

COMPETENCY REQUIREMENTS (draft copy 8-4-03)

WIRELESS COMMUNICATIONS ELECTRONICS TECHNICIAN – MSS VERSION 2004e

The following is a listing of each topic considered necessary to be included in a course of study directed towards the education of workers performing installation, maintenance and repair of mobile and fixed radio communications systems. There are 26 general categories of training. This COMPETENCY listing is the syllabus, or identification of each individual subject, in which the technician must be knowledgeable and skilled.

Technicians seeking the USMSS Certified Electronics Technician specialty are required to also have a basic education in fundamental electronics. That basic knowledge is assessed in the Associate CET examination. The Associate CET exam, plus the USMSS wireless communications specialty examination go together to form the complete journeyman CET exam.

MSS COMPETENCIES

1.0 RADIO THEORY

- 1.1 Describe electromagnetic transmission and reception theory
- 1.2 List common radio frequency bands
- 1.3 Draw a basic block diagram of a radio transmitter and a receiver
- 1.4 Define bandwidth and describe common radio and TV channel limits
- 1.5 List the functions of receiver stages
- 1.6 Describe frequency tuning or channel switching methods
- 1.7 Explain the function of different types of amplifiers
- 1.8 Name ten major events or personalities in radio history

2.0 COMPONENTS, TERMINOLOGY & SYMBOLS

- 2.1 Identify the components below, their symbols and usages:
 - 2.1.1 Microphones & speakers
 - 2.1.2 Rheostats & potentiometers
 - 2.1.3 L R & C
 - 2.1.4 Batteries
 - 2.1.5 Transistors
 - 2.1.6 Integrated Circuits
 - 2.1.7 Special IC circuits
 - 2.1.8 Relays and thyristor switches
 - 2.1.9 Motors and generators
 - 2.1.10 Fuses & circuit breakers
 - 2.1.11 Power supply components
- 2.2 Describe common types of electronic displays

3.0 BASIC ANALOG CIRCUITS

- 3.1 Describe basic AC and DC radio power supplies
- 3.2 Draw a basic audio amplifier circuit
- 3.3 Identify and explain the purposes of RF and IF stages
- 3.4 Compare AM and FM audio detectors
- 3.5 Explain AVC – automatic volume control and AGC (automatic gain control) circuits and their operation
- 3.6 Name the major segments of a transmitter carrier generation circuit
- 3.7 Explain how various modulators are used in transmitters
- 3.8 Explain what each of the components of a transmitter power output circuits do
- 3.9 Draw the circuit for an operational amplifier and explain its operation
- 3.10 Define gain and explain how it is measured
- 3.11 Define bi-directional amplifier and explain where they are used

- 3.12 Explain the purpose and concept of PLL(phase locked loop) & VCO (voltage controlled oscillator) circuits

4.0 ANTENNAS AND TOWERS

- 4.1 Explain wave propagation and its relative speed in air or cabling
- 4.2 Describe reception theory and mobile antennas
- 4.3 Draw polar patterns for different types of antennas
- 4.4 Define antenna gain and explain why it is important
- 4.5 Draw the circuits for antenna combining networks
- 4.6 Explain how diplexers and duplexers are used
- 4.7 Define cavities, circulators and isolators and show where they are used
- 4.8 Explain the purpose and methods of grounding communications products
- 4.9 Explain lightning protection devices
- 4.10 Describe base station antennas
- 4.11 Define receiver multi-coupling
- 4.12 List radio tower components and installation practices
- 4.13 Explain tower safety and OSHA (Occupational Safety and Health Agency) contractor regulations

5.0 CABLING & CONNECTORS

- 5.1 Describe coaxial cable characteristics
- 5.2 Properly install coaxial connectors, jacks, plugs, explaining crimping and preping
- 5.3 Explain cable routing – bend ratios – pulling tension and building cabling regulations
- 5.4 Explain the purpose of NEC (National Electric Code) Art 770
- 5.5 Compare proper and improper impedance matching principles
- 5.6 Define ground loop and name common causes and effects
- 5.7 Define balanced/unbalanced pairs
- 5.8 Explain line loss for different types of cabling
- 5.9 Explain the importance of proper cable termination
- 5.10 Explain the principles used in Frequency Domain Reflectometry
- 5.11 Compare Time Domain Reflectometry with FDR
- 5.12 Identify N, UHF, Mini UHF, BNC, TNC, SMA, 7/16 DIN fittings
- 5.13 List common color codes for telephone wiring.

