Amateur Radio Technician Class Licensing Course
Boy Scout Venturing Crew 80, Alexandria, VA

First Christian Church
Mount Vernon Amateur Radio Club (MVARC)

Quick Links: Click on Link - Right click on screen for options

Video segments are not included - Press Home to return to this page - F1 is help

Not for distribution. Thank you

Copyrights and Distribution

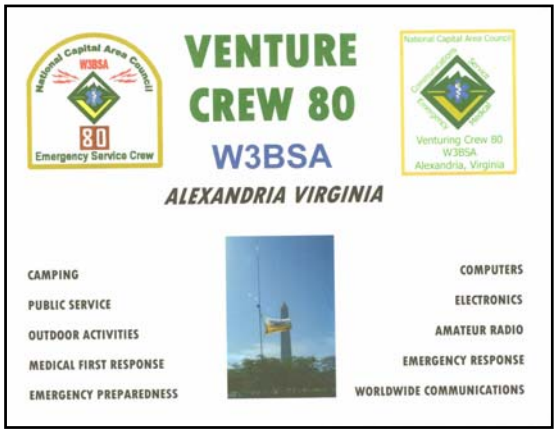
Amateur Radio Technician Class Licensing Course
Boy Scout Venturing Crew 80, Alexandria, VA
First Christian Church
Mount Vernon Amateur Radio Club (MVARC)

Day 1 Starts Here

Amateur Radio Technician Class Licensing Course

Sponsors

Scout Venturing Crew 80
First Christian Church
Mount Vernon Amateur Radio Club (MVARC)



Amateur Radio Technician Class Licensing Course

Instructors:

- **Dick – WA4USB**
- **Demi – K4BSA**
- **Jim – K3BUC**
- **Bill – W2BSA**

Meet your Instructors
Dick Harman WA4USB

- **First licensed in 1964**
  Novice, Tech, General, Advanced, Extra
- Control Op K4US Repeater
- 35+ years Scout Leader
  Cubs, Boy Scouts, Explorer
- Committee Chair Crew 80
- Retired 20+ years
- Computers since '59

7

Meet your Instructors
Demi Pulas K4BSA

- **First licensed in 1965**
  Extra the Hard Way (20 wpm Morse Code)
- **Crew 80 Advisor since 1995**
- **~ 40 years Scout Leader**

8

Meet your Instructors
Bill Stewart W2BSA

- **First licensed in 1993**
  - **Amateur Extra License**
- **Scout Leader 20+ years**
  - **Crew 80 COR**
  - **Crew 80 Committee Member**
  - **Scout leader since 1990**
  - **Colonial District STEM Coordinator**

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Meet your Instructors

Jim Buchanan K3BUC

- First licensed in High School
  - Novice - 1 year non-renewable
- BSEE, + Digital Computers
- Naval Air Systems Command
- Maintained interest in Radio
- Tech, General, Extra & Crew in 2004
- Scout + Scouter 30 years

Amateur Radio Technician Class

- Other groups using nearby rooms
- House Keeping
  - Restrooms
  - Fire Exits
  - Outside Access

Goals of this Course

1. Learn about Amateur Radio activities
2. Learn about Radio and Electronics

Goals of this Course

3. Pass the Exam and Obtain your FCC Technician Class Amateur Radio License!
4. The license will authorize you to operate a Amateur (Ham) Radio Station (transmitter)

13

Introductions

- Your name and a little about yourself
- Someone you know who is a Ham
- What you hope to gain by being a Ham
- Do you have experience with amateur radio?
- What are your expectations?

14

Our history

We have been teaching this course for about 20 years

We have learned what works and have included lessons learned in this course

15

How to study to ensure passing exam

- Read assignments when due
  - Each and every question is in the handbook
    - Correct answers are in the manual
    - **You MUST take the on line practice tests at home and pass at least 80% to ensure success**
      arrrl. org/ examreview
- How class will be run
  - Q&A's at end of each section

16

Methods of Learning

- Some courses teach you to memorize exam questions and answers
- That method does not lead to real advancement in your knowledge

17

We are NOT teaching answers

We give you the concepts and knowledge so you will understand what is going on

- There are many on line practice exams that you can take as often as you wish at no cost

18

A BAG lunch is RECOMMENDED

- Lunch: about Noon
  30 minutes for lunch
- Exam Sat Feb 14 9:30 am

Expectations

- Class will start and end on time
- Instructors will be prepared
- Students are expected to read assigned material before class and be prepared to learn
- Ham radio is not a spectator sport, active participation during class discussions is vital to success - obtaining your License

Course Outline

- Welcome to amateur radio
- Electricity, Components and Circuits
- Radio and Signals Fundamentals
- Propagation, Antennas and Feedlines
- Amateur Radio Equipment
- Communicating with other hams
- Licensing regulations
- Operating regulations
- Safety
- Test preparation and review

Let's Get Started

We intend to give you the knowledge to pass the exam

Your knowledge and understanding will grow as you enjoy and use amateur radio

October 2012

- BSA Jamboree On The Air
- Boy Scouts in Irving Texas spoke with an astronaut on the International Space Station using Amateur Radio relayed through amateur stations in Australia - here is a short clip

Steps to obtaining your ticket

- Study the ***Ham Radio License Manual***
- Review the questions in the book
- Take interactive practice exams
- Pass a 35-question multiple choice test
  - Questions are from the question pool in the back of the book
  - Answer 26 correctly
- No Morse code is required

About the exam

Back of the book page 11-1

Sub-elements..T1A T2A T3A T4A

One question on your exam from each of the 35 "Sub-elements"

Exact text of Q and A …. But

Q and A (both) may be re-sequenced

26 correct to pass

Lets say it another way

1. Read the assigned pages
2. Pay attention in class
3. Do the practice exams

Most probably (> 90%) earn your license – when you do 1 and 2 and 3

Sequence of Presentations

- We do not follow the exact book sequence
- We generally follow Chapter content
- Our purpose is to make it easy to understand and make sense
- Page numbers will be in the bottom left corner of slides

Chapter 1

What is Amateur Radio ?

Today's Topics

1. What makes Amateur Radio unique
2. Why the FCC makes rules
3. Activities involving Amateur Radio
4. How to find other hams
5. Technician License
6. Next week

1-1

What is Amateur Radio?

- Amateur Radio is a personal radio service authorized by the Federal Communications Commission (FCC)
  1. The purpose is to advance skills in the technical and communication phases of the radio art

What is Amateur Radio?

- Amateur Radio is a personal radio service authorized by the Federal Communications Commission (FCC)

2. To promote the development of an emergency communication capability to assist communities when needed

What is Amateur Radio?

- Amateur Radio is a personal radio service authorized by the Federal Communications Commission (FCC)

3. To develop a pool of trained radio operators

What is Amateur Radio?

- Amateur Radio is a personal radio service authorized by the Federal Communications Commission (FCC)

4. To promote international goodwill by connecting private citizens in countries around the globe

What is Amateur Radio?

- Amateur Radio is a personal radio service authorized by the Federal Communications Commission (FCC)

5. Through ham radio, you will become an ambassador for your community and your country

34

Why does the FCC make rules

- Amateur Radio is a Licensed Service
- Hams can buy or build or modify their own equipment
- Knowledge and skills are required
- That's why we have licenses

1-13

35

What do hams do?

- Communicate
- Participate
- Experiment
- Build
- Compete
- Serve their communities
- Life-long learning

1-8

36

About Ham Radio

About Ham Radio

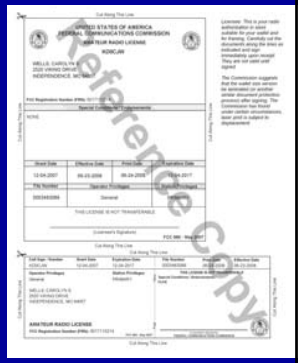
The Amateur Radio Service is intended for persons who are interested in radio technique solely with a personal aim and without pecuniary interest.

There is no age requirement for holding an FCC Amateur Radio License.

About Ham Radio

- T1A02 The agency that regulates and enforces the rules for the Amateur Radio Service in the United States is the FCC.
- T1C10 You may operate to transmit after you pass the examination elements required for your first amateur radio license as soon as your name and call sign appear in the FCC's ULS database.

- T1C08 The normal term for an FCC-issued primary station/operator license grant is ***ten years.***
- T1C09 The grace period following the expiration of an amateur license within which the license may be renewed is ***two years.***



About Ham Radio

- T1C11 If your license has expired and is still within the allowable grace period, you may **not** continue to operate to transmit until the ULS database shows that the license has been renewed.
- T1A10 The FCC Part 97 definition of an amateur station is a station in the Amateur Radio Service consisting of the apparatus necessary for carrying on radio communications.

Take Aways

Purpose of the amateur service

- The Amateur Radio Service is intended for those persons who are interested in radio technique solely with a personal aim and without **pecuniary interest**. [97.3(a)(4)]

The Federal Communications Commission (FCC) is the government agency that regulates and enforces the rules for the Amateur Radio Service in the United States. [97.1]

Element 2 Technician Class
Question Pool

About Ham Radio

Valid July 1, 2014

Through

June 30, 2018

43

How soon may you operate a transmitter on an amateur service frequency after you pass the examination required for your first amateur radio license?

A. Immediately
B. 30 days after the test date
C. As soon as your name and call sign appear in the FCC's ULS database
D. As soon as you receive your license in the mail from the FCC

44

What is the normal term for an FCC-issued primary station/operator license grant?

A. Five years
B. Life
C. Ten years
D. Twenty years

45

What makes ham radio different?

- There are many other radio services available
  - CB – no license required
  - FRS & GMRS
- Some are licensed to commercial carriers and leased to consumers
  - Cell phones

What makes ham radio different?

- Ham radio has:
  - Less restrictions
  - More frequencies (channels or bands to utilize)
  - More power (to improve range and quality)
  - More ways to communicate
  - It's free to operate your radio

With more privileges comes more responsibility

- Ham radios have the potential of interfering with other radio services
- Ham radios have unlimited reach - easily reach around the globe and into space
- No commercial use

With more privileges comes more responsibility

- FCC authorization is required to ensure the operator is qualified to operate the radio safely, appropriately, and within the rules and regs –

that is why we are here

49

Amateur Radio Activities

- We make contacts with other hams
- Support emergencies and public service events
- Awards and contests
- Build, Invent, and modify our radios and other equipment

50

How do I get a License ?

- Learn
- Understand
- Be prepared to pass the FCC exam, administered by volunteer examiners on February 14, 2014 at 9:30 am

51

Some things can be reasoned or calculated

- **A few things have to be memorized**
  - FCC rules
  - A few formulas
  - Authorized frequencies

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Amateur Radio License Structure

Class	Requirements	Elements	Frequency Privileges
TECHNICIAN	Basic Theory, Rules and Regulations	2	HF (CW + Limited Voice & Data) VHF (All Modes) UHF (All Modes)
GENERAL	Basic and General Theory	2, 3	More HF (All Modes) VHF (All Modes) UHF (ALL Modes)
EXTRA	Comprehensive Theory	2, 3, 4	All HF (All Modes) All VHF (All Modes) All UHF (All Modes)

1-14

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Course Schedule

- **Four Consecutive Saturdays**

January 17 3:00 PM – 5:00 PM
(Introduction)

January 24 9:00 AM – 3:00 PM
(Instruction)

January 31 9:00 AM – 3:00 PM
(Instruction)

February 7 9:00 AM – 3:00 PM
(Instruction, Review, Exam prep)

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Course Schedule

- Exam one week after the end of the course
  - 35 questions - 26 correct to pass
- If you are close to passing they usually offer a retest immediately
- The VE team usually has several versions of the exam

55

License Exam :

February 14 9:30 AM – 10:30 AM

MVARC offers VE Exams on the Second Saturday of each month at 9:30 – no fee

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Course Schedule

- We have enough time in the class to cover the information needed to pass the license exam
- We must stay on topic to stay on time
- If you need something off topic, please ask an instructor off-line

57

Let's begin your ham radio journey

- We have touched briefly on what ham radio is — more will follow

58

Let's look at some exam questions now

T1A01
T1C10
T1C13
T1A05
T1A10

We have discussed much of this

They are in the back of your book

59

T1A01

Which of the following is a purpose of the Amateur Radio Service as stated in the FCC rules and regulations?

A. Providing communications for international non-profit organizations

B. Advancing skills in the technical and communication phases of the radio art

C. Providing personal radio communications for as many citizens as possible

D. All of these choices are correct

60

T1C10

How soon after passing the examination for your first amateur radio license may you operate a transmitter on an amateur service frequency?

A. Immediately

B. 30 days after the test date

C. As soon as your operator/station license grant appears in the FCC's license database

D. You must wait until you receive your license in the mail from the FCC

T1C13

For which licenses classes are new licenses currently available from the FCC?

A. Novice, Technician, General, Advanced

B. Technician, Technician Plus, General, Advanced

C. Novice, Technician Plus, General, Advanced

D. Technician, General, Amateur Extra

T1A05

Which of the following is a purpose of the Amateur Radio Service rules and regulations as defined by the FCC?

