



# Line and Antenna Sweep (LAS) Competency Requirements

The following is a listing of each topic considered necessary to be included in a course of study towards the education of technicians performing a Line and Antenna Sweep using a frequency domain reflectometer (FDR).

There are 11 categories of knowledge. This COMPETENCY listing is the syllabus, or identification of each individual subject, in which the technician must be knowledgeable and skilled. A special course, fee and hands-on exam from an ETA<sup>®</sup> approved school are the required pre-requisites before sitting for the knowledge exam.

Technicians seeking the ETA<sup>®</sup> Line and Antenna Sweep Technician stand-alone certification would be aided by having a basic education in fundamental electronics and wireless communications. Technicians seeking the ETA<sup>®</sup> Line and Antenna Sweep Technician journeyman certification must have the basic Associate CET certification.

## 1.0 INTRODUCTION TO ANTENNA SYSTEM COMMISSIONING

- 1.1. Explain the purpose of antenna system commissioning
- 1.2. Explain the benefits of antenna system commissioning
- 1.3. List the technologies available for antenna system commissioning
  - 1.3.1. Time Domain Reflectometer (TDR)
  - 1.3.2. Frequency Domain Reflectometer (FDR)
- 1.4. Define a comparison of TDR and FDR
- 1.5. List system diagram requirements
- 1.6. List antenna system commissioning documentation requirements

## 2.0 RADIO FREQUENCY (RF) FUNDAMENTALS

- 2.1. Explain the maximum power theorem and maximum power transfer
- 2.2. Explain impedance mismatch
- 2.3. Explain signal reflections
- 2.4. Explain how to calculate reflection coefficient
- 2.5. Explain voltage standing wave ratio (VSWR)
- 2.6. Explain standing waves
- 2.7. Describe return loss
- 2.8. Compare impedance mismatch versus VSWR or return loss
- 2.9. Explain attenuation/insertion loss
- 2.10. Describe electromagnetic wave propagation
- 2.11. List antenna system components

## 3.0 MATHEMATICS

- 3.1. Explain Absolute values
- 3.2. Describe decibel (dB) math
- 3.3. Explain decibel values:
  - 3.3.1. dBm
  - 3.3.2. dBc
  - 3.3.3. dBd
  - 3.3.4. dBi
- 3.4. Describe power ratios
- 3.5. Describe voltage ratios
- 3.6. Explain how to add decibel values
- 3.7. Explain vector summing

## 4.0 COAXIAL CABLE FUNDAMENTALS

- 4.1. Describe coaxial cable construction
- 4.2. Explain what determines coaxial cable impedance
- 4.3. Explain "Skin effect" in a conductor
- 4.4. Explain a coaxial cable equivalent circuit

- 4.5. Explain coaxial cable velocity factor
- 4.6. Explain coaxial cable attenuation or cable loss changes with:
  - 4.6.1. cable size
  - 4.6.2. frequency

## **5.0 COAXIAL CABLE INSTALLATION**

- 5.1. Describe RF transmission line hanger usage and mounting conventions
- 5.2. Explain the importance of hanger spacing
- 5.3. Describe RF transmission line grounding requirements as defined by codes and standards
- 5.4. Describe proper grounding kits
- 5.5. Describe proper weatherproofing procedures
- 5.6. Explain proper bending radius
- 5.7. Describe lightning protection recommendations

## **6.0 RF CONNECTORS**

- 6.1. List connector types
- 6.2. Explain connector specifications
- 6.3. Describe connector installation requirements
  - 6.3.1. List cable preparation procedures
  - 6.3.2. Explain proper connector torque
- 6.4. List connector installation tools
- 6.5. Explain “Passive Intermodulation”

## **7.0 ANTENNAS**

- 7.1. Explain antenna theory
- 7.2. List antenna specifications
- 7.3. Describe antenna wavelength
- 7.4. Explain velocity factor
- 7.5. List antenna types:
  - 7.5.1. isotropic
  - 7.5.2. omni directional
  - 7.5.3. directional
  - 7.5.4. dipole
- 7.6. Explain antenna radiation pattern
- 7.7. Explain antenna gain
- 7.8. Explain antenna beam width
- 7.9. Explain antenna bandwidth
- 7.10. Explain antenna polarization
- 7.11. Explain antenna beam tilt factors:
  - 7.11.1. mechanical
  - 7.11.2. electrical
- 7.12. Describe antenna mounting
  - 7.12.1. Explain the effect of improper mounting
- 7.13. Explain RF coverage

## **8.0 FREQUENCY DOMAIN REFLECTOMETER (FDR) TESTING**

- 8.1. Describe adapter usage requirements
- 8.2. Describe calibration standards usage and care
- 8.3. Explain calibration importance and requirements
- 8.4. Explain phase-stable cable requirements and usage
- 8.5. Describe antenna testing:
  - 8.5.1. Return loss
  - 8.5.2. Frequency bandwidth
- 8.6. Describe attenuation or insertion loss testing:
  - 8.6.1. Specific components
  - 8.6.2. Antenna system
  - 8.6.3. Difference between insertion loss test and return loss test
- 8.7. Describe coax cable testing:

- 8.7.1. attenuation or cable loss
- 8.7.2. return loss or match
- 8.7.3. distance-to-fault return loss
- 8.8. Describe antenna system testing:
  - 8.8.1. return loss or match
  - 8.8.2. distance-to-fault
  - 8.8.3. Antenna system sweep “signatures”

## **9.0 FREQUENCY DOMAIN REFLECTOMETER TEST INTERPRETATION**

- 9.1. Compare measured component(s) return loss values with manufacturer specifications:
  - 9.1.1. Feed line
  - 9.1.2. Connector
  - 9.1.3. Antenna response
  - 9.1.4. Other components
- 9.2. Calculate expected system return loss value and compare to measured value
  - 9.2.1. Utilize software tool
  - 9.2.2. Demonstrate knowledge of function
- 9.3. Compare location of component(s) on the system diagram to the measured locations
  - 9.3.1. Identify system components at appropriate levels
  - 9.3.2. Identify fault locations
  - 9.3.3. Identify possible fault causes
- 9.4. Antenna system sweep signature characteristics
  - 9.4.1. Identify antenna meets spec

## **10.0 FREQUENCY DOMAIN REFLECTOMETER OPERATION**

- 10.1. Describe the FDR calibration process
- 10.2. Explain setting markers and limit lines
- 10.3. Describe selecting test type or mode
- 10.4. Describe selecting display amplitude and/or auto scale
- 10.5. Describe selecting test frequency range
- 10.6. Describe selecting test distance range
- 10.7. Describe selecting cable type for a DTF test
- 10.8. Describe setting windowing or smoothing option
- 10.9. Describe storing and recalling a trace
- 10.10. Explain how to name a trace
- 10.11. Describe setting FDR time and date
- 10.12. List PC software tools

## **11.0 TROUBLESHOOTING**

- 11.1. Describe common antenna problems
- 11.2. Describe common cable problems
- 11.3. Describe common connector problems
- 11.4. Describe how to compare baseline sweep traces with current traces

## **End of Line and Antenna Sweep Technician Competencies Listings**

Find An ETA Approved School / Test Site:

<http://www.eta-i.org/testing.html>

**Suggested Additional Study Material and Resources:**

Useful white papers can be found at the following web sites:

<http://birdrf.com/> and [www.anritsu.com](http://www.anritsu.com)

Useful web sites:

<http://doverts.com/> and <http://iwaradio.com/> and **Radio-Electronics.com**, Ian Poole; author/editor

**Wiring for Wireless Sites**; Ira Wiesenfeld, P.E.; ISBN 978-1401810375; Thompson Delmar Learning; 2002; pp. 260

**Practical Antenna Handbook, 5E**; Joseph Carr & George (Bud) W. Hippisley; ISBN 978-0071639583; McGraw-Hill/Tab Electronics; 2011; pp.784

**Modern Electronic Communication, 9E**; Jeff Beasley & Gary M. Miller; ISBN 978-0132251136; Prentice Hall; 2007; pp.992

**Handbook of Radio & Wireless Technology**; Sam Gibilisco; ISBN 978-0070230248; McGraw-Hill Professional; 1998; pp.640

**Basic Radio, Principles & Technology**; Ian Poole; ISBN 978-0750626323; Newnes; 1994; pp.224

**ARRL Handbook, 2016 edition**; American Radio Relay League, ISBN 978-1-62595-042-0, available online from [www.ARRL.org](http://www.ARRL.org);

ETA certification programs are accredited through the ICAC, complying with the ISO/IEC 17024 standard.