6.0 BLOCK DIAGRAMS, SCHEMATICS, FLOW CHARTS

- 6.1 Identify diagram symbols used in communications radio service
- 6.2 Trace power and signal paths in a radio receiver and transmitter
- 6.3 Describe the purpose and locate schematic test points
- 6.4 Estimate normal signals and voltages expected at schematic locations
- 6.5 Describe the purpose of flow charts

7.0 HAND TOOLS AND SOLDERING

- 7.1 Explain and demonstrate the proper usage of basic hand tools
- 7.2 Describe and demonstrate the proper usage of soldering irons and aids
- 7.3 Explain how de-soldering equipment and aids are used
- 7.4 Define flux and explain its purposes
- 7.5 Define cold – defective solder joints and list reasons they occur
- 7.6 Describe methods of replacing surface mount components
- 7.7 Describe wire wrap replacement precautions
- 7.8 List proper equipment care routines
- 7.9 Explain how hot air bonding equipment is used

8.0 SAFETY

- 8.1 Define ESD (Electrostatic Discharge)
- 8.2 List safety precautions when handling fiber optics cabling
- 8.3 List hazards potential when using power tools

- 8.4 Define First Aid and explain precautions uncertified people should abide by
- 8.5 List fire potentials in electronics technician work environments
- 8.6 List electrical shock potential peculiar to electronics workers
- 8.7 Describe transmitter RF (Radio Frequency) exposure hazards
- 8.8 Describe ground faults and devices to preclude shock hazards
- 8.9 List Beryllium hazards
- 8.10 Explain ladder precautions and lifts dangers

9.0 GROUNDING – LIGHTNING PROTECTION

- 9.1 Describe antenna grounding conventions
- 9.2 Name NEC lightning protection rules articles
- 9.3 List ground fault protection devices
- 9.4 Define grounding blocks and show how rods and proper wire sizes are used
- 9.5 Explain how equipment protection is enhanced with the use of MOVs

10.0 MATHEMATICS AND FORMULAS

- 10.1 Convert dB (decibel) readings to dBmV and microvolt levels
- 10.2 Explain and compare dBi, dBm, dBw, dBd terminology
- 10.3 Demonstrate proper use for scientific calculators
- 10.4 List numbering systems commonly used in technician work
- 10.5 Convert frequency to wavelength and vice-versa

11.0 INTERFACING

- 11.1 List expected signal levels into or out of interconnected products used in radio work
- 11.2 Define impedance matching and explain impedance mismatch
- 11.3 Identify common connectors used in two-way radio work
- 11.4 Explain signal conflict and list detrimental effects

12.0 DIGITAL CIRCUITS

- 12.1 Draw the symbols for digital gates and their truth tables
- 12.2 Compare common memory devices used in radio communications
- 12.3 Explain how tuning is accomplished in radio receivers and transmitters
- 12.4 Describe how microprocessor controls are used in radio
- 12.5 Compare RAM – PROM – EEPROM – ROM
- 12.6 Describe how DACs (Digital to Analog Converters) and ADCs are used
- 12.7 Define modems and explain its purposes

13.0 COMPUTER APPLICATIONS

- 13.1 Demonstrate the ability to use:
 - 13.11 Word processors
 - 13.12 Data bases
 - 13.13 Spread sheets
 - 13.14 Internet
 - 13.15 Parts procurement services
 - 13.16 Virus eradication systems
 - 13.17 Diagnostic programs
 - 13.18 Utility programs
 - 13.19 Laptop with Com port, null modem, terminal software

14.0 MOBILE SYSTEMS

- 14.1 Describe base simplex operation
- 14.2 Explain how mobile relay – simplex/duplex works
- 14.3 Compare remote control and manual control systems
- 14.4 Define RF link and explain its purpose
- 14.5 Explain paging systems communications
- 14.6 Describe trunking (single/multi-site)

- 14.7 Compare conventional single and multi-site communications systems
- 14.8 Define simulcast systems and list their purposes
- 14.9 Define satellite voting systems and show how they are used
- 14.10 Compare wireless data systems with two-way voice communications
- 14.11 Describe CTCSS squelch operation
- 14.12 Define and list how DCSS is used
- 14.13 Explain the differences between point-to-point and point-to-multipoint transmissions
- 14.14 Define SCADA and explain its purpose

15.0 SATELLITE – DATA – TELECOMMUNICATIONS

- 15.1 Explain the applications pertaining to two-way radio for the following:
 - 15.1.1 Satellite
 - 15.1.2 GPS (Global Positioning System)
 - 15.1.3 High speed telephone
 - 15.1.4 Telecommunications
- 15.2 List potential interference to or from 15.1 items