A. Enhancing international goodwill

B. Providing inexpensive communication for local emergency organizations

C. Training of operators in military radio operating procedures

D. All of these choices are correct

T1A10

What is the definition of an amateur radio station?

A. A station in an Amateur Radio Service consisting of the apparatus necessary for carrying on radio communications

B. A building where Amateur Radio receivers, transmitters, and RF power amplifiers are installed

C. Any radio station operated by a non-professional

D. Any radio station for hobby use

Next week

- Read Chapters 1, 3, 2 and 4
- Chapter 4 may be next week or the week after next - it depends
- Bring your questions
- If you have time, try a practice exam or two

Next Week's Topics

1. Electricity, Components and Circuits
2. Radio and Signal Fundamentals
3. Types of Radios
4. Propagation Antennas and Feed lines

February 14 Exam

- Please bring the following:
- 1) Picture ID or a DMV "child's ID" which looks like a drivers license.
  OR a parent with the same last name and address AND info that only a parent would have such as a birth certificate - parent ID IS NOT the preferred ID
- 2) SSN

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February 14 Exam

- If you hold any FCC license and have a FRN please bring that also
- Such as GMRS

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What are you going to do before next Saturday?

Read 1, 3, 2 and 4

Try a practice exam or two

The score does not matter

Questions?

Something you don't understand?

What is bothering you?

Amateur Radio Technician Class Licensing Course
Boy Scout Venturing Crew 80, Alexandria, VA
First Christian Church
Mount Vernon Amateur Radio Club (MVARC)

Day 2 Starts Here

January 20, 2015

Today's Topics

1. Electricity, Components and Circuits
2. Radio and Signal Fundamentals
3. Types of Radios
4. Propagation Antennas and Feed lines
5. What to prepare for next week

Chapter 3

Electricity, Components, Circuits

- In the following presentations, we provide an overview of the topic
- In later sessions, we come back with greater detail
- Don't hesitate to ask questions
- If we ask you to hold that thought, please jot it down

VIDEO Segments

- These videos are from a pre-2006 video for the Technician License Course
- The concepts have not changed
- References to specific exam questions are no longer current

The video mentions "the test"

The test is revised every 4 years -- you should rely on the current question pool in the back of your book

Fundamentals of Electricity

When dealing with electricity what we are referring to is the flow of electrons through a conductor

- Electrons are negatively charged atomic particles
  The opposite charge is the positive charge
- A conductor is a material that allows electrons to move with relative freedom

Fundamentals of Electricity

- In electronics and radio, we control the flow of electrons to make things happen
- Knowledge of how we control the flow of electrons helps you understand how to operate your radio

We are going to watch a video segment about Electrical Principles

In other words, Basic Electricity, Electrical components, and Units that we use to measure electricity

18

Characteristics of Electricity

- Three characteristics of electricity
  - Voltage
  - Current
  - Resistance
- Each can be measured

3-1

80

Characteristics of Electricity

- The flow of water through a hose is a good analogy to the three characteristics of electricity and how they are related

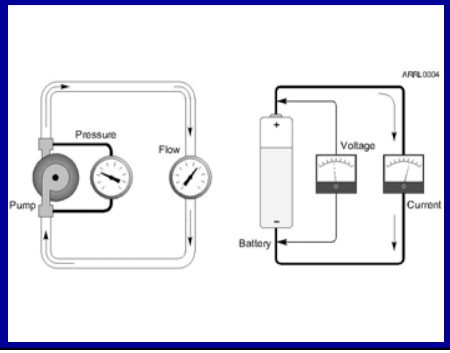
81

Page 3-2

Middle of page

82

Characteristics of Electricity



83

Characteristics are Inter-related

- Voltage, current, and resistance must be present to have current flow
- Just like water flowing through a hose, changes in voltage, current, and resistance affect each other
- That effect is mathematically expressed in Ohm's Law

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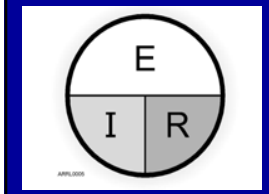
Ohm's Law



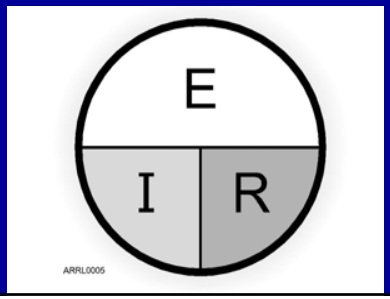
E is voltage
Unit is volt
I is current
Unit is ampere
R is resistance
Unit is ohm

R = E/I
I = E/R
E = I x R

3-4

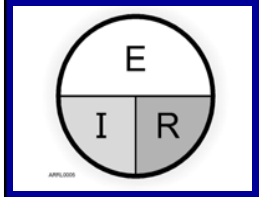
85

When you take the exam write this down on the scratch paper



86

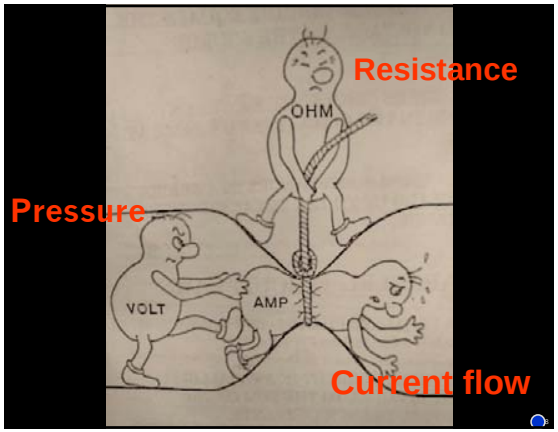
When you take the exam write this down on the scratch paper



E = Volts

I = Amps | R = Ohms

87

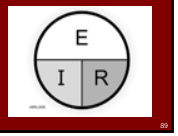


Ohm's Law:

"Resistance is not futile"

It is voltage divided by current

$R = E \div I$



89

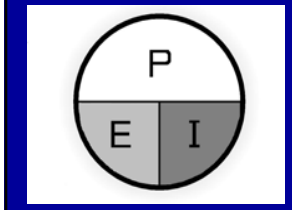
Moving Electrons – Doing Something Useful

- Anytime energy is expended to do something - work is performed
- When moving electrons do some work, power is consumed
- Power is measured in **Watts**

90

Power Formula

Power - the amount of current that is pushed through a conductor or device to do work



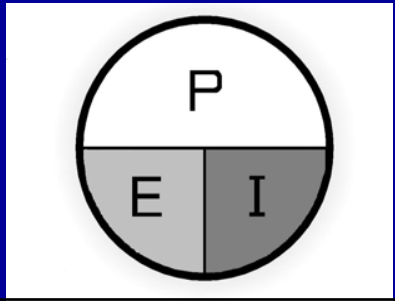
P is power
Unit is watt
E is voltage
Unit is volt
I is current
Unit is ampere

P = E x I
E = P/I
I = P/E

3-4

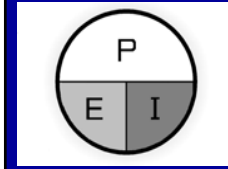
91

When you take the exam write this down on the scratch paper



92

When you take the exam write this down on the scratch paper



P = Watts

E = Volts | I = Amps

93

Two Kinds of Current

Alternating Current (AC)
and
Direct Current (DC)

94

Two Kinds of Current

When current flows alternatively in one direction then in the opposite direction, it is called **Alternating Current** (AC)

- Your household current is AC
- Cross country power lines use AC
- Radio waves are AC

3-6 (top right)

95

Two Kinds of Current

When current flows in only one direction, it is called Direct Current (DC)

- Batteries are a source of DC
- Most electronic devices are powered by DC
- Batteries are in flashlights and start your car

3-6

96

Alternating Current

The speed at which the Alternating Current changes direction is called

Frequency

It is measured in Hertz

It used to be Cycles (same thing)

Hertz (per second)

Much more later!

97

The Electric Circuit – an Electronic Roadmap

- For current to flow, there must be a path from one side of the source of the current to the other side of the source – this path is called a circuit
  - There must be a hose (conductive path) through which the water (current) can flow

98

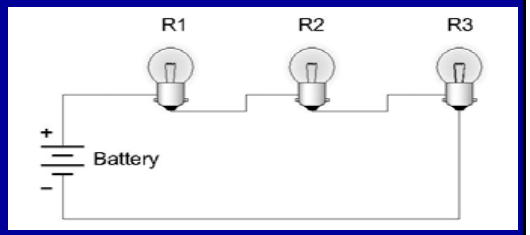
The Electric Circuit – an Electronic Roadmap

- Next, we will introduce some terms that are used to describe circuits

99

Series Circuits

- Series circuits provide only one path for current flow

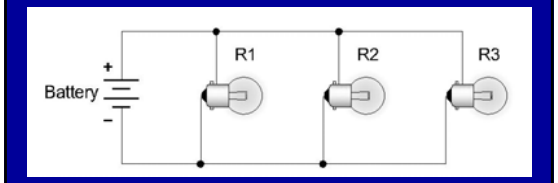


3-2

100

Parallel Circuits

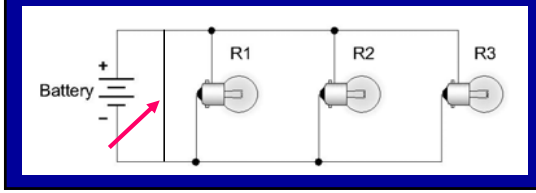
- Parallel circuits provide alternative paths for current flow



101

Short Circuit

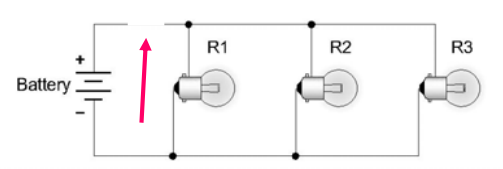
- When there is an unintentional current path that by-passes areas of the circuit – this is a short circuit



102

Open Circuit

- When the current path is broken so that there is a gap that the electrons can not jump – this is an open circuit



Questions?

Chapter 3.2

Components and Units

3-6

Controlling the Flow of Current

- To make an electronic device (like a radio) do something useful (like a receiver), we need to control and manipulate the flow of current
- There are a number of different electronic components that we use to do this

Components

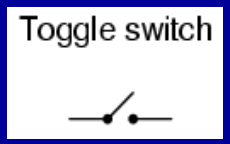
An introduction to names and symbols

Video

Practical Electronics

Switch

- The function of the switch is to permit or not permit the flow of current through it



3-13

109

Resistor

- The function of the resistor is to restrict (limit) the flow of current through it

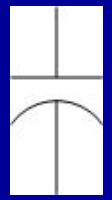
Circuit Symbol

110

Capacitor

- The function of the capacitor is to temporarily store electric current
  - Like a very temporary storage battery
  - Stores energy in an electrostatic field

Circuit Symbol



111

Inductor

- The function of the inductor is to temporarily store electric current
  - Is basically a coil of wire
  - Stores energy in a magnetic field

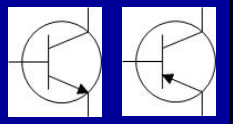
Circuit Symbol

112

Transistor

- The function of the transistor is to variably control the flow of current
  - Much like an electronically controlled valve
  - Like the faucet in your sink

Circuit Symbol



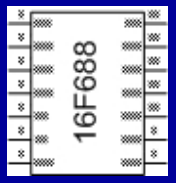
113

Integrated Circuit

The Integrated circuit is a collection of components contained in one device that accomplishes a specific task

- Acts like a "black-box"

Circuit Symbol



114

Protective Components – Intentional Open Circuits

Fuses and circuit breakers are designed to interrupt the flow of current if the current becomes uncontrolled

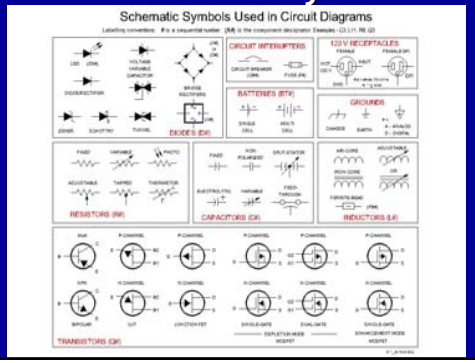
Circuit Symbol

Protective Components – Intentional Open Circuits

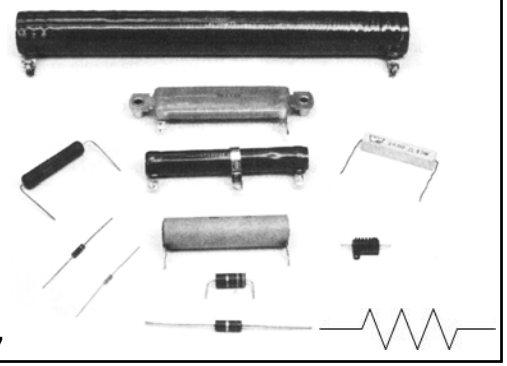
- Fuses blow – one time protection
- Circuit breakers trip – can be reset and reused

Circuit Symbol

Some Circuit Symbols

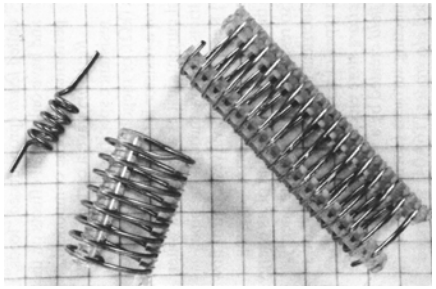


What are these?



