

1 Module Details**Module Name****High Voltage Power Supplies****Nominal duration**

It is expected that students with the appropriate entry knowledge and skills will successfully complete this module in 40 hours

Module code

NUE657

Discipline code

0703230 Electronic Installation and Maintenance

2 Module purpose

This module will provide the student with the necessary theoretical and practical skills to assess, measure, maintain, and test high voltage components and power supplies associated with radar transmitters, displays and other systems utilising high and extra high DC or AC voltages.

3 Prerequisites

NE 120 - Radar Principles

NE 121 - Radar Applications

4 Relationship to competency standards

This module provides some of the knowledge and skills underpinning competency in the following standards:

National Electrotechnology Industry Standards, Unit NES803

Metals and Engineering Industry Standards, Units 18.51, 18.57A, 18.62A.

5 Content

1. Safety

- safety symbols
 - high voltages
 - ionising radiation hazards
 - non-ionising radiation hazards
- signs
 - high voltages
 - ionising radiation hazards
 - non-ionising radiation hazards
- personnel safety in the vicinity of radiation hazards

- personnel safety in the vicinity of high voltage sources
- high voltage arcing
- insulation breakdown
- carbon tracking
- ionisation
- measurement of high and extra high voltages

2. Test equipment

- applications
 - electrometers
 - high voltage probes
 - ionisation testers
 - insulation testers
 - discharge probes
 - DC and AC voltmeters, millivoltmeters, microvoltmeters
 - DC and AC ammeters, milliampmeters, microampmeters
 - scaling networks
 - corona
 - spark gaps
 - creepage
 - tracking
- calibration
- errors of measurement and their effects
- charts and graphs used in assessing equipment and materials
 - dielectric characteristics
 - insulation characteristics
 - air ionisation gaps

3. High voltage sources and components

- Voltage doublers
- Voltage triplers and higher voltage multipliers
- Van der Graaff generators
- Cockcroft Walton generators
- Pulse transformers
- Pulse forming networks
- Modulators
- Travelling wave linear accelerator
- Cyclic accelerator
- Gas tubes

- Hydrogen Thyratrons
- Diodes/solid state thyratrons
- Capacitors
- Transformers
- Bleed resistors

4. Routine maintenance procedures

- Schedules
- Safety precautions
- Fault finding

5. EMI/EMC

- Causes
- Effects
- Standards

6 Assessment strategy

Assessment methods

Assessment should be progressive reflecting a holistic approach to ensure the module purpose is met. To assist in ensuring validity, reliability and fairness assessment instruments should include practical exercises, assignments and written tests consisting of a number of item types, such as multiple choice, short answer and problem solving.

Conditions of assessment

Learning and assessment will take place in a classroom/laboratory environment and in a real or simulated radar installation.

7 Learning Outcome

Details

Learning Outcome 1

Outline the risks to personnel from high voltage sources and the materials and components associated with such sources.

Assessment criteria

- 1.1 Describe the safety signs and symbols associated with high voltages.
- 1.2 State the physiological effects of ionising phenomena.
- 1.3 Describe the precautions necessary to protect personnel working on, or adjacent to typical high voltage sources
- 1.4 State the emergency rescue procedures appropriate to high voltage installations

Learning Outcome 2

Describe the operating principles of typical high voltage sources.

Assessment criteria

- 2.1 Briefly describe the history of high voltage power supplies
- 2.2 Define the following terms in relation to high voltage/extra high voltage sources:
 - high voltage/high tension
 - extra high voltage
 - creepage
 - ionisation
 - carbon tracking
 - doubler/tripler
 - pulse forming network
 - bleed resistor
 - insulation breakdown
 - corona
 - circuit parameters
 - high voltage isolation
- 2.3 Draw the block diagrams of typical high voltage sources and identify the major components.
- 2.4 Describe the operating parameters of the major components of typical high voltage power supplies including:
 - supply voltage/current

- output voltage/current
- ripple
- protection
- adjustment
- testing
- efficiency
- expected life
- stability
- cooling
- size
- handling considerations

2.5 Describe the physical construction of typical high voltage sources

2.6 Describe the operating principles of typical high voltage sources and their major components.

Learning Outcome 3

Measure parameters associated with DC and AC high voltage sources and components.

3.1 Describe the characterising parameters associated with high voltage sources and components.

3.2 Select suitable test equipment from commercial test equipment catalogues appropriate for high voltage measurements.

3.3 Calibrate a range of high voltage test equipment

3.4 Describe the effects of measurement errors that can occur in high voltage measurements.

3.5 Use charts and graphs to determine:

- creepage distances
- airgap discharge distance
- insulation resistance versus temperature/age/humidity/pressure
- dielectric constant

3.6 Use test equipment to measure parameters associated with high voltage sources and

	associated with high voltage sources and components.
Learning Outcome 4	Describe maintenance procedures for typical high voltage power supplies.
Assessment criteria	<p>4.1 Describe symptoms of component deterioration in high voltage power supplies</p> <p>4.2 Describe maintenance schedules and procedures for high voltage power supplies</p> <p>4.3 Describe potential hazards and safety precautions necessary when undertaking maintenance on high voltage power supplies.</p> <p>4.4 Describe fault finding procedures on typical high voltage power supplies.</p>
Learning Outcome 5	Describe the role of EMI/EMC, in high voltage power supplies
Assessment criteria	<p>5.1 Describe how EMI can be generated through switching and other transients.</p> <p>5.2 Describe typical methods for reducing EMI</p> <p>5.3 Describe possible effects of EMI on high voltage power supplies</p> <p>5.4 Describe the procedures for ensuring high voltage power supplies conform to EMC standards</p>
8 Delivery of the module	
Delivery strategy	Delivery strategies must be suitable for learning both theoretical and practical aspects described in the module purpose. It is considered that the most effective way to achieve this is by the integration of theory and practice where students learn by experimentation and through research and laboratory reports. It is recommended that learning and assessment be facilitated in a holistic

Resource requirements

manner, which may require a learning outcome sequence other than that indicated in the module.

Students will need access to modern test equipment suitable for high voltage measurement applications such as:

- electrometers
- high voltage probes
- ionisation testers
- insulation testers
- discharge probes
- DC and AC voltmeters, millivoltmeters, microvoltmeters
- DC and AC ammeters, milliammeters, microammeters

The laboratory used for the teaching of practical aspects of this module will require a small working radar, or similar and appropriate high voltage /extra high voltage generation sources. Whilst measurements may be carried out using low power test sources, the use of a complete system as an item of test equipment will provide the student with a much greater “real world” experience.

Useful references include

- Skolnik. Introduction to Radar
- Skolnik. Radar Handbook
- Kennedy G. Electronic Communication Systems. McGraw Hill Publishers
- DeFrance J. Communications Electronics Circuits. Rinehart Press
- Bell D. Electronic Instruments and Measurements. Reston Publishing
- Pearsman P. Solid State Industrial Electronics. Reston Publishing
- Dungan F. Electronic Communications Systems Delmar Publishing
- Shradar R. Electronic Communications. McMillan Publishing.
- ITT. Reference Data for Radio Engineers. Sams Publishing

Occupational health and safety requirements

- Acker A. How to speak Radar, Basic Fundamentals and Applications of Radar. Varian Associates
- NAVSEA 0967-LP-000-0120, Electronic Installations and Maintenance - Electric Circuits
- NAVSEA 0967-LP-000-0020, Electronic Installations and Maintenance - Radar

A safe and healthy environment will be provided for students

and teachers as well as safety procedures followed with regard to teaching/learning activities.