16.0 FCC – FAA – OSHA – NEC

- 16.1 List the general topics contained in CFR 47 Part 15 (CFR is Code of Federal Regulations)
- 16.2 Explain basic FCC (Federal Communications Commission) rules pertaining to two-way communications
- 16.3 List FAA (Federal Aviation Administration) rules pertaining to communications systems
- 16.4 List OSHA safety rules for contractors and workers at heights
- 16.5 List NEC (National Electric Code) provisions applicable to radio, antenna, cabling workers
- 16.6 List licenses required for radio stations and technicians

17.0 FREQUENCY BANDS FOR MOBILE COMMUNICATIONS

- 17.1 List common RF transmission band assignments or allotments
- 17.2 List competing services encountered by radio workers

18.0 TEST EQUIPMENT

- 18.1 Explain the functions of a Communications Service Analyzer
- 18.2 Describe how the TDR (Time Domain Reflectometer), OTDR and FDR are used
- 18.3 Define SWR (Standing Wave Ratio) and show how SWR and watt meters are used
- 18.4 Compare S/N and C/N
- 18.5 Demonstrate how dummy loads – DMMs (Digital Multimeters), logic probes, pulzers, and signal generators are used
- 18.6 Explain SINAD/AC voltmeter/distortion analyzers and audio generators usage
- 18.7 Demonstrate how spectrum analyzers are used
- 18.8 Identify common RF test cables and converters used in 2-way communications
- 18.9 Describe how variable power supplies are used in service technician work

19.0 TROUBLESHOOTING & MEASUREMENTS

- 19.1 Describe techniques for localizing circuitry defects in communications equipment
- 19.2 Demonstrate how to use block diagrams and test points
- 19.3 Explain how to perform power measurements
- 19.4 Explain how to use heat or cold to locate intermittent circuitry problems
- 19.5 Compare PC board and surface mount component replacement techniques
- 19.6 Demonstrate how to use frequency measurement equipment
- 19.7 Define overdrive and explain its causes and effects

20. BUSINESS RADIO NETWORKS

- 20.1 Demonstrate proficiency in operational characteristics of 2-way radio communications systems
- 20.2 List technical characteristics of working communications systems

- 20.3 Explain programming characteristics of system receivers and transmitters
- 21.0 INTERNET APPLICATIONS**
 - 21.1 Demonstrate parts, literature and product information/ordering via Internet
 - 21.2 Access troubleshooting and diagnostics software
- 22.0 MODULATIONS SCHEMES**
 - 22.1 Describe AM (Amplitude Modulation) methods and limits
 - 22.2 Describe FM (Frequency Modulation) methods and deviation limits
 - 22.3 Explain the principles and advantages of single sideband – SSB (Single Side Band)
 - 22.4 Define TDMA (Time Domain Reflectometry) and describe the concept
 - 22.5 Compare CDMA (Code Division Multiple Access) with TDMA and FDMA modulation schemes
 - 22.6 Compare FDMA with TDMA (Time Division Multiple Access) and CDMA
 - 22.7 Define and describe QPSK (Quadrature Phase Shift Keying)
- 23.0 CONTROL SYSTEMS**
 - 23.1 Describe how tone control-systems operate
 - 23.2 Define CTCSS and explain its advantage over other systems
 - 23.3 Define SCADA
 - 23.4 Explain how remote control-operation is accomplished
- 24.0 WORKPLACE PRACTICES**
 - 24.1 Explain work area environment concerns for technicians
 - 24.2 Explain RF monitoring and its purpose
 - 24.3 Explain billing procedures for repairs and important factors
 - 24.4 Perform productivity calculations for yourself and the total shop
- 25.0 LINE SWEEPING**
 - 25.1 Explain the purpose & theory of line sweeping
 - 25.2 Describe the functions of BIRD and ANRITSU brand test equipment used in line sweeping head-end sites
 - 25.3 Explain proper documentation in transmission sites
- 26.0 RF INTERFERENCE**
 - 26.1 Define de-sense and explain the causes
 - 26.2 List reasons for spurious emissions
 - 26.3 Explain Site compatibility and reasons for site incompatibility
 - 26.4 Describe co and adjacent-channel interference
 - 26.5 List interference detection methods
 - 26.6 Define inter-modulation and list causes

Notes: Certain of the above items will appear redundant, having been addressed in more than one CATEGORY. Also, some of the Competencies above may well have been included in the BASIC or Associate level training and certification skills standards and examination. In most cases these redundant items may need only slight revisiting of the topic. However, they are included more than once so that there is assurance that their application in each category is addressed.

This competencies listing is compiled to serve two purposes: 1. To provide educational institutions with the material they need to construct a course outline for any course of instruction in wireless communications. Also to provide an outline for those studying to sit for the USMSS exams a guide to the knowledge and skills they will need.

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