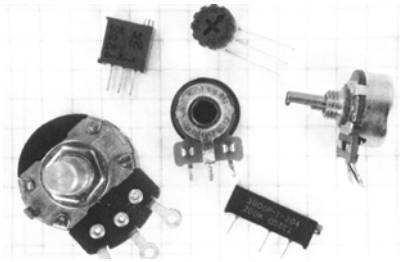
3-7

What are these?



3-8

What are these?



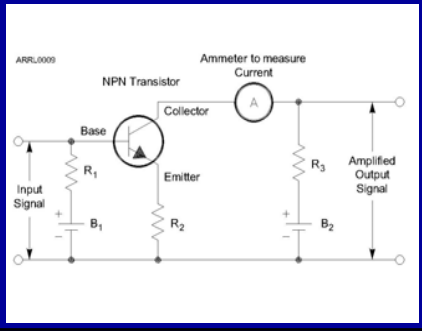
3-8

Video

Power Amps and other devices

11

Putting it all together – a circuit diagram



122

Questions?

123

Numbers,

Numbers,

Numbers

2-2

124

Dealing with Very Big and Very Small Numeric Values

- In electronics we deal with large and small numbers
- The international metric system provides a method of dealing with the wide range of values

125

Metric Units

International System of Units (SI)

Kilo-

Mega-

Centi-

Milli-

Micro-

2-2

126

Prefix	Symbol		Multiplication Factor
Tera	T	10^{12}	1,000,000,000,000
Giga	G	10^{9}	1,000,000,000
Mega	M	10^{6}	1,000,000
Kilo	k	10^{3}	1,000
Hecto	h	10^{2}	100
Deca	da	10^{1}	10
Deci	d	10^{-1}	0.1
Centi	c	10^{-2}	0.01
Milli	m	10^{-3}	0.001
Micro	μ	10^{-6}	0.000001
Nano	n	10^{-9}	0.000000001
Pico	p	10^{-12}	0.000000000001

127

T5B01
How many milliamperes is the same as 1.5 amperes?

A. 15 milliamperes
B. 150 milliamperes
C. 1500 milliamperes
D. 15000 milliamperes

128

Chapter 2

Radio and Signals Fundamentals

129

Radio Signals and Waves

2-1

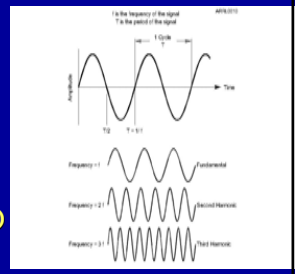
Radio Waves are AC

- In alternating current (AC) the electrons flow in one direction one moment and then the opposite direction the next moment
- Radio waves (electromagnetic radiation) are AC waves
- Radio waves are used to carry the information you want to convey to someone else

Wave Vocabulary

As we study radio waves, we will learn some new terms

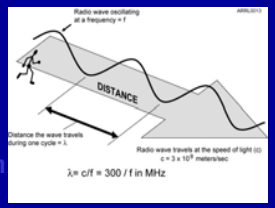
- Amplitude
- Frequency (Hertz)
- Period
- Wavelength (Meters)
- Harmonics



2-2

Wavelength

- The distance a radio wave travels during one cycle
  - One complete change between magnetic and electric fields



2-5

133

Finding where you are on the radio dial

- There are two ways to tell someone where to meet you on the radio dial (spectrum)
  - Band
  - Frequency

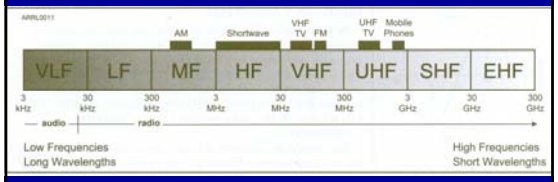
134

Radio Frequency (RF) Spectrum

- The RF Spectrum is the range of wave frequencies which will leave an antenna and travel through space
- The RF Spectrum is divided into segments of frequencies that have a unique behavior

135

Radio Frequency (RF) Spectrum



3kHz to 30kHz is primarily an audio (sound wave) portion of the spectrum. In some cases, RF waves can also be generated at these frequencies.

2-4

136

So, Where am I?

- How to tell where you are in the spectrum -
- Bands identify the segment of the spectrum where you will operate
  - Wavelength is used to identify the band
- Frequencies identify specifically where you are within the band

137

Another use for frequency and wavelength

- For the station antenna to efficiently send the radio wave out into space, the antenna must be designed for the specific operating frequency
  - The antenna length needs to closely match the wavelength of the frequency to be used

138

Another use for frequency and wavelength

Any mismatch between antenna length and frequency wavelength will result in radio frequency energy being reflected back to the transmitter, not going (being emitted) into space

139

Practice problem frequency and wavelength

What is the wavelength in meters of a RF signal of 7 Mhz?

300 divided by 7

42 meters (common use 40 m.)

70 goes into 300 about 4 times

7 times 4 is 28

140

Practice problem frequency and wavelength

What is the wavelength in meters of a RF signal of 144 Mhz?

300 divided by 144

2 meters

144 goes into 300 twice

141

Calculators

- You may use a calculator during the exam
- Be prepared to show that all memories are clear
- You can not store formulas or answers to questions on your calculator and use it on the exam

142

Antennas are part capacitor – part inductor – part resistor

Antennas have characteristics of capacitors, inductors, and resistors

We discussed these earlier

143

Antennas are part capacitor – part inductor – part resistor

- Capacitors and inductors, because they store energy in fields, react differently to AC and DC
  - Special kind of resistance to the flow of AC – called reactance

144

Resonance

- Because capacitors and inductors store energy in different ways, the stored energy can actually cancel each other under the right conditions
  - Capacitors – electrostatic field
  - Inductors – magnetic field
- Cancelled energy (current) = zero reactance, leaving only resistance

145

Resonant Antenna

- If an antenna is designed correctly, the capacitive reactance cancels the inductive reactance
- Theoretically, the resulting reactance is zero
  - Leaving only resistance – meaning minimum impediment to the flow of the radio frequency currents flowing in the antenna and sending the radio wave into space

146

Harmonics

- A harmonic is a multiple of the original frequency
- A second harmonic is 2 x Frequency
- A third harmonic is 3 x Frequency
- In antennas, even harmonics cancel but odd harmonics may radiate causing interference

147

Ham Slang

- An antenna is a sky hook
- Something that transmits is a rig
- A bunch of antennas is an antenna farm

(not on test)

2-11

148

Questions?

149

Chapter 2.2

Introduction to Modulation

2-6

150

Adding Information - Modulation

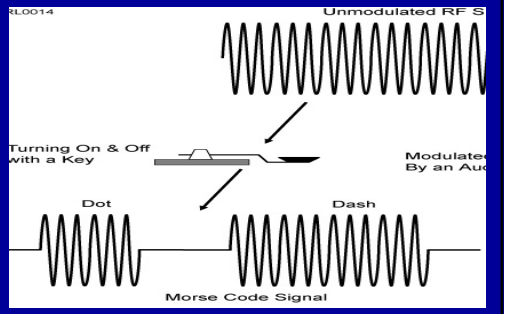
- When we imprint some information on the radio wave, we modulate the wave
  - Turn the wave on and off
  - Voice AM and FM
  - Data
- Different modulation techniques are called modes

151

Video Types of Emissions

21

Morse Code – on and off



2-7

153

Characteristics of voice

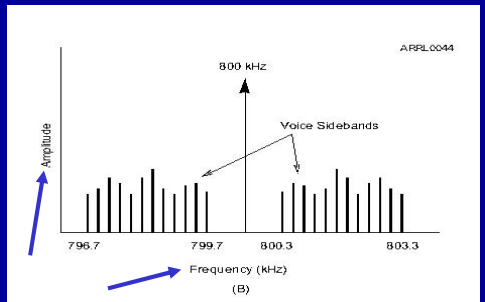
- Sound waves that make up your voice are a range of audio frequencies
- Most voices range from 300 hertz to about 3000 Hz
- Our hearing range goes to about 20 kHz

Amplitude Modulation (AM)

In AM, the amplitude of the carrier wave is modified in step with the waveform of the information (voice)

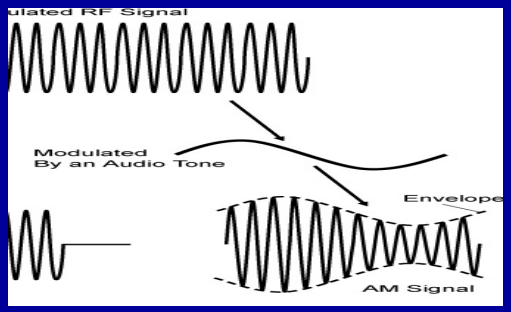
Combining Voice with an RF carrier produces 2 identical sidebands

Voice Modulation



2-8

Amplitude Modulation (AM)



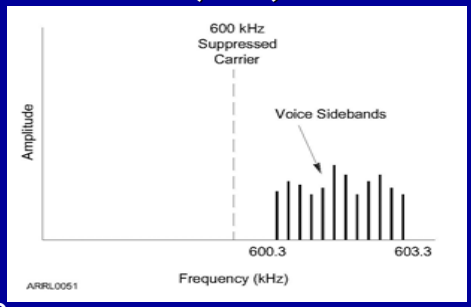
157

Single Sideband Modulation (SSB)

- Combining Voice with an RF carrier produces 2 identical sidebands
- We can improve efficiency of transmission by transmitting only one sideband and then reconstruct the missing sideband at the receiver

158

Single Sideband Modulation (SSB)



2-9

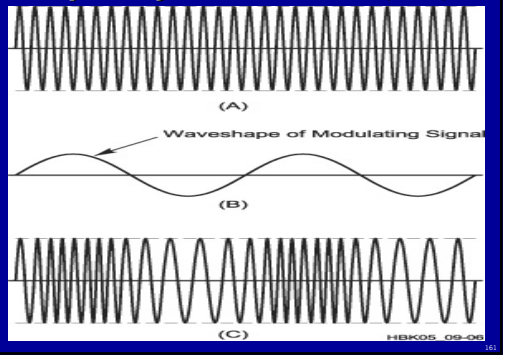
159

Frequency Modulation (FM)

- Instead of varying amplitude, if we vary the frequency in step with the information waveform – FM is produced
- We shift the frequency of the transmitter up and down to carry information

160

Frequency Modulation (FM)



2-9

161

Transmitting Data

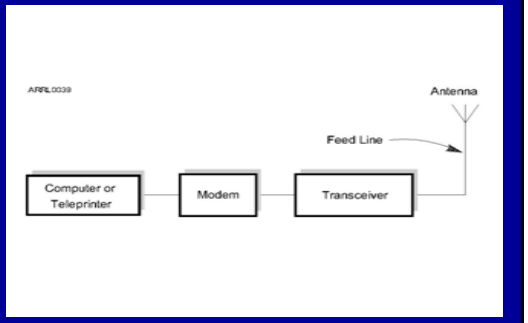
- Data is made up of binary bits 1 and 0 - On and off states
- Modems translate the data into a format capable of modulating a carrier wave

162

Transmitting Data

- A terminal node controller (TNC) is a special modem used in ham radio
- There are many more kinds of modems developed as data transmission technology advances

Data Transmission Setup



Questions?

Chapter 2.3

Basic Types of:

- Radios
- Equipment
- Equipment Definitions

2-11

166

Terms

- Receiver
- Transmitter
- Transceiver
- Antenna

167

Basic Station Organization

- Station Equipment
  - Receiver
  - Transmitter
  - Antenna
  - Power Supply
- Accessory Station Equipment
- Repeaters

168

What happens during radio communication?

Transmitting (sending a signal)

1. Information (voice, data, video, commands, etc.) is converted to an **electronic form**
2. The **electronic form** is attached or imbedded in a **radio wave** (a carrier)
3. The **radio wave** is sent out from the station antenna into space

What happens during radio communication?

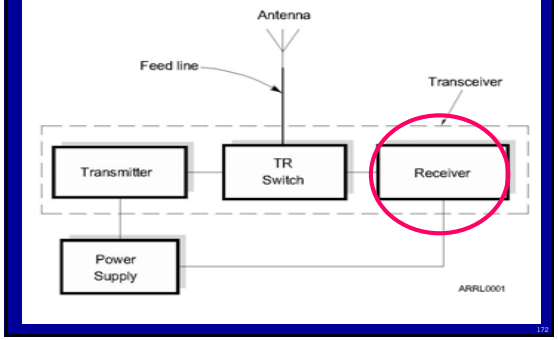
Receiving:

1. The antenna intercepts the radio wave (carrier) with the information
2. The receiver extracts the information from the carrier wave
3. The information is presented as a sound, picture, or words on a computer screen …

What happens during radio communication?

- This sounds simple, but it in reality is complex
- Complexity is one thing that makes ham radio fun…learning all about how radios work
- Don't be intimidated, you will be required to only know the basics, but you can learn as much about the ''art and science'' of radio as you want

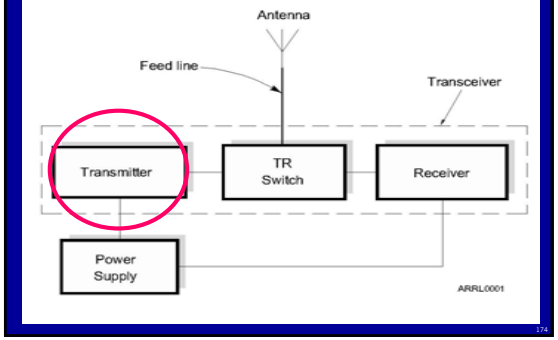
Receiver



Receiver Controls

- Main tuning dial for received frequency (or channel) selection
- Frequency display
- Volume control
- Other accessory controls for mode (kind of information to process), filters (to mitigate interference), etc.

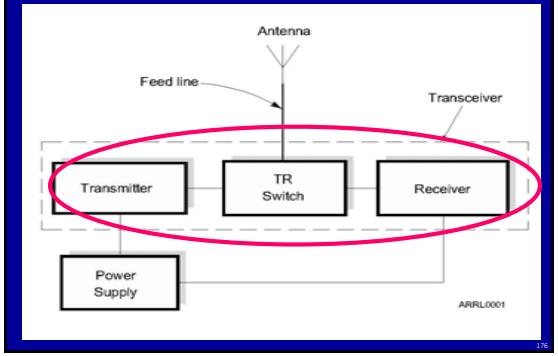
Transmitter



Transmitter Controls

- Main tuning dial for transmitted frequency (or channel) selection
- Frequency display
- Power control (transmitted signal strength)
- Other accessory controls for mode (kind of information to process), etc.

Transceiver



The transceiver

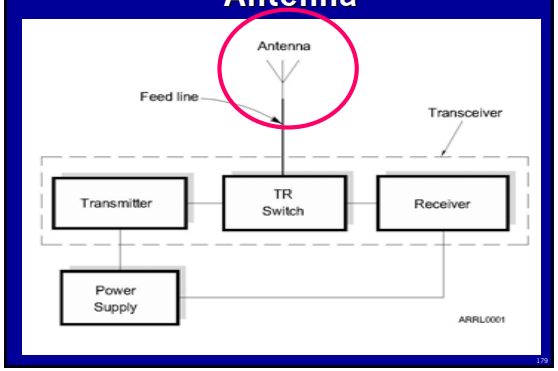
- Modern transmitters and receivers are combined in one unit – a transceiver
  - Saves space, Costs less
- Many of the controls of the transmitter and receiver are the same
- Many electronic circuits are shared in the transceiver

Transceiver Controls

- Some are physical knobs that you manually adjust
- Some are controlled by an internal computer -- you control the settings with keypad entries that control the computer in the transceiver

178

Antenna



179

Antenna

The antenna exposes your station to the world

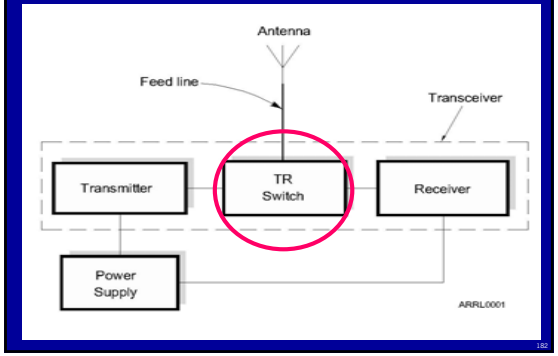
1. Facilitates the radiation of your signal into space (electromagnetic radiation)
2. Intercepts someone else's signal

180

Antenna

- Many times the transmitting and receiving antenna are the same antenna
- Your antenna is connected to your station by a wire called a feed line

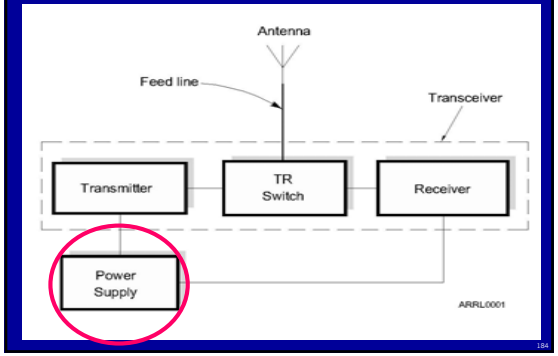
TR Switch



Transmit/Receive (TR) Switch

- When the antenna is shared between the transmitter and receiver, the TR switch allows the antenna to be switched to the transmitter when sending and to the receiver when receiving
- In a transceiver, this TR switch is inside the unit and requires no attention by the operator

Power Supply



184

Power Supply

- Your radio station needs some sort of power to operate
  - Battery
  - Household current converted to proper voltage
  - Alternative sources

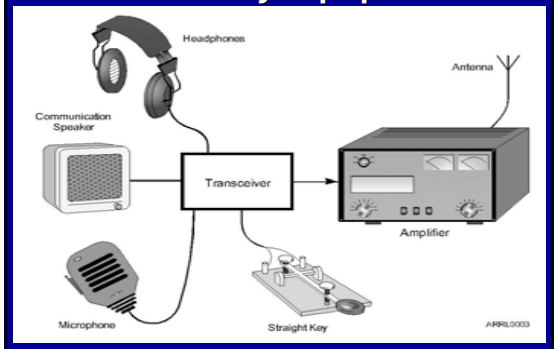
185

Power Supply

- Most modern radios operate on 12 volts direct current (DC)
  - A power supply converts household current to the type of current and the correct voltage to operate your station
  - Could be internal or external
- You are probably familiar with "wall-wart" power supplies

186

Accessory Equipment



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Radio Circuits

- Oscillators and Amplifiers
- Filters
- Modulators
- Mixers
- Demodulators
- Detectors
- Product Detectors
- Frequency Discriminators
- Receivers - Direct Conversion
- Receivers - Superhetrodyne
- Transverters

Some things you may see on the exam

Don't need to know how each works, just what it does

188

Oscillators

Produces a steady low power signal at a specific frequency

Feeds a Driver that isolates the load on the oscillator

Runs all the time

189

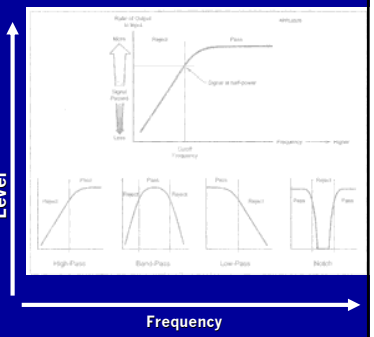
Amplifier

Increases a low power signal

Could also be a power Amplifier

Filters

- High Pass
- Low Pass
- Band Pass
- Notch
- Cutoff is ½ signal level



3-17

Modulator

Adds voice or data to a RF signal or carrier which can then be transmitted by radio

Could be a telegraph key or microphone output

Mixer

- Combines two RF signals
- Produces the sum and difference of the input signals
- Shifts frequencies for some purpose (filtering)
- Is NOT an AUDIO mixer

3-17

193

Demodulator

- Reverses what a Modulator does
- Separates the RF from the voice
- A computer Modem is a Modulator and Demodulator in a single box - works two ways - does both jobs
- Many different types

  We will talk about several types

194

Detector

Demodulates AM

Can be used in AM broadcast radio receivers

195

Product Detector

Demodulates CW and SSB signals

196

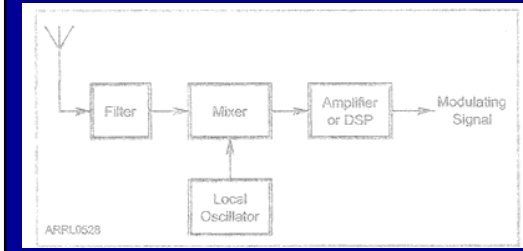
Frequency Discriminator

Demodulates Frequency Modulation (FM) signals

197

Receiver - Direct Conversion

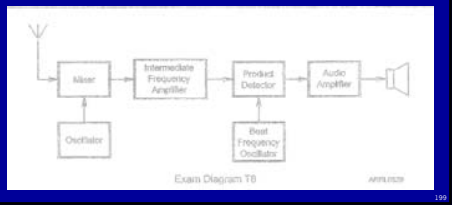
- Single Conversion of RF back into the original modulating signal



198

Receiver - Superhetrodyne "Superhet"

- Uses Intermediate Frequency (IF) amplifier and filters
- Uses a Beat Frequency Oscillator to recover CW and SSB



199

Transverter

- Converts one RF frequency to another
- For example 28 Mhz to 222 Mhz and from 222Mhz to 28 Mhz allowing a single transceiver to operate on both bands

200

T7A05

What is the name of a circuit that generates a signal of a desired frequency?

A. Reactance modulator
B. Product detector
C. Low-pass filter
D. Oscillator

201

Radio Circuits Pages 3-16 thru 3-19

- Oscillators and Amplifiers
- Filters
- Modulators
- Mixers
- Demodulators
- Detectors
- Product Detectors
- Frequency Discriminators
- Receivers - Direct Conversion
- Receivers - Superhetrodyne
- Transverters

Lets review what these things are used for

Basic Station Accessories

- Human interface
  - Microphones
  - Speakers
  - Earphones
  - Computer
  - Morse code key
  - TV camera
- Station performance
  - Antenna tuner
  - SWR meter (antenna match checker)
  - Amplifier
  - Antenna rotor (turning antenna)
  - Filters

203

Questions?

204

Types of Radios

Generalized Transceiver Categories

- Single Band FM — VHF or UHF
- Dual Band — VHF/UHF FM
- Multi-mode — VHF/UHF
- Multi-band VHF/UHF — HF and
- Hand-held (HT)

Single Band Transceiver

- Probably the most common starter rig
- Operated from 12 volts DC, will require external power supply
- Will require an external antenna
- Can be operated mobile or as a base station
- Limited to frequency modulation (FM) and either 2 meters or 70 cm bands
- Up to approximately 50 watts output

Dual Band Transceiver

- Same as the single band transceiver but includes additional band(s)
- Most common 2 m and 70 cm bands
- Could be tri-bander
- Depending on antenna connectors, might require separate coax for each band or duplexer for single coax

208

Multi-mode Transceiver

- Can be single or dual band
- Main difference is that these rigs can operate on all major modes SSB/AM/FM, CW, Data, RTTY etc.
- More features add complexity and cost
- Most flexible of the rigs that will allow you to explore new modes as you gain experience

209

Multi-band Transceiver

- Covers several bands – can be limited to HF or can be HF/VHF/UHF
- Also covers all modes
- Frequently 100 watts on HF, some power limitations on high bands (50 watts)
- Larger units have internal power supplies, smaller units require external power (12 V)

210

Hand-held (HT) Transceiver

- Small hand-held FM units
- Can be single band or dual band
- Limited power (usually 5 watts or less)
- Includes power (battery) and antenna in one package
- An attractive first starter rig – but make sure it is what you want

211

Comparison

	Single Band	Dual Band	Multi-mode	Multi-band	HT
Freq Agility	Limited	Medium	Medium	Full	Limited
Functionality	Limited	Limited	Full	Full	Limited
Ease of Use	Easy	Medium	Medium	Difficult	Easy
Programming	Easy	Easy	Medium	Challenging	Easy/Medium
Power	Low	Low	Medium	High	Low
Cost	Low	Modest	High	High	Low

212

More on equipment

In future lessons

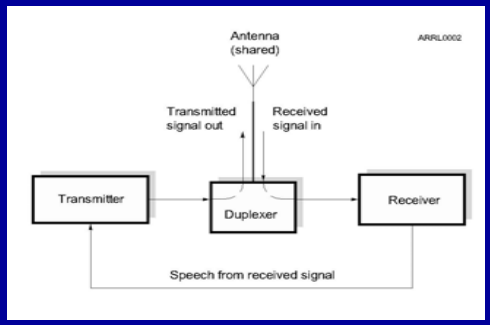
213

Introduction to Repeaters

- Extend your coverage range
- Normally VHF or UHF
- Some on HF (6 and 10 meters)

214

Introduction to Repeaters



2-11

215

Special stations you will use (Repeaters)

- Repeaters are automated stations located at high places that receive and then retransmits your signal - simultaneously
  - Dramatically improves range
- The basic components of a repeater are the same as your station: receiver, transmitter, antenna, and power supply

Repeaters

- But, repeaters are transmitting and receiving at the same time, on different frequencies using the same antenna
- Repeaters do not use T/R switches because they are transmitting and receiving simultaneously

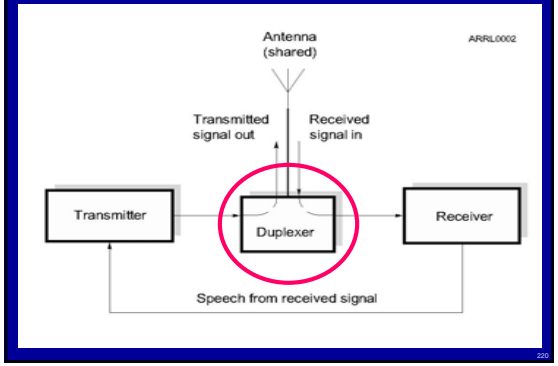
Repeaters

- The K4US repeater
  - Receives on 146.055 Mhz
  - Transmits on 146.655 Mhz
- Your radio
  - Receives on 146.655
  - Transmits on 146.055

Repeaters

- This requires a very high quality and specialized filter to prevent the transmitted signal from over-powering the receiver
- This specialized filter is called a duplexer
- The receiver sees the antenna
- The transmitter sees the antenna
- The receiver does NOT see the repeater's transmitter (else smoke)

Repeater



220

Repeaters

We will cover repeaters in detail in a later lesson

221

Questions?

