;
Electricity (Safety) Regulations 2010;
Health and Safety at Work Act 2015;
NZS 2772.1:1999 *Radiofrequency fields – Maximum exposure levels – 3 kHz to 300 GHz*;
Official Information Notices, available from https://www.rsm.govt.nz/;

and all subsequent amendments and replacements.

3 Definitions

AGC – Automatic Gain Control.
AF – Audio Frequency.
AM – Amplitude Modulation.
Company practice – those practices and procedures that have been circulated by the company for use by their employees.
CW – interrupted Continuous Wave or interrupted Carrier Wave transmissions
EME/EMR – Electromagnetic emissions/ Electromagnetic Radiation, specifically exposure levels permitted for workers and public.
FM – Frequency Modulation.
FSK – Frequency Shift Keying.
IF – Intermediate Frequency.
Industry conventions – a set of agreed, specified, or generally accepted standards.
Industry practice – those practices that competent practitioners within the industry recognise as current industry best practice.
ISB – Independent Side Band Modulation.
OFDM – Orthogonal Frequency Division Multiplexing.
PSK – Phase Shift Keying.
QAM – Quadrature Amplitude Modulation.
RF – Radio Frequency.
Safe and sound practice – relating to the installation of electrical equipment as defined in AS/NZS 3000:2018 *Electrical Installations - Known as the Australian/New Zealand Wiring Rules.*
SCADA – Supervisory Control and Data Acquisition, any control system that is designed to collect, analyse, and visualize data from industrial equipment.
SSB – Single Side Band.
TCP-IP – Transmission Control Protocol – Internet Protocol.

4 Assessment

a Competence may be assessed on:
  i Systems installations may include but are not limited to – radio, low voltage, extra-low voltage, data and voice, TV broadcasting, standalone power systems, solar;
  ii Locations may include but are not limited to – vehicles, caravans, mobile homes, transmission and reception sites, repeaters, mobile sites;
  iii Cabling and communications may include but are not limited to – copper, twisted-pair, coaxial copper, data cable, fibre optical cables, waveguides, Wi-Fi, bluetooth or some combination of these;
b All measurements are to be expressed in Système Internationale (SI) units and multipliers.
c Mathematical proof of the subject matter covered by this unit standard is not required.

5 Range

a 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 safe and sound practice;
vi applicable site, company and industry practice, and industry conventions;
vii where appropriate or applicable, environmental requirements, manufacturer instructions, specifications, data sheets and manufacturer, supplier and company health and safety procedures.

Outcomes and performance criteria

Outcome 1

Demonstrate knowledge of radio waves and the electromagnetic spectrum.

Performance criteria

1.1 Describe the electromagnetic spectrum.

Range may include but is not limited to – frequency bands, band characteristics, typical usage, spectrum management; evidence of three is required.

1.2 Describe the properties and behaviour of electromagnetic waves in non-mathematical terms.

Range wavelength and frequency, electrostatic field, electromagnetic field, inverse square law, reflection, refraction, diffraction, ground sky and space wave propagation.

1.3 Describe the use of test equipment required to take measurements and perform adjustments, in terms of configuration, commissioning, performance and restoration of operation of systems and hardware.

Range RF Power Meter, Dummy Load, AF Generator, RF Generator, Frequency Counter, Field Strength Meter, Modulation Meter, Deviation Meter, Spectrum Analyser, Network Analyser, Battery tester, Battery Condition Tester, Time Domain Reflectometer, Optical Power Meter, Fibre Identifier, Visual Light Source, Visual Fault Locator.

1.4 Explain the impact of convergence on RF test equipment.

1.5 Identify hazards associated with installing or servicing wireless systems and interfaces and outline the appropriate safety procedures in each case.

Range Hazards EME/EMR, Heights.

Outcome 2

Describe the properties and behaviour of transmission lines and antenna systems.

Performance criteria

2.1 Identify characteristics of radio frequency feedlines.

Range feedlines – open wire, coaxial cable, waveguide, fibre optical cable;
characteristics include but are not limited to – impedance, loss over frequency, termination requirements, velocity factor, attenuation, absorption.

2.2 Describe the construction and properties of commonly used antennas.

Range construction – voltage and current distribution, beam width, polarisation, director, reflector driven element;
antennas include but are not limited to – long wire, dipole, grounded quarter wave Marconi, directional, folded dipole and Yagi, wide band including rhombic, log period, high gain including hyperboloid and paraboloid, Horn antenna.

2.3 Describe the methods of coupling the antenna to the radio transmitter, and the consequences of mismatched feeders

Range coupling methods may include – delta match, transformer match, balun, LC network match, quarter wave stub match directional coupler;
consequences include – open circuit, short circuit, standing waves.

2.4 Describe diversity antenna systems and potential applications.

Outcome 3

Demonstrate knowledge of modulation and encoding.

Performance criteria

3.1 Describe different methods of analogue modulation based on characteristics, efficiency and noise rejection.

Range may include but is not limited to – AM, SSB, ISB, FM;
evidence of three is required.

3.2 Describe different methods of digital modulation based on characteristics, efficiency and noise rejection.

Range may include but is not limited to – CW, FSK, PSK, QAM;
evidence of three is required.

3.3 Explain frequency and time division multiplexing.

Range guard bands, OFDM, sampling, quantising, encoding, companding, compression, synchronous, asynchronous.

Outcome 4

Demonstrate knowledge of radio frequency signal reception.

Performance criteria

4.1 Explain common terminology associated with radio receivers.

Range includes but is not limited to – selectivity, sensitivity, image frequency rejection filtering, AGC, tracking, RF gain, IF gain, AF gain.

4.2 Explain the operation of a reception superheterodyne receiver for AM and SSB.

Range includes but is not limited to – filtering, AGC, RF gain, IF gain, AF gain, a block diagram.

4.3 Explain the operation of a reception superheterodyne receiver for FM.

Range includes but is not limited to – filtering, AGC, RF gain, IF gain, AF gain pre-emphasis, de-emphasis, a block diagram.

Outcome 5

Demonstrate knowledge of radio interference.

Performance criteria

5.1 Describe the nature of noise and its measurement.

Range internal noise, external noise, signal to noise ratio.

5.2 Identify the sources of interference on radio signals.

Range internal to equipment, external to equipment.

Outcome 6

Demonstrate knowledge of modern communication systems.

Performance criteria

6.1 Explain the principles and practices of radio data communications and connectivity solutions.

Range may include but is not limited to – encoded voice, encryption, TCP/IP, multiplexed data, command and control systems, SCADA, serial data (RS232 and 485);
evidence of three is required.

6.2 Describe the products and systems interfaces in relation to pinout, function and electrical connection.

Range interfaces may include but are not limited to – DB9, DB25, RJ11, RJ12, RJ45, RJ50, USB, EIA422, profibus, LC, SC;
evidence of five interfaces is required across three products.

6.3 Identify available technologies, products or services for given end user requirements.

Range may include but is not limited to – Voice, Data, Mixed Voice and Data, TCP/IP connectivity, multiplexed data, command and control systems, SCADA, serial data;
evidence of three end user requirements is required.

Planned review date	31 December 2026

Status information and last date for assessment for superseded versions

Process	Version	Date	Last Date for Assessment
Registration	1	25 November 2021	N/A

Consent and Moderation Requirements (CMR) reference	0003

This CMR can be accessed at http://www.nzqa.govt.nz/framework/search/index.do.

Comments on this unit standard

Please contact Waihanga Ara Rau Construction and Infrastructure Workforce Development Council qualifications@waihanga.nz if you wish to suggest changes to the content of this unit standard.