

20.2.0 RADIO SYSTEMS

20.2.1 Introduction

This module is designed to equip the trainee with the necessary knowledge, skills and attitude required to understand the principles of radio transmission and reception. Trainees undertaking this module unit require prior knowledge of electronics and micro electronics. Upon completion of the unit trainees will be able to maintain and repair radio equipment

20.2.2 General Objectives

By the end of this module unit, the trainee should be able to:

- a) understand the concepts of radio systems
- b) understand the use and application of radio systems
- c) understand principles of wave propagation and antennas

20.2.3 Module Summary and Time Allocation

Radio Systems

Code	Module Unit	Content	Time Hrs		
			Th.	Pra.	Total
20.2.1	Amplitude Modulated	<ul style="list-style-type: none"> • Definition of AM • Principles of AM • Operation of AM modulators • Single sideband generation • Double sideband 	10	12	22
20.2.2	Am Radio Receivers	<ul style="list-style-type: none"> • Operation of TRF • Operation of superhet radio receiver • Choice of local oscillator frequency • Interference • Choice of I.F. • Receiver parameters • Automatic gain control 	16	24	40

		<ul style="list-style-type: none"> • Receiver circuits 			
20.2.3	Frequency Modulates (FM) Radio Transmitters	<ul style="list-style-type: none"> • Definition of FM • Principles of FM • Generation of FM wave • Noise • Stereophonic FM multiplex 	8	12	20
	FM Radio Receivers	<ul style="list-style-type: none"> • Operation of FM receiver • Operation of F.M. receiver circuits • Stereo F.M. multiplex • Automatic frequency control • Automatic gain control 	4	6	10
20.2.5	Wave Propagation and Antennas	<ul style="list-style-type: none"> • Fundamentals of electromagnetic waves • Modes of radio wave propagation • Effects of the environment • Fading • Principles of antenna radiation • Operation of antennas • Terminologies 	8	4	12
Total Time			46	58	104

20.2.1 AMPLITUDE MODULATED (AM) RADIOS TRANSMITTERS

Theory

20.2.1T0 *Specific Objectives*

By the end of the sub module unit, the trainee should be able to:

- d) define amplitude modulation
- e) explain principles of amplitude modulation
- f) explain the operation of AM modulators
- g) describe methods of single sideband generation
- h) describe the double side band (DSB)

Competences

The trainee should have the ability to:

- i) Measure AM radio transmitter parameters
- ii) Maintain and repair AM radio transmitters

Content

20.2.1T1 Definition of amplitude modulation

20.2.1T2 Principles of amplitude modulation

- i) AM theory
- ii) Frequency spectrum
- iii) Power relations in AM wave
- iv) High and low level modulation

20.2.1T3 Operation of AM modulators

- i) Transistor modulator
- ii) Transistor balanced modulator
- iii) Diode single balanced modulator
 - i) Cowan modulator
 - ii) Ring modulator
 - iii) Modulated class C amplifier

20.2.1T4 Single Side Band generation

- i) Filter method
- ii) Phase shift method

20.2.1T5 Double Side-Band

Practice

20.2.1P0 *Specific Objectives*

By the end of the sub module unit, the trainee should be able to:

- a) measure AM radio parameters
- b) maintain and repair AM radio transmitters

Content

20.2.1P1 Measurement of AM radio transmitter parameters

- i) Carrier level
- ii) Modulating signal level
- iii) Modulation depth
- iv) Carrier frequency
- v) Modulating signal frequency
- vi) Bandwidth

20.2.1P2 Maintenance and repair of AM radio transmitters

- i) Carrier frequency generators
- ii) Modulators
- iii) Buffer amplifier
- iv) Audio frequency amplifiers
- v) Frequency synthesizers
- vi) Power amplifiers
- vii) Filter circuits
- viii) Phase shifting networks
- ix) Antennae coupling circuits

Suggested Learning

Resources

- i) AM radio transmitter training kit
- ii) Modulated signal generators
- iii) Cathode ray oscilloscope
- iv) Spectrum/ wave Analyzers
- v) Measuring instruments
- vi) Power supply units
- vii) Modulation meter

20.2.2 AMPLITUDE MODULATION (AM) RADIO RECEIVERS

Theory

20.2.2T0 *Specific Objectives*

By the end of the sub module unit, the trainee should be able to:

- a) describe the operation of a tuned radio frequency (T.R.F) radio receiver
- b) describe the operation of a super heterodyne radio receiver
- c) explain choice of local oscillator frequency
- d) explain radio interference and their rejection
- e) state factors to consider in choosing intermediate frequency
- f) define receiver parameters
- g) explain automatic gain control
- h) explain the operation of selected receiver circuits

Competencies

The trainee should have the ability to:

- i) Measure AM radio receiver parameters
- ii) Repair of AM radio receivers

Content

- 20.2.2T1 Operation of T.R.F
 - i) Antennae
 - ii) R.F amplifier
 - iii) Loudspeaker
- 20.2.2T2 Operation of super heterodyne radio receiver
 - i) Antennae
 - ii) R.F receiver
 - iii) Mixer
 - iv) Local oscillator
 - v) R.F amplifier
 - vi) Detector
 - vii) A.F amplifier
 - viii) Loud speaker
- 20.2.2T3 Choice of local oscillator frequency
- 20.2.2T4 Interference and their rejection
 - i) Image signal
 - ii) Co channel
 - iii) Local oscillator radiation
 - iv) I.F trap
- 20.2.2T5 Choice of intermediate frequency
 - i) I.F bandwidth
 - ii) Interference signals
 - iii) I.F gain and stability
 - iv) Adjacent channel (selectivity)
- 20.2.2T6 Definition of receiver parameters
 - i) Sensitivity
 - ii) Selectivity
 - iii) Double splitting

- iv) Adjacent channel ratio

20.2.2T7 Automatic gain control (A.G.C)

- i) No A.G.C
- ii) Delayed A.G.C
- iii) Simple A.G.C
- iv) Ideal A.G.C

20.2.2T8 Operation of receiver circuits

- i) Separately excited mixer
- ii) Self excited mixer
- iii) Diode detector
- iv) Muting (squelch)

Practice

20.2.2P0 *Specific objectives*

By the end of the sub module unit, the trainee should be able to:

- a) measure AM radio receiver parameters
- b) identify fault symptoms
- c) carry out static and dynamic test on AM radio receiver
- d) repair AM radio receivers

Content

20.2.2P1 Measurement of AM radio receiver parameters

- i) Sensitivity
- ii) Selectivity
- iii) Interference
- iv) Gain
- v) Output power

20.2.2P2 Fault symptoms

- i) No output

- ii) Motor boating
- iii) Dead receiver
- iv) Weak output signal
- v) Intermittent operation
- vi) Wobbling output
- vii) Hissing noise
- viii) Two stations picked at the same dial setting
- ix) Noisy output
- x) Fading

20.2.2P3 Tests

- i) Static
- ii) Dynamic

20.2.2P4 Repair of AM radio receivers

- i) Fault detection
- ii) Fault location
- iii) Fault repair
- iv) Final tests

Suggested Learning

Resources

- i) CRO
- ii) AM radio receiver training kit
- iii) Multimeters
- iv) Bench power supply
- v) Modulated signal generators
- vi) Standard electronic toolkit
- vii) Components

20.2.3 FREQUENCY MODULATED (FM) RADIO TRANSMITTER

Theory

20.2.3T0 *Specific Objectives*

By the end of the sub module unit, the trainee should be able to:

- a) define frequency modulation
- b) explain the principles of frequency modulation
- c) describe methods of generating FM wave
- d) state the effects of noise on an FM wave
- e) explain stereophonic FM multiplexing

Competences

The trainee should have the ability to:

- i) Measure FM radio parameters
- ii) Maintain and repair FM radio transmitters

Content

20.2.3T1 Definition of frequency modulation

20.2.1T2 Principles of frequency modulation -FM theory

20.2.3T3 Generation of FM wave

- i) Transistor reactance modulator
- ii) Automatic Frequency Control
- iii) Varacter diode modulator
- iv) AFC system (block diagram)

- v) Armstrong systems (block diagram)

20.2.3T4 Noise

- vi) Cochannel interference
- vii) Capture effect
- viii) Noise on carrier

20.2.3T5 Stereophonic FM multiplex

Practice

20.2.3P0 *Specific Objectives*

By the end of the sub module unit, the trainee should be able to:

- a) measure FM parameters
- b) maintain and repair FM transmitters

Content

20.2.3P1 Measurement of FM parameters

- i) Carrier level
- ii) Carrier frequency
- iii) Modulating signal frequency
- iv) Deviation
- v) Modulation index
- vi) Bandwidth

20.2.3P2 Maintenance and repair

- i) Carrier frequency generators
- ii) Modulators
- iii) Buffer amplifier
- iv) Audio frequency amplifiers
- v) Frequency multipliers
- vi) Discriminator
- vii) Power amplifiers

- viii) Antennae coupling circuits

Suggested Learning Resources:

- i) FM transmitter training kits
- ii) Modulated signal generators
- iii) Cathode Ray Oscilloscope
- iv) Spectrum/wave analyzers
- v) Multimeters
- vi) Bench power supplies

20.2.4 FREQUENCY MODULATED (FM) RADIO RECEIVERS

Theory

20.2.4T0 *Specific Objectives*

By the end of the sub module unit, the trainee should be able to:

- a) describe the operation of FM receiver
- b) explain the operation of receiver circuits
- c) explain the operation of FM multiplex reception
- d) explain automatic frequency control (AFC)
- e) explain automatic gain control (AGC)

Competence

The trainee should have the ability to::

- i) Measure FM receiver parameters
- ii) Repair FM radio receivers

Content

- 20.2.4T1 Operation of FM receiver
 - i) Block diagram
 - ii) r.f amplifier
 - iii) mixer
 - iv) local oscillator
 - v) i.f amplifier
 - vi) discriminator
 - vii) de – emphasis network
 - viii) a.f and power amplifiers
 - ix) loudspeakers
- 20.2.4T2 Operation of receiver circuits
 - i) amplitude limiter
 - ii) slope detector
 - iii) phase discriminator
 - iv) ratio detector
- 20.2.4T3 Stereo FM multiplex
 - block diagrams
- 20.2.4T4 Automatic frequency control (AFC)
- 20.2.4T5 Automatic gain control (AGC)

Practice

- 20.2.4P0 *Specific Objectives*

By the end of the unit, the trainee should be able to:

- a) measure FM radio parameters
- b) identify receive fault symptoms
- c) carry out static and dynamic test
- d) repair FM radio receivers

Content

- 20.2.4P1 Measurement of FM radio receiver parameters
 - i) Gain
 - ii) Power output
 - iii) Deviation (frequency drift)
 - iv) Selectivity
 - v) Distortion
- 20.2.4P2 Fault symptoms
 - i) Dead receiver
 - ii) Frequency drifts
 - iii) Motor boating
 - iv) No output
 - v) Weak output
 - vi) Intermittent operation
 - vii) Hissing noise
 - viii) Wobbling output
 - ix) Noisy output
 - x) Fading
- 20.2.4P3 Static and dynamic tests
- 20.2.4P4 Repair of FM radio receivers
 - i) Fault detection
 - ii) Fault location
 - iii) Fault repair
 - iv) Final tests

Suggested Learning

Resources:

- i) FM radio receiver training kit
- ii) Distortion meters
- iii) Cathode Ray Oscilloscope
- iv) Multimeters
- v) Standard electronic kit
- vi) Bench power supply
- vii) Modulated signal generators
- viii) Audio signal generators
- ix) Deviation meters

20.2.5 WAVE PROPAGATION AND ANTENNAS

Theory

20.2.5T0 *Specific Objectives*

By the end of the sub module unit, the trainee should be able to:

- a) explain fundamentals of electromagnetic waves
- b) describe modes of radio wave propagation
- c) state the effects of the environment on radio waves
- d) describe fading
- e) explain principles of antenna radiation

- f) describe the operation of various types of antennas
- g) define various terminologies applied to wave propagation

Competencies

The trainee should have the ability to construct and install an aerial

Content

20.2.5T1 Fundamentals of electromagnetic waves

- i) Electric field
- ii) Magnetic field
- iii) Direction of propagation
- iv) Free space

20.2.5T2 Modes of radio wave propagation

- i) Ground waves
- ii) Sky waves

20.2.5T3 Effects of the environment

- i) Reflection
- ii) Refraction
- iii) Interference
- iv) Diffraction

20.2.5T4 Fading

- i) General fading
- ii) Selective fading

20.2.5T5 Principles of antenna radiation

- i) Closed loops of magnetic flux
- ii) Closed loops of electric flux
- iii) Electromagnetic wave

- iv) Polarization
- v) Induction field
- vi) Dipole
- 20.2.5T6 Operation of various types of antennas
 - i) rod aerial
 - ii) loop aerial
 - iii) whip aerial
 - iv) broadside array
 - v) end-fire array
 - vi) folded dipole
 - vii) yagi uda
 - viii) rhobic
 - ix) radiation patterns
- 20.2.5T7 Terminologies
 - i) Wave propagation
 - critical frequency
 - maximum usable frequency
 - skip distance
 - multi-hop transmission
 - virtual height
 - ducts
 - ii) Antennas
 - directive
 - radiation resistance
 - beamwidth
 - polarization

- front-to-back ratio
- gain

Practice

- 20.2.5P0 *Specific Objectives*
 By the end of the sub module unit, the trainee should be able to:
- a) construct an aerial
 - b) install an aerial

Content

- 20.2.5P1 Construction of aerials
- i) Reflector
 - ii) Dipole
 - iii) Directors
- 20.2.5P2 Installation of aerials
- i) Aerial coupling
 - ii) Directivity

Suggested Learning

Resources

- i) Aluminum rods
- ii) Receiver (TV/Radio)
- iii) Screws
- iv) Coaxial cable
- v) Twin wire
- vi) Aluminum plate
- vii) Drilling and cutting tools