222

Amateur Radio Technician Class Licensing Course
Boy Scout Venturing Crew 80, Alexandria, VA
First Christian Church
Mount Vernon Amateur Radio Club (MVARC)

Day 3 Starts Here

January 20, 2015

223

Questions?

Something you don't understand?

What is bothering you?

224

Chapter 4 Propagation

4-1

225

Radio Wave Propagation Topics

- How signals travel
- Antenna Basics
- Feed Lines
- What is SWR
- How to build a practical antenna

4-1

226

Radio Wave Propagation Getting from Point A to Point B

- Radio waves propagate by many mechanisms
  - The science of wave propagations has many facets
- We will discuss 3 basic ways:
  - Line of sight
  - Ground wave
  - Sky-wave

227

Line-of-Sight

- If a source of radio energy can been seen by the receiver, then the radio energy will travel in a straight line from transmitter to receiver
  - There is some attenuation of the signal as the radio wave travels
- This is the primary propagation mode for VHF and UHF signals

228

Ground Wave

- Some radio frequency ranges (lower HF frequencies) will hug the earth's surface as they travel
- These waves will travel beyond the range of line-of-sight
- A few hundred miles

229

Ionosphere

- Radiation from the sun momentarily will strip electrons away from the parent atom in the upper reaches of the atmosphere
  - Creates ions
- The region where ionization occurs is called the Ionosphere

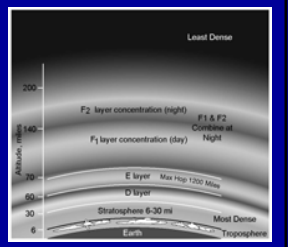
4-3

230

Levels of the Ionosphere

Density of the atmosphere affects:

- The intensity of the radiation that can penetrate to that level
- The amount of ionization that occurs
- How quickly the electrons re-combine with the nucleus

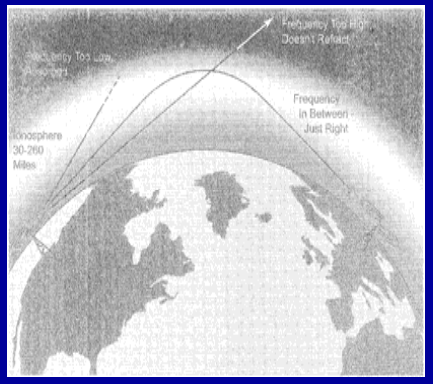


4-3

231

Ionosphere – a leaky RF Mirror

- The ionized layers of the atmosphere actually act as an RF mirror that reflect certain frequencies back to earth
- Sky-wave propagation is responsible for most long-range, over the horizon communication
- Reflection depends on frequency and angle of incidence



4-4

What are LUF and MUF?

- Lowest Usable Frequency
- Maximum Usable Frequency
- If too low => absorbed
- If too high => goes into space
- Just right => bounces back to earth miles and miles away

4-4

Sun Spot Cycle

- The level of ionization depends of the radiation intensity of the sun
- Radiation from the sun is related to the number of sun spots on the sun's surface
  - High number of sun spots, high ionizing radiation emitted from the sun
- Sun spot activity follows an 11-year cycle

235

Antennas and Feed Lines

- Feed line delivers the signal to and from the antenna

  More on this shortly

4-5

236

What are Decibels ?

- dB is the ratio of two quantities as a power of 10
  - 3 dB is half power
  + 3 dB is twice power

4-7

237

Exam Questions T5B09, 10 and 11

Please turn to page 11-34 in the back of your book and write down the letter of the correct answer

We will go over your answers in a couple of minutes

Exam Questions T5B09, 10 and 11

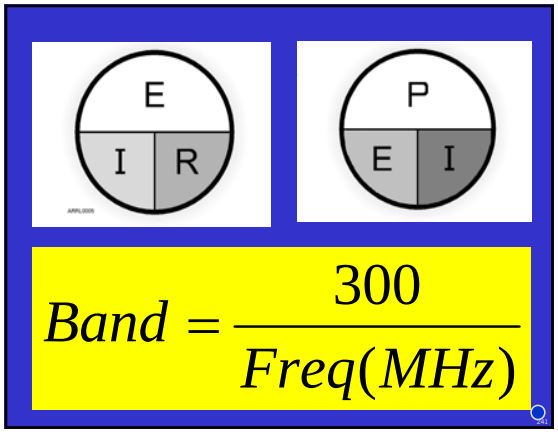
- T5B9 The approximate amount of change, measured in decibels (dB), of a power increase from 5 watts to 10 watts is 3dB.
- T5B10 The approximate amount of change, measured in decibels (dB), of a power decrease from 12 watts to 3 watts is 6dB.
- T5B11 The approximate amount of change, measured in decibels (dB), of a power increase from 20 watts to 200 watts is 10 dB.

Two times or ½ of the power is a 3db change

Ham Bands

Let's think about
- Ohms Law
- Power
- Frequency

As we look at Band Plans


E
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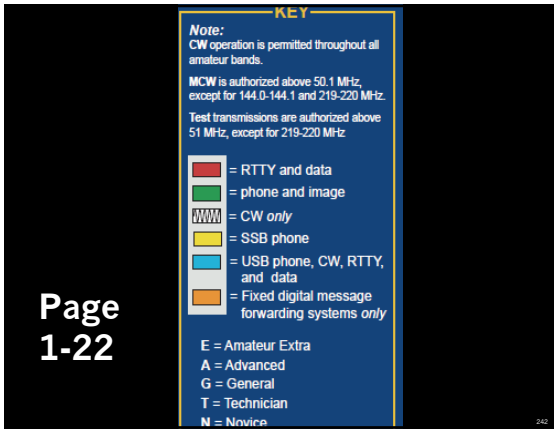
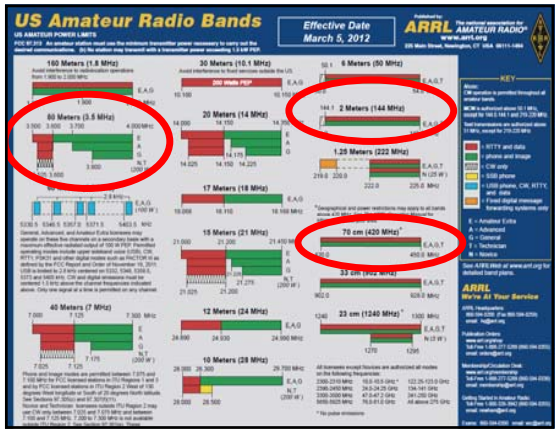
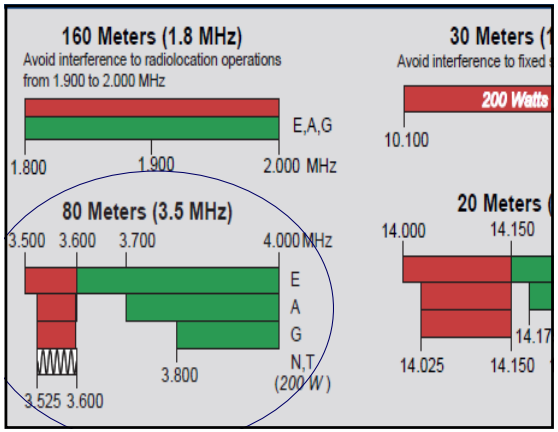
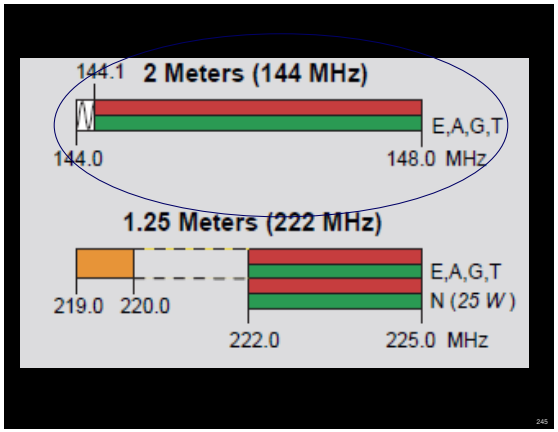
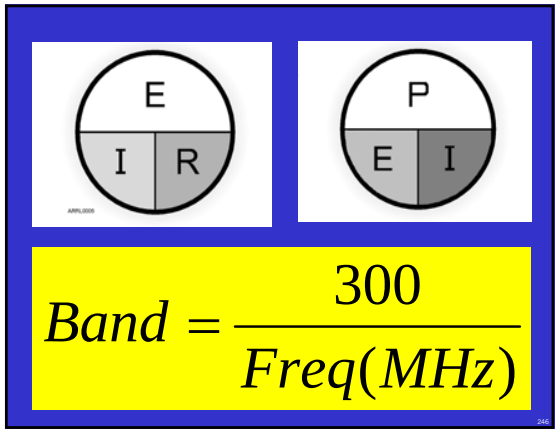
E
I
$Band = \frac{300}{Freq(MHz)}$


KEY
Note:
CW operation is permitted throughout all amateur bands.
MCW is authorized above 50.1 MHz, except for 144.0-144.1 and 219-220 MHz.
Test transmissions are authorized above 51 MHz, except for 219-220 MHz
= RTTY and data
= phone and image
= CW only
= SSB phone
= USB phone, CW, RTTY, and data
= Fixed digital message forwarding systems only
E = Amateur Extra
A = Advanced
G = General
T = Technician
N = Novice
Page 1-22


US Amateur Radio Bands
Effective Date March 5, 2012
ARRL
160 Meters (1.8 MHz)
80 Meters (3.5 MHz)
40 Meters (7 MHz)
30 Meters (10.1 MHz)
20 Meters (14 MHz)
17 Meters (18 MHz)
15 Meters (21 MHz)
12 Meters (24 MHz)
10 Meters (28 MHz)
6 Meters (50 MHz)
2 Meters (144 MHz)
1.25 Meters (222 MHz)
70 cm (420 MHz)
33 cm (902 MHz)
23 cm (1240 MHz)


160 Meters (1.8 MHz)
Avoid interference to radiolocation operations
from 1.900 to 2.000 MHz
E,A,G
1.800
1.900
2.000 MHz
30 Meters (1
Avoid interference to fixed
200 Watts
10.100
80 Meters (3.5 MHz)
3.500 3.600 3.700 4.000 MHz
E
A
G
N,T
(200 W)
3.800
3.525 3.600
20 Meters (
14.000 14.150
14.17
14.025 14.150

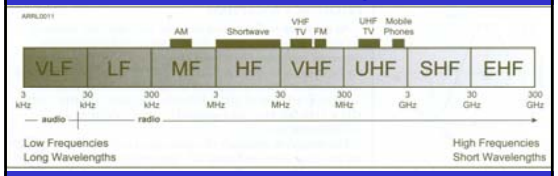

144.1 2 Meters (144 MHz)
E,A,G,T
144.0
148.0 MHz
1.25 Meters (222 MHz)
E,A,G,T
N (25 W)
219.0 220.0
222.0
225.0 MHz


E
I R
P
E I
$Band = \frac{300}{Freq(MHz)}$

Band in METERS	Frequency in Mhz	
80	3.5	HF = 3 to 30
40	7	
30	10	
20	14	
17	18	
15	21	
12	24.8	
10	28	
6	50	VHF = 30 to 300
2	144	
1.25	222	
0.7	420	UHF 300 - 3000
0.33	902	

Radio Frequency (RF) Spectrum

This has been corrected in your book



3kHz to 30kHz is primarily an audio (sound wave) portion of the spectrum. In some cases, RF waves can also be generated at these frequencies.

2-4

Chapter 4 Antennas

Video

Antennas

25

250

The Antenna System

- **Antenna:** Facilitates the sending of your signal to some distant station
- **Feed line:** Connects your station to the antenna
- **Test and matching equipment:** Allows you to monitor antenna performance

251

Antenna vocabulary

- **Driven element:** where the transmitted energy enters the antenna
- **Polarization:** the direction of the electric field relative to the surface of the earth
  - Same as the physical direction
  - Vertical – Horizontal - Circular

252

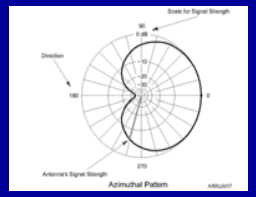
Antenna vocabulary

- **Omni-directional** - radiates in **all directions**
- **Directional beam** - focuses radiation in specific directions
- **Gain** – apparent increase in power in a particular direction because energy is focused in that direction
  - Measured in decibels (dB)

253

Antenna Radiation Patterns

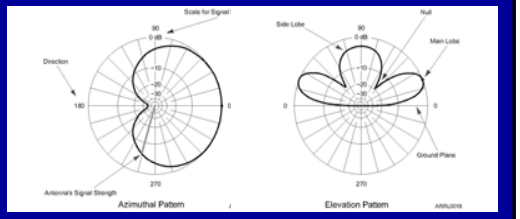
- Radiation patterns are a way of visualizing antenna performance
- The further the line is away from the center of the graph, the stronger the signal at that point



4-7

254

Antenna Radiation Patterns



Horizontal **Vertical**

255

Impedance – AC Resistance

- A quick review of a previous concept: impedance
  - Antennas have characteristics of capacitors, inductors, and resistors
- The combined response of these component parts to alternating currents (radio waves) is called **Impedance**

256

Antenna Impedance

- Antennas have a characteristic impedance
- Expressed in Ohms – common value 50 Ohms
- Depends on:
  - Antenna design
  - Height above the ground
  - Distance from surrounding obstacles
  - Frequency of operation
  - Other factors

257

Feed Line - Antenna - SWR

- For efficient transfer of energy from the transmitter to the feed line and from the feed line to the antenna, the impedances need to match
- When there is mismatch of impedances, things may still work, but not as effectively as they could

258

Video

Feed Lines

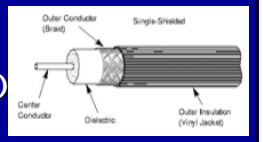
10

Feed line types

- The purpose of the feed line is to get energy from your station to the antenna
- Basic feed line types
  - Coax cable
  - Open-wire or ladder line
- Each has a characteristic impedance, each has its unique application

Coaxial Cable (Coax)

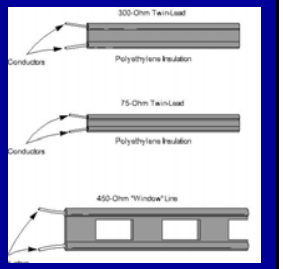
- Most common feed line
- Easy to use
- Matches impedance of modern radio equipment (50 Ohms)
- Some loss of signal depending on coax quality (cost)



4-8

Open-wire/Ladder Line

- Used in special applications
- Need an antenna tuner to make impedance match – but allows a lot of flexibility
- Theoretically a very low loss



262

Test and Matching Equipment

- Proper impedance matching is important enough to deserve some simple test equipment as you develop your station repertoire
- Basic Test Equipment: S.W.R. Meter
- Matching Equipment: Antenna Tuner

263

Standing Wave Ratio (SWR)

- If the antenna and feed line impedances are not perfectly matched, some RF energy is not radiated into space and is returned (reflected) back to the source

4-9

264

Standing Wave Ratio (SWR)

- Reflected energy must go somewhere
- Usually it is converted into heat
- Sometimes it just floats around looking for somewhere to go
- If the energy is not going out the antenna, it is wasted and may cause damage to the transmitter

265

Video

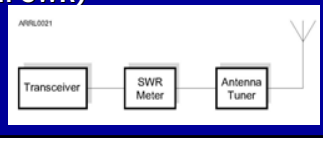
Standing Wave Ratio (SWR)

The ratio of energy going out to energy coming back

266

SWR Meter

- The SWR meter is inserted in the feed line and indicates the reflected energy – measures the mismatch between feed line impedance and antenna impedance
- You make adjustments to the antenna to minimize the reflected energy (minimum SWR)



267

Nothings Perfect

- Although the goal is to get 100% of your radio energy radiated into space, that is virtually impossible
- What is an acceptable level of loss (reflected power or SWR?)
  - 1:1 is perfect
  - 2:1 should be the max you should accept (as a general rule)
    - Modern radios will start lowering power automatically when SWR is above 2:1
  - 3:1 is when you need to do something to reduce SWR

268

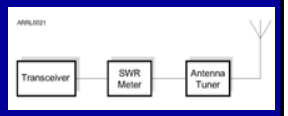
Antenna Tuner

- One way to make antenna matching adjustments is to use an antenna tuner
- Antenna tuners are impedance transformers (they actually do not tune the antenna)
  - When used appropriately they are effective
  - When used inappropriately they just make a bad antenna look good to the transmitter…a bad antenna is still bad

269

How to use an Antenna Tuner

- Monitor the SWR meter
- Make adjustments on the tuner until the minimum SWR is achieved
  - The impedance of the antenna is transformed to more closely match the impedance of the transmitter



270

Questions?

Practical Antenna Systems

Dipoles and Ground-Planes

4-11

How long should the antenna be ?

When working with antennas, it is important to know how long ?

Antenna length is based on the wavelength that we want to use

There is a relationship between frequency and wavelength

Antennas can be full or fractional wavelengths long

Symbol and Formula

This is one of those things that needs to be memorized

λ = Wavelength

½ Wave antenna length in Feet is 468 divided by the Frequency in MHz

¼ Wavelength is 234 divided by the Frequency in MHz

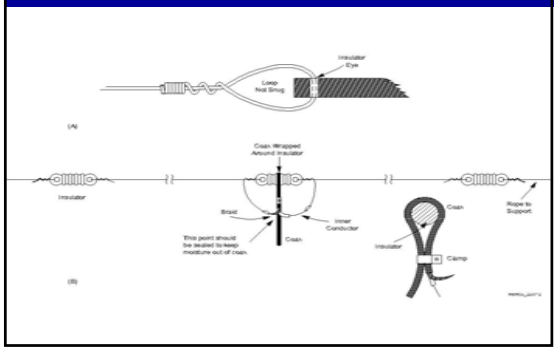
274

The Dipole

- A basic antenna
  - Two conductive, equal length parts
  - Feed line connected in the middle
- Total length is ½ wavelength (1/2 λ)
- Dipole Length (in feet) = 468 / Frequency (in MHz)

275

The Dipole



The Ground-plane

- Simply a dipole that is oriented perpendicular (vertical to the earth's surface)
- One half of the dipole is replaced by the ground-plane
  - Earth
  - Car roof or trunk lid - or other metal surface
  - Radial wires

277

The Ground-plane

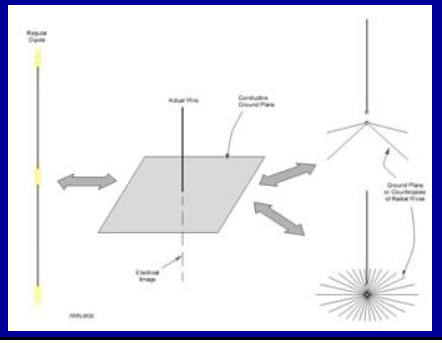
Length (in feet) = 234 / Frequency (in MHz)

Wavelength

½ Wavelength - Dipole
¼ Wavelength – Ground-plane above ground

278

The Ground-plane



4-12

279

Loop Antennas – Dipole Variations

- Quad
- Delta
- Horizontal

280

Beam Antennas

- Beam antennas focus or direct RF energy in a desired direction
  - Gain - An apparent increase in power in the desired direction (both transmit and receive)

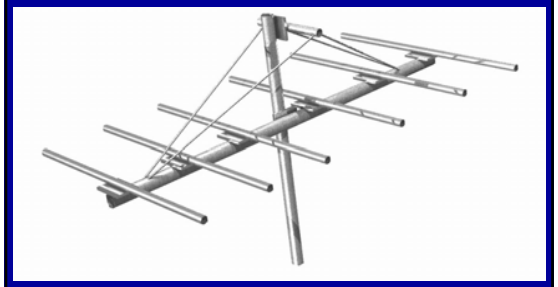
281

Beam Antennas

- Yagi (rod like elements – TV antennas)
- Quad (square wire loop elements)

282

Beam Antennas



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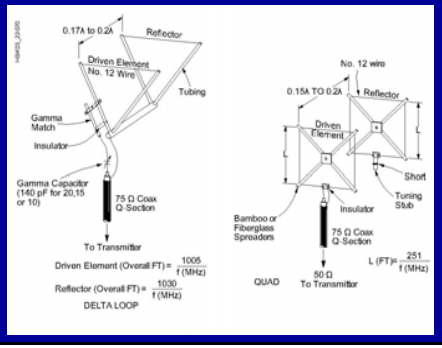
Beam Antennas



284

Beam Antenna Elements

- Driven element connected to the radio by the feed line
- Reflector element is on the back side
- Director element is on the front side toward the desired direction

285

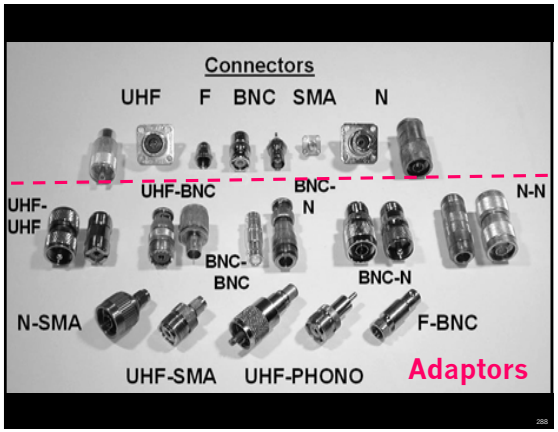
Coax Feed lines

- RG-58
- RG-8
- RG-213
- RG-174
- Hardline

Coax Connectors

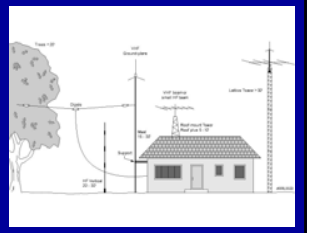
- SO-239/PL259
- BNC
- N
- SMA

4-17



Antenna Supports

- Trees
- Towers or masts
- Covenants and antenna restrictions must be considered



Antenna System Devices

- Balun
- Duplexer
- Antenna Switches
- SWR Meter
- Antenna Analyzer
- Antenna tuners

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Antenna System Devices Antenna Analyzer

Connect to antenna

Very low power signal

Adjustable in frequency

Meter shows SWR

Determine resonant frequencies of the antenna

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Questions?

Chapter 5 Equipment

Chapter 5.1

Transmitters Receivers and Transceivers

5-1

Vocabulary

- RX = Receiver
- TX = Transmitter
- VFO = Variable Frequency Oscillator – a frequency control

5-1

295

Rig Vocabulary

- We will now talk about vocabulary specific to the functions and controls of a transmitter and receiver
- Leading to ‘‘How to operate a Transceiver’’

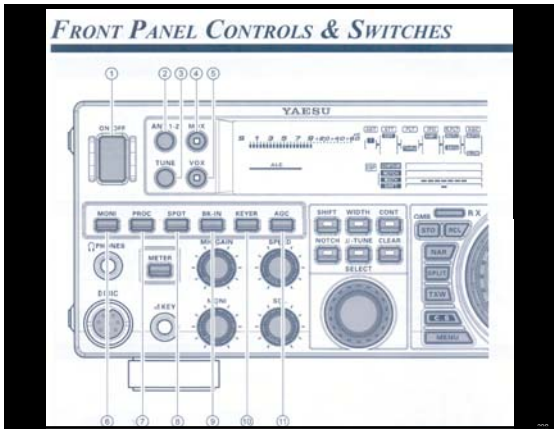
296

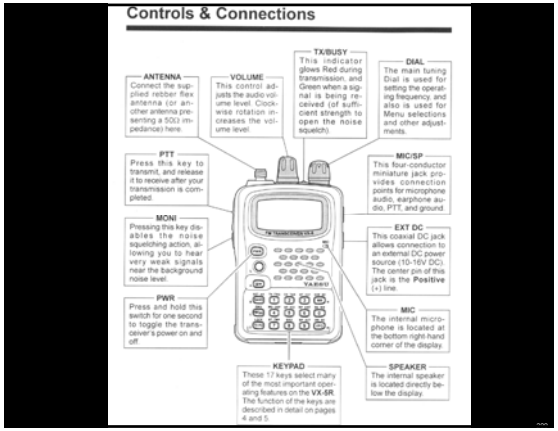
Radios have Instructions

Pictures
Explanations
Operating Instructions

Here are some samples

297





Transmitter

Transmitter Controls and Functions

- Microphone (Audio) control
  - Gain
    - How loudly you need to talk to be heard

5-3

301

Transmitter Controls and Functions

Microphone (Audio) control

- Speech Compressor or Speech Processor
  - Compacting your speech into a narrow frequency range to enhance "punch"

302

Transmitter Controls and Functions

- Microphone (Audio) control
  - Too much gain or compression can cause problems
    - Splatter
    - Over-deviation
    - Over-modulation

303

Transmitter Controls and Functions

- Automatic Level Control (ALC)
  - Automatically limits transmitter drive (output level) to prevent problems associated with too much gain or compression
- Also can control external power amplifier operation

304

Transmitter Controls and Functions

- Transmission on/off (not power)
  - Push-to-Talk (PTT)
  - Voice-Operated Transmission (VOX)
    - VOX Gain
    - VOX Delay
    - Anti-VOX
  - Key Jack

305

Transmitter Controls and Functions

Microphones
- Hand mikes
- Desk mikes
- Speaker-mikes
- Headsets or boom-sets
- Internal mikes

- Speak across the mike, not into the mike

306

Transmitter Controls and Functions

- Morse Keys
  - Straight
  - Semi-automatic (Bug)
  - Electronic keyer, paddle

307

Receiver

Receiver Controls and Functions

- AF Gain or Volume
  - Controls the audio level to the speaker or headphones
- RF Gain or Sensitivity
  - Controls the strength of radio signal entering the receiver's detector
  - Used to limit (attenuate) very strong local signals
  - Usually operated in the full-open position

309

Receiver Controls and Functions

- Automatic Gain Control (AGC)
  - Automatically limits the incoming signals during signal (voice) peaks
    - Prevents peaks from capturing the receiver and limiting reception of lower level portions of the incoming signal
  - Fast setting for CW
  - Slow settings for SSB and AM
  - Not used in FM because of the type of signal used in FM

310

Recipe for a Transceiver

- Take -
  - A Receiver and
  - A Transmitter and
  - Put them in the same box, and
  - Share common controls and circuits (mix well)
- You have a Transceiver

311

Single Band Transceiver

Multi-Band Tranceiver

Transceiver Controls and Functions

- Main tuning dial (both TX and RX)
  - Controls the frequency selection via the Variable Frequency Oscillator (VFO)
  - Could be an actual dial or key pad or programmed channels

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Transceiver Controls and Functions

- Main tuning dial (both TX and RX)
  - Variable frequency step size (tuning rate, resolution)
  - Could have more than one VFO (control more than one frequency at a time)

315

Transceiver Controls and Functions

- Mode Selector (both TX and RX multi-mode rigs)
  - AM/FM/SSB (LSB or USB)
  - CW
  - Data (RTTY)
- Could be automatic based on recognized band-plan

Transceiver Controls and Functions

- Reception and Transmission Meter
  - In transmit indicates output power or ALC or other functions as selected by switch setting
- In receive indicates signal strength
  - In "S" units S1 through S9 – S9 is strongest
  - Also have dB over S9 for very strong signals

Power Amplifier

Equipment

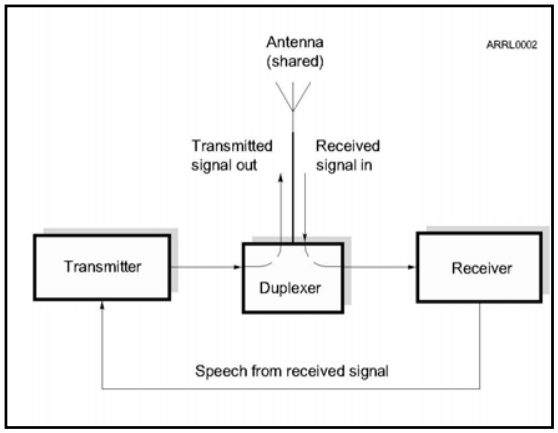
Repeaters

What is a Repeater?

- Specialized transmitter/receiver interconnected by computer controller
- Generally located at a high place

What is a Repeater?

- Receives your signal and simultaneously re-transmits your signal on a different frequency
- Dramatically extends line-of-sight range, If both users can "see the repeater's antenna"



A Little Vocabulary

Simplex

- Transmitting and receiving on the same frequency
- Each user takes turns to transmit
- Is the preferred method if it works

323

A Little Vocabulary

Duplex

- Transmitting on one frequency while simultaneously listening on a different frequency
- Repeaters use duplex

324

A Little Vocabulary

Duplex

Output frequency – the frequency the repeater transmits on and *you listen* to

Input frequency – the frequency the repeater listens to and *you transmit* on

Things to Know to Use a Repeater

- Output frequency
- Frequency offset
  - and therefore the input frequency
- Repeater access tones (if any)

Repeater Output Frequency

- Repeaters are frequently identified by their output frequency
  - "Meet you on the 443.50 machine."
    - Here the specific frequency is used
  - "Let's go to 94."
    - Here an abbreviation for a standard repeater channel is used meaning 146.94 MHz
  - "How about the MVARC repeater?"
    - Here the repeater is referenced by the sponsoring club name

Standard Repeater Frequency Offset

- The shift or offset frequencies are standardized to help facilitate repeater use
- There are + and – shifts depending on the band plan
- Different bands have a different standardized amount of shift

Repeater Frequency Offset

Standard Repeater Offsets by Band

Band	*Offset*
10 Meters	–100 kHz
6 Meters	Varies by region: –500 kHz, –1 MHz, –1.7 MHz
2 Meters	+ or -600 kHz
1.25 Meters	–1.6 MHz
70 cm	+ or -5 MHz
902 MHz	12 MHz
1296 MHz	12 MHz

Repeater Access Tones

- Sometimes multiple repeaters on the same frequency pair can be accessed at the same time
- To preclude unintentional access, many repeaters require a sub-audible tone be present before the repeater controller will recognize the signal as a valid and turn on

Repeater Access Tones

- These tones are called by various names (depending on equipment manufacturer)
  - CTCSS – Continuous Tone Coded Squelch System
  - PL
  - Privacy codes or tones

331

Repeater Access Tones

- Access tones are usually published along with repeater frequencies
- Could also be announced when the repeater identifies -"PL is 141.3"
- Tones are generally programmed into the radio along with frequency and offset

332

K4US Repeater Access

- 146.655 (-)
- PL 141.3

333

Repeater Controller

Computer that controls repeater

- Sends Repeater ID (callsign)
- Time-out protection
- Courtesy tone
- Auto Patch
- DTMF pad test

334

Repeater Controller

- Station ID - Morse or voice
  - Same ID requirements as you have
  - Every 10 minutes
- Time-out protection
  - Sometimes called the alligator
  - Protects against continuous transmission in the event of a stuck PPT or long winded hams

335

Repeater Controller

- Courtesy tone – Wait for the tone before transmitting
- Repeater timer – limits a single transmission to 3 minutes
- Press 9-1-1 for Alexandria PD/EMS
- Press 555 to test your tone pad
- Press 725* for record - playback
- Many other functions

336

K4US Repeater

- When you use any of these (sending tones only) you still must ID at the end – otherwise it is an **unidentified** transmission
  - 911 for Alexandria PD/EMS
  - 555 to test your tone pad
  - 725* for record - playback

337

George Washington National Masonic Memorial

338

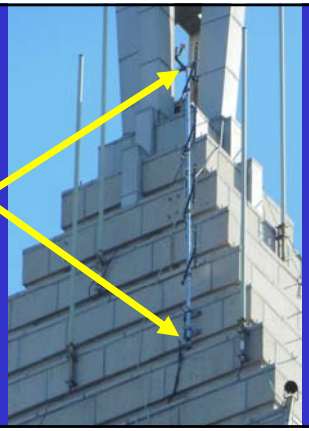
Looking down from base of antenna

339

At the base of the antenna looking up

340

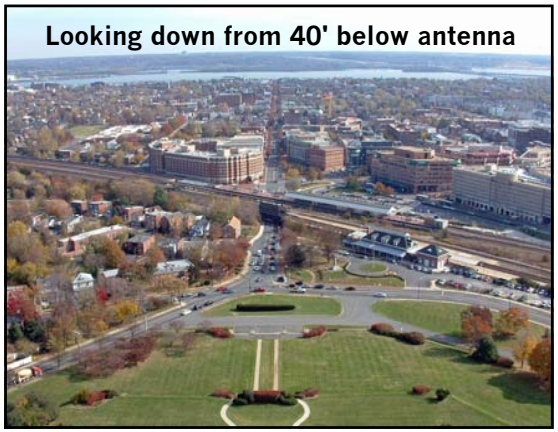
Mast is 20 feet long



341

342

Looking down from 40' below antenna



Questions?

Chapter 5.2
Equipment

Digital Modes

5-9

Data (Digital) Modes

- There are several different ways to send data over amateur radio
- Here is a brief overview

Yes, CW using Morse Code is a Digital Mode

5-9

Digital Modes

- HF using SSB
  - RTTY - 5 bit Baudot
  - Winlink 2000 (Pactor, Winmor)
  - Keyboard to keyboard - PSK31, MFSK
- VHF & UHF
  - Packet AX.25
  - Winlink 2000 (B2F)

Data Modes

- Connecting computers via ham radio
  - Some systems use radio to connect to Internet gateways
- The bulk of the work is done by specialized modems or computer software/sound card
  - Terminal Node Controller (TNC)
  - Multiple Protocol Controller (MPC)

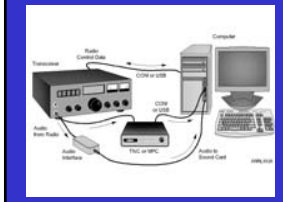
349

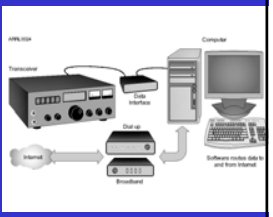
TNC – MPC

- Provide digital interface between computer and radio
  - Package the data into proper format
  - Convert digital data into audio tones representing 1s and 0s of digital data
  - Send/receive tones to transceiver
  - Control the transceiver

350

Data Station Setup





351

Questions?

Chapter 5.3

Equipment

Power Supplies and Batteries

5-15

Power Supplies

- Most modern radio equipment runs on 12 volts DC
- Household current is 120 volts AC
- Power supplies convert 120 volts AC to 12 volts DC
  - 13.8 volts DC is the common voltage you will see
  - This is the charging voltage for motorized vehicles

Power Supply Ratings Voltage and Current

- **Continuous** duty – how much current can be supplied over the long term
- **Intermittent** duty – how much surge current can be supplied over the short term
- **Regulation** – how well the power supply can handle rapid current changes

Types of Power Supplies

- **Linear**
  - Transformers
  - Heavy (physically)
  - Heavy duty current
  - Expensive
- **Switching**
  - Electronics instead of transformers
  - Light weight and small
  - Not as robust
  - Less expensive

May be source of RFI

Inverters and Generators

- Inverters convert DC into AC
  - Square, triangle, sine-wave inverters
- Generators create AC
  - Gas powered
  - Various voltage and current ratings
  - Special precautions

Batteries

- Create current through a chemical reaction
  - Made up of individual cells (approximately 1.5 volts per cell) connected in series or parallel

5-16

358

Batteries

- Battery types
  - Disposable
  - Rechargeable
  - Storage
- Power capabilities rated in Ampere-hours
  - Amps X time

359

Battery Charging

- Some batteries can be recharged, some cannot
- Use the proper charger for the battery being charged
- Batteries will wear out over time

360

Battery Charging

- Best if batteries are maintained fully charged
  - Over-charging will cause heating and could damage the battery
- Some batteries (lead-acid) will release toxic fumes during charging so require ventilation

361

Handheld Transceivers

- Single, dual and multi-band versions (with increasing cost and complexity)
  - Some have expanded receiver coverage (wide-band receive)
- Very portable and self-contained
  - Internal microphone and speaker
  - Rubber duck antenna
  - Battery powered

362

Nice to have handheld accessories

- Extra battery packs
- Drop-in, fast charger
- Extended antenna
- External microphone and speaker
- Headset

363

Chapter 5.4

Radio Frequency Interference

- Also known as RFI
- May be man made

5-19

Radio Frequency Interference

- Strong signals
- Automobile ignition noise
- Electric Welding
- Fluorescent lights - Grow lights
- Air Cleaners
- Power Lines
- Computers
- Fare Card Machines

5-19

Radio Frequency Interference

- Un-wanted, un-intentional signals from some electronic device that interferes with radio wave reception
- You can prevent creating RFI by operating your transmitting equipment properly

RFI Mitigation

- Filters attenuate (reduce) interfering signals – but do not totally eliminate them
- Types
  - High Pass
  - Low Pass
  - Band Pass

367

RFI Mitigation

- Ferrite - the RFI Buster
- Snap on ceramic magnets

368

Filters

- High pass –generally on the receive side
- Low pass – generally on the transmit side
- Band-pass – used within most radio equipment

369

Types of RFI

- Direct detection – offending signals get into the electronics circuits to cause interference
- Overload – strong signal that overwhelms the weaker, wanted signal
- Harmonics – even multiples of the offending signal that coincided with the wanted signal

370

Cable TV Interference

- Usually the result of broken shielding somewhere in the cable
  - Loose connections
  - Broken connections
  - Corroded connections
- Usually solved by proper cable maintenance by cable supplier
  - If the subscriber is a legitimate subscriber

371

Noise Sources

- Electrical arcs (motors, thermostats, electric fences, neon signs)
- Power lines
- Motor vehicle ignitions
- Motor vehicle alternators
- Switching power supplies
- Computers, networks, TV sets

372

Dealing with RFI

- Make sure you operate your equipment properly
- Eliminate interference in your own home first

373

Dealing with RFI

- Strong signals may overwhelm a receiver's ability to reject them. This is called fundamental overload. Symptoms include:
  - Severe interference on all channels of a TV or FM receiver, or
  - an amateur may hear bursts or fragments of conversations when the strong signal is present

374

Dealing with RFI

- If the interfering frequency is similar to that of the desired signal, it may not be possible to remove the transmitted signal with a high-pass or a low-pass filter because the desired signal will be removed as well.

375

Dealing with RFI

- In cases like these, such as when a TV receiver is overloaded by a nearby 2-meter transmitter, a notch filter is required that removes a specific band of frequencies. The notch filter is installed at the receiver and is used to reduce the interfering signal to a level that can be handled properly by the receiver.

376

Dealing with RFI

- Take interference complaints seriously
- Make sure that you're really not the cause (demonstrate that you don't interfere within your own home)

377

Dealing with RFI

- Offer to help eliminate the RFI, even if you are not at fault
- Consult ARRL RFI Resources for help and assistance

378

What the Rules Say

- RFI from and to unlicensed devices is the responsibility of the users of such devices
- Bottom line – if your station is operating properly, you are protected against interference complaints

379

What the Rules Say

BUT – be a good neighbor because they may (probably) not be familiar with Part 15 rules and regulations

380

Questions?

381

Chapter 6

Communicating with other hams

Contact Basics

Band Plans

Making a Contact

6-1

Typical Telephone Conversation

- Greeting
- Identify who is participating
- Exchange information, generally taking turns
- Salutations
- End the conversation

6-1

Typical Ham Contact (QSO)

- Greeting
- Identify who is participating
- Exchange information, generally taking turns
- Salutations
- End the conversation

Radio Manners

- Speak clearly and distinctly
- It is a GIANT party line, select topics accordingly
- Shared use of frequencies

385

Radio Manners

- Signal Reports
- Power level
- Location

386

Signal Reports

- RST
  - **R**eadability (1-5)
  - **S**trength (1-9)
  - **T**one (CW only 1-9)
  - "Your RST is 58"

6-3

387

Readability (1-5)

1 - Unreadable
2 - Barely readable, occasional words distinguishable
3 - Readable with considerable difficulty
4 - Readable with practically no difficulty
5 - Perfectly readable

388

Strength (1-9)

1 - Faint signals, barely perceptible
2 - Very weak signals
3 - Weak signals
4 - Fair signals
5 - Fairly good signals
6 - Good signals
7 - Moderately strong signals
8 - Strong signals
9 - Extremely strong signals

389

Tone (CW & Digital only 1-9)

1 - Sixty cycle AC or less, very rough and broad
2 - Very rough AC, very harsh and broad
3 - Rough AC tone, rectified but not filtered
4 - Rough note, some trace of filtering
5 - Filtered rectified AC but strongly ripple-modulated
6 - Filtered tone, definite trace of ripple modulation
7 - Near pure tone, trace of ripple modulation
8 - Near perfect tone, slight trace of modulation
9 - Perfect tone, no trace of ripple or modulation of any kind

390

Q Signals

- Shorthand from the telegraphy and CW world, some migrated to voice
- Followed by question mark is asking
- No question mark is answer or statement

6-5

391

Some Q Signals

- QTH ? "Where are you located"
- QTH "Alexandria Va"
- QSY up 2 "move up 2 Khz to a clearer frequency"
- QRZ ? "Who is calling me"
- Slang: QLF - please send with your Left Foot - (not on test)

392

Radio Manners

- Ham radio is self-regulated
  - ARRL Official Observers
- Logging
- QSL's
  - Awards Program

393

Band Plans

- A band plan is a way of organizing the use of radio frequencies
  - Formal and legal plan
  - Informal – gentleman's agreement

6-9

394

Operating Dos and Don'ts

- Use CQ versus "monitoring"
- Use phonetics
- Taking turns and breaking-in
- Station identification
- Using repeaters
- Using simplex

395

Radio Manners

Appropriate topics

- Indecent & obscene **PROHIBITED**
- Try to stay clear of provocative subjects: **politics, religion, sexual**
- Weather and radio equipment are frequently good topics

6-4

396

Using Repeaters

- Offset
- Access tones
- How to ID
- Linked Repeaters
- Autopatch
- Open/Closed

6-15

Digital and Internet

- Echolink
- IRLP
- WinLink
- D-Star

6-19

Questions?

Chapter 6

Communicating with other hams

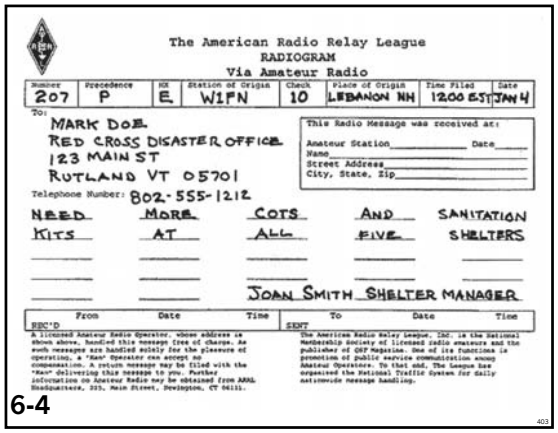
Nets

Nets

- Net is short for "Network"
  - Evolved over the years of radio to share and exchange information in an organized and efficient way with accuracy
- Social Nets
- Traffic Nets
- Emergency and Public Service Nets

Traffic Nets

- Traffic refers to formal messages that are relayed via ham radio
- Formal structure to ensure accuracy – National Traffic System (NTS)
  - Procedures
  - Accountability



The American Radio Relay League
RADIOGRAM
Via Amateur Radio

Number	Precedence	HX	Station of Origin	Check	Place of Origin	Time Filed	Date
207	P	E	W1FN	10	LEBANON NH	1200 EST	JAN 4

TO:
MARK DOE
RED CROSS DISASTER OFFICE
123 MAIN ST
RUTLAND VT 05701
Telephone Number: 802-555-1212

This Radio Message was received at:
Amateur Station _____ Date _____
Name _____
Street Address _____
City, State, Zip _____

NEED MORE COTS AND SANITATION
KITS AT ALL FIVE SHELTERS

JOAN SMITH SHELTER MANAGER

REC'D From	Date	Time	SENT To	Date	Time

A licensed Amateur Radio operator, whose address is shown above, handled this message free of charge. As such messages are handled solely for the pleasure of operating, a "Ham" operator can accept no compensation. A return message may be filed with the "Ham" delivering this message to you. Further information on Amateur Radio may be obtained from ARRL Headquarters, 225, Main Street, Newington, CT 06111.

The American Radio Relay League, Inc. is the National membership society of licensed radio amateurs and the publisher of QST Magazine. One of its functions is promotion of public service communication among Amateur Operators. To that end, The League has organized the National Traffic System for daily nationwide message handling.

6-4

403

Emergency and Public Service Nets

- Public Service Nets – training for emergency nets
  - Training for ham operators as well as supported emergency managers
- Emergency Nets

404

Net Structure

- Net Control Station (NCS)
  - Traffic cop that controls the flow of information
- Check-in and check-out procedures
- Communications discipline vital
  - Learn and follow procedures
  - Speak only when directed, and only to whom directed
  - Follow through with your commitments

405

Amateur Radio Technician Class Licensing Course
Boy Scout Venturing Crew 80, Alexandria, VA
First Christian Church
Mount Vernon Amateur Radio Club (MVARC)

Day 4 Starts Here

January 20, 2015

406

Questions?

Something you don't understand?

What is bothering you?

407

Chapter 6

Communicating with other hams

Emergency Communications

6-24

408

Supporting Emergency Operations

- One of the pivotal reasons for the existence of Amateur Radio
- You will be licensed communicators
  - Get involved and use what you have learned
- Know where you fit in the overall emergency management team

409

EMCOMM Tips

- Don't become part of the problem
- You are a communicator, not a decision or policy maker
- Don't give out unauthorized information
- Know your abilities and limitations- keep yourself safe
- Follow radio discipline and net procedures
- Protect personal information-ham radio communications is a "party line"

410

EMCOMM Training

- If you are going to participate in EMCOMM: get training
- Take EMCOMM courses
  - ARRL EMCOMM Courses 1, 2, and 3
  - NIMS and FEMA courses

411

EMCOMM

- Actively participate in EMCOMM activities
  - Nets
  - Public service activities
  - Attend community meetings and get involved in your community

412

EMCOMM Organizations

- Radio Amateur Civil Emergency Service (RACES)
  - Supports civil emergencies
  - National in scope

413

EMCOMM Organizations

- Amateur Radio Emergency Service (ARES)
  - Local and regional in scope
  - Supports non-governmental agencies supported
  - ARRL sponsored

414

Emergency Declarations

- FCC may declare a Temporary State of Communications Emergency
- Includes details of conditions and rules to be followed
- Specifics communicated through web sites and ARRL bulletins, the NTS, and on-the-air
- Avoid operating on restricted frequencies unless engaged in relief efforts

415

Making and Answering Distress Calls

- Rule #1 – speak in plain language!
- Mayday (voice); SOS (Morse code)
- Identify
- Give location
- State the situation
- Describe assistance required
- Provide other important information

416

Tactical Communications

- Tactical Call Signs
  "Fire Command", "Main Street School Shelter", "Incident Commander"
  - Facilitate communications
  - Location or function specific
  - Transcends operator changes
- FCC ID rules still apply
  Your FCC Call Sign - every 10 minutes and at end

417

Emergency Equipment

- "Go-kits"
  - Portable ham radio equipment
  - Emergency power sources
  - Personal survival supplies and equipment

418

Questions?

419

Chapter 6

Communicating with other hams

Special Modes and Techniques

6-29

420

Awards

- DXCC
  - Contacting 100 different countries and/or entities
- WAS
  - Contacting 50 states
- VUCC
  - Contacting 100 grid squares on VHF/UHF

421

Special Events

- Special Event stations are set up to commemorate some significant local event
- Usually stations are demonstration stations set up for public display
- Commemorative certificates are awarded for contacting the stations

422

Special Events

- Call Signs = 1 by 1 W1J K3D

Which type of call sign has a single letter in both its prefix and suffix?

A. Vanity
B. Sequential
C. Special event
D. In-memoriam

T1C01

423

Contests

- Field Day - June
- Sweepstakes - November
- QSO Parties
- CQ DX Contest

- Contest Corral (a list in QST)

424

Amateur Satellites

- OSCAR
  - Orbiting Satellites Carrying Amateur Radio
- Modes
  - FM
  - Analog (SSB and CW)
  - Digital
- International Space Station

6-30

425

What satellite contacts sound like

- FM contact

- SSB contact

Very loud

- ISS contact

426

Digital Techniques

- Radio Teletype (RTTY)
  - Single letters sent as they are typed
- AMTOR and PACTOR
  - Small grouping of letters sent with error correction
- Packet and Packet Networks
  - Groups (packets) of collected data sent with error correction and automatic forwarding
- PSK31
  - Different modulation technique

What Digital sounds like

- RTTY
- AMTOR
- PACTOR
- PACKET
- PSK31

Digital Mode Modulation Techniques

- Digital means two states: ON and OFF
  - Digital code is a sequence of ON and OFF states or 1's and 0's
  - The letter "A" is 0100 0001 (41 hexadecimal or 65 decimal)
- When two audio tones are used to represent the ON and OFF states it is called Frequency Shift Keying (FSK)
- When changing phase states are used to represent ON and OFF states it is calls Phase Shift Keying (PSK)

Communicating Digitally

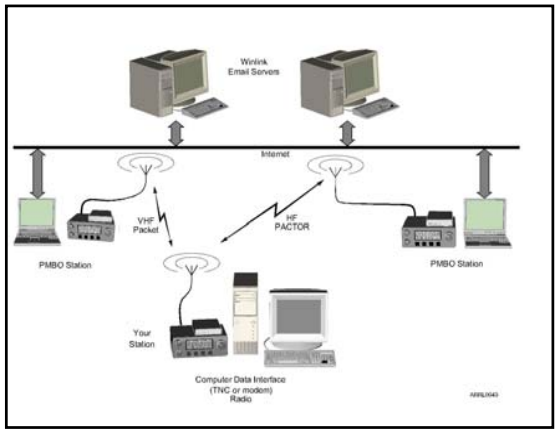
- Keyboard-to-keyboard
  - Live exchange using computer keyboards
  - Digipeaters extend range

430

Store and forward networks

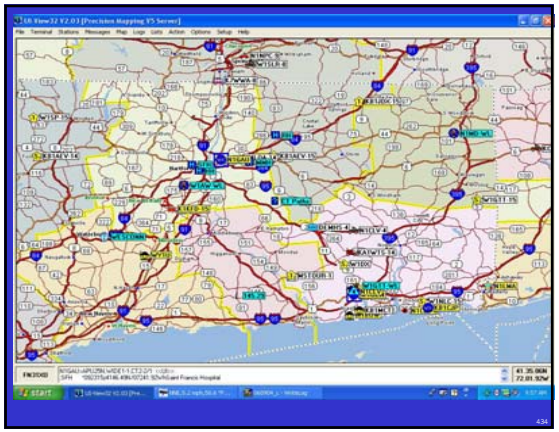
- Packet networks, bulletin boards
  - Digipeaters make up the backbone of packet networks
- Internet-Radio connections
  - WinLink
  - Radio connections are Internet Gateways

431



APRS

- Automatic Position Reporting System (APRS)
- Packet based Global Positioning System (GPS) position reporting
  - Uses a packet-like digipeater system to create an APRS network (also Internet connected)



Video

Slow Scan TV (SSTV)
- Sending snap-shot pictures

Amateur TV (ATV)
- Similar to commