

# Line and Antenna Sweeping (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 Line and Antenna Sweeping using a frequency domain reflectometer (FDR).

There are 11 categories of training. 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 is the required pre-requisite before sitting for the knowledge exam.

Technicians seeking the ETA<sup>®</sup> Line and Antenna Sweeping Technician certification would be aided by having a basic education in fundamental electronics and wireless communications.

## Antenna System Analysis Competencies

### 1. Introduction to Antenna System Commissioning

- 1.1. Purpose of antenna system commissioning
- 1.2. Benefits of antenna system commissioning
- 1.3. Technologies available for antenna system commissioning
  - 1.3.1. Time Domain Reflectometer (TDR)
  - 1.3.2. Frequency Domain Reflectometer (FDR)
- 1.4. Comparison of TDR and FDR
- 1.5. System diagram requirements
- 1.6. Antenna system commissioning documentation requirements

### 2. RF Fundamentals

- 2.1. Maximum power theorem and maximum power transfer
- 2.2. Impedance mismatch
- 2.3. Signal reflections
- 2.4. Reflection coefficient
- 2.5. Voltage standing wave ratio (VSWR)
- 2.6. Standing waves
- 2.7. Return loss
- 2.8. Impedance mismatch versus VSWR or return loss
- 2.9. Attenuation/insertion loss
- 2.10. Electromagnetic wave propagation
- 2.11. Antenna system components

### **3. Mathematics**

- 3.1. Absolute values
- 3.2. Decibel math
- 3.3. Decibel values
  - 3.3.1. dBm
  - 3.3.2. dBc
  - 3.3.3. dBd
  - 3.3.4. dBi
- 3.4. Power ratios
- 3.5. Voltage ratios
- 3.6. Adding decibel values
- 3.7. Vector summing

### **4. Coaxial Cable Fundamentals**

- 4.1. Coaxial cable construction
- 4.2. Coaxial cable impedance
- 4.3. Skin effect
- 4.4. Coaxial cable equivalent circuit
- 4.5. Coaxial cable velocity factor
- 4.6. Coaxial cable attenuation or cable loss
  - 4.6.1. changes with cable size
  - 4.6.2. changes with frequency

### **5. Coaxial Cable Installation**

- 5.1. RF transmission line hangers
- 5.2. Hanger spacing
- 5.3. RF transmission line grounding requirements
- 5.4. Grounding kits
- 5.5. Weatherproofing
- 5.6. Bending radius
- 5.7. Lightning protection recommendations

### **6. RF Connectors**

- 6.1. Connector types
- 6.2. Connector specifications
- 6.3. Connector installation requirements
  - 6.3.1. cable preparation
  - 6.3.2. connector torque
- 6.4. Connector installation tools
- 6.5. Passive intermodulation

## **7. Antennas**

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

## **8. Frequency Domain Reflectometer Testing**

- 8.1. Adapter usage requirements
- 8.2. Calibration standards usage and care
- 8.3. Calibration importance and requirements
- 8.4. Phase-stable cable requirements and usage
- 8.5. Antenna testing
  - 8.5.1. Return loss
  - 8.5.2. Frequency bandwidth
- 8.6. 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. 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. Antenna system testing
  - 8.8.1. return loss or match
  - 8.8.2. distance-to-fault
  - 8.8.3. Antenna system sweep “signatures”

## 9. Frequency Domain Reflectometer Test Interpretation

- 9.1. Compare measured component(s) return loss values with manufacturer specifications
  - 9.1.1. Feed line specifications
  - 9.1.2. Connector specification
  - 9.1.3. Antenna response specifications
  - 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. FDR Operation

- 10.1. FDR calibration process
- 10.2. Setting markers and limit lines
- 10.3. Selecting test type or mode
- 10.4. Selecting display amplitude and/or auto scale
- 10.5. Selecting test frequency range
- 10.6. Selecting test distance range
- 10.7. Selecting cable type for a DTF test
- 10.8. Setting windowing or smoothing option
- 10.9. Storing and recalling a trace
- 10.10. Naming a trace
- 10.11. Setting FDR time and date
- 10.12. PC software tools

## 11. Troubleshooting

- 11.1. Common antenna problems
- 11.2. Common cable problems
- 11.3. Common connector problems
- 11.4. Comparing baseline sweep traces with current traces

## Recommended Study Material

- Useful white papers can be found at the following web sites: [www.anritsu.com](http://www.anritsu.com) and [www.bird-electronic.com](http://www.bird-electronic.com)
- *Practical Antenna Handbook* – ISBN 0071374353
- *Modern Electronic Communication* – ISBN 0131130374
- *Handbook of Radio & Wireless Technology* – ISBN 0070230242
- *Basic Radio, Principles & Technology* – ISBN 0750626321