Title	**Demonstrate and apply knowledge of electronic product reliability and advanced electronic measurement and diagnosis**		
Level	**4**	**Credits**	**15**

Purpose	This unit standard is intended for electronics technicians and covers product reliability and the use of test equipment widely used in the electronics industry and laboratories to measure electronic circuits at an advanced level. People credited with this unit standard are able to: – demonstrate knowledge of electronic component reliability failure modes – describe environmental factors that affect electronic equipment reliability and techniques to minimise these effects – use advanced functions of oscilloscopes – use advanced measurement techniques – apply basic instrument calibration procedures – demonstrate the use of typical fault-finding equipment – demonstrate and apply knowledge of repair strategies and the economic viability of repair, and – demonstrate and apply knowledge of logical and systematic fault-finding techniques to diagnose faults on microprocessor and/or microcontroller-based equipment.

Classification	Electronic Engineering > Core Electronics

Available grade	Achieved

Guidance Information

1 Recommended skills and knowledge for entry: Unit 20715, *Demonstrate and apply knowledge of analogue principles for electronics technicians*.

2 References
Electricity Act 1992
Electricity (Safety) Regulations 2010
Electrical Workers Registration Board (*EWRB*) *Rules of the Board and Teaching Guidelines* available at www.ewrb.govt.nz
Health and Safety at Work Act 2015 and associated regulations
and all subsequent amendments and replacements.

3 Definitions
Bath-tub method – a method of evaluating the reliability and failure characteristics of a machine, the ‘bathtub’ curve reflects the failure rate vs time.

CMOS – complementary metal oxide semiconductor.
FFT – fast Fourier transform.
FIT – Failure in time. 1 FIT or failure unit = 1 failure/10^9 hours.
G-force – either the force of gravity on a particular celestial body or the force of acceleration anywhere.
HF – high frequency.
Industry practice – those practices that competent practitioners within the industry recognise as current industry best practice.
IP – ingress protection.
LCR – combination of inductance, capacitance, resistance.
LF – low frequency.
MDT – mean down time.
Microcontroller – an integrated circuit that contains most of the components needed to control physical processes. Typically this includes a CPU, RAM, some kind of ROM, timers, interrupt control, and analogue or digital converters, all on the same chip. Some microcontrollers also incorporate interpreter software, and additional support circuitry such as EEPROM, voltage regulator, and ceramic oscillator.
MTBF – mean time between failures.
MTTF – mean time to failure.
MTTR – mean time to repair.
PCB – printed circuit board.
SCR – silicon controlled rectifier.
TDR –time domain reflectometer.
TV – television.

4 Range
- a Electrical, radiation, and workshop or laboratory safety practices are to be observed at all times.
- b All measurements are to be expressed in Système Internationale (SI) units and multipliers.
- c Candidates are expected to have memorised all formulae used in calculations.
- d Use of non-programmable calculators is permitted during assessments.
- e 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 EWRB Rules of the Board
  - vi safe and sound practice
  - vii applicable site, company and industry practice.

Outcomes and performance criteria

Outcome 1

Demonstrate knowledge of electronic component reliability failure modes.

Performance criteria

1.1 Explain terminology associated with reliability of electronic components.

Range terminology – MTBF, MTTF, MTTR, MDT, FIT.

1.2 Describe strategies to improve reliability with reference to the bath-tub model.

Range may include but is not limited to – burn-in, extreme temperature cycling, extreme voltage cycling, extreme load cycling, replacement before failure strategy;
evidence of four is required.

1.3 Select components using manufacturers' data to meet a specified average life expectancy for a typical application or product.

Range may include but is not limited to – capacitor life-time versus stress, semiconductor device (power rating) life expectancy versus stress; stress factors versus temperature, pulse current, pulse voltage, contact life time versus loading;
evidence of three is required.

1.4 Identify common circuit design errors that may reduce the life of components or cause functional failure.

Range may include but is not limited to – rapid discharge of electrolytic capacitors, discharge of capacitor through protection circuits, latch-up of voltage regulators due to reverse biasing, signal voltage applied to input of CMOS device with power off;
evidence of three is required.

1.5 Describe examples of situations where the normal failure mode of a component needs to be taken into account and state the expected effect on performance and safety.

Range may include but is not limited to – fails to an open circuit condition, fails to a short circuit condition, safety aspects, reset state of microprocessor ports;
evidence of three is required.

1.6 Describe different failure modes of components.

Range may include but is not limited to – SCR, relay, transistor, capacitor.

1.7 Describe crowbar protection with the aid of diagrams.

1.8 Identify design factors that affect the maintainability of a product.

Range construction, modular design, hot swap, MDT.

1.9 Describe simple system reliability models or strategies.

Range series model, parallel redundancy.

Outcome 2

Describe environmental factors that affect electronic equipment reliability and techniques to minimise these effects.

Performance criteria

2.1 Describe possible damaging effects of environmental factors on electronic equipment.

Range may include but is not limited to – high ambient temperature, component overheating and burnout; high humidity and dust, mildew, tracking; high vibration and G-force; bending and fracture of leads, plug or socket separation; corrosive chemical atmosphere, corrosion of PCB tracks and component leads, tracking;
evidence of four is required.

2.2 Describe techniques to minimise the effects of harsh environments on electronic equipment.

Range temperature may include but is not limited to – cooling (radiative, conductive, convective or fan), derating, heat sinking, proximity of heat sources;
humidity and dust may include but is not limited to – IP rated enclosures, creepage distance, optocoupler and transformer selection, air filters;
high vibration and G-force may include but is not limited to – component or circuit board mounting, selection of locking connectors, potting;
corrosive atmosphere may include but is not limited to – creepage distance, conformal coating, IP rated enclosures;
evidence of three from each of temperature, humidity and dust, high vibration and G-force, and corrosive atmosphere is required.

Outcome 3

Use advanced functions of oscilloscopes.

Performance criteria

3.1 Use dual time base and delayed trigger functions to examine complex repetitive waveforms on oscilloscopes.

3.2 Use various trigger modes to examine complex repetitive waveforms on oscilloscopes.

Range may include but is not limited to – HF, TV;
evidence of two is required.

3.3 Use the X-Y input functions to display waveforms.

Range may include but is not limited to – device transfer characteristics, clock synchronisation, phase measurement, frequency measurement.

3.4 Use digital storage facilities to capture complex waveforms.

Range may include but is not limited to – pre-trigger events, non-recurring waveforms, low frequency waveforms.

3.5 Use the cursors to make voltage and time measurements.

3.6 Apply mathematical functions relating to reliability.

Range includes but is not limited to – FFT.

3.7 Capture waveforms and print, or plot, or store for future analysis.

3.8 Demonstrate the use of input probes.

Range may include but is not limited to – probe compensation, impedance loading, lead capacitance.

Outcome 4

Use advanced measurement techniques.

Performance criteria

4.1 Measure true rise time and compare to predicted rise time and explain differences in terms of losses produced by measuring instrument, probe, and equipment under test.

4.2 Create calibration charts for instrument reading corrections at the limits of the instrument.

4.3 Demonstrate square wave testing of analogue equipment.

Range may include but is not limited to – preshoot, overshoot, high frequency loss, low frequency loss, loss of fundamental, ringing, hum;
evidence of three is required.

4.4 Determine input and output impedance using resistor substitution.

Outcome 5

Apply basic instrument calibration procedures.

Performance criteria

5.1 Check typical laboratory instruments for calibration using manufacturers' or standards specifications.

Range may include but is not limited to – function generator, voltmeter, power supply, insulation resistance tester; evidence of three is required.

5.2 Use calibration devices in accordance with manufacturers' calibration standards.

5.3 Check instruments are calibrated in accordance with ISO 9000 project identification and traceability requirements.

Outcome 6

Demonstrate the use of typical fault-finding equipment.

Range selected equipment is to be relevant to the field of study being followed; evidence of three fault-finding aids or pieces of equipment is required.

Performance criteria

6.1 Demonstrate the use of typical fault finding and diagnostic equipment.

Range may include but is not limited to – spectrum analyser or FFT analyser; TDR or cable fault locator or cable scanner; harmonic analyser; power line analyser; protocol analyser; analogue signature analysis, for example a Huntron Tracker®; LCR bridge; universal frequency counter; function generator with AM or FM modulation; function or arbitrary waveform generator; TV pattern generator.

Outcome 7

Demonstrate and apply knowledge of repair strategies and the economic viability of repair.

Performance criteria

7.1 Identify hazards in relation to fault finding and describe safety procedures to be observed.

7.2 Describe the economics of equipment or module replacement versus component level repair.

7.3 Explain half split, linear (beginning to end), and previous history and experience methods of fault finding.

7.4 Explain record keeping techniques.

7.5 Discuss board swapping as a method of fault finding and identify situations in which it may be used.

Range includes but is not limited to – warranty issues, confirmation of diagnostics, time critical repairs.

Outcome 8

Demonstrate and apply knowledge of logical and systematic fault-finding techniques to diagnose faults on microprocessor and/or microcontroller-based equipment.

Range evidence of four different faults is required.

Performance criteria

8.1 Identify hazards in relation to fault finding and describe safety procedures to be observed.

8.2 Explain the logic of the methods and techniques used to find faults in microprocessor and/or microcontroller-based equipment.

8.3 Use onboard tools, diagnostic software, or instruments to locate faults in microprocessor and/or microcontroller-based equipment to confirm hardware or software faults.

8.4 Diagnose faults without compromising the integrity of the product or system.

8.5 Diagnose faults through logical and systematic analysis of symptoms, observation, simulation, and measurement.

8.6 Demonstrate housekeeping at the repair station.

8.7 Apply techniques of equipment isolation.

Range includes but is not limited to – signs, locks on isolation switches.

Replacement information	This unit standard replaced unit standard 20718 and unit standard 20721.

Planned review date	31 December 2025

Status information and last date for assessment for superseded versions

Process	Version	Date	Last Date for Assessment
Registration	1	21 July 2011	31 December 2022
Review	2	24 June 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@WaihangaAraRau.nz if you wish to suggest changes to the content of this unit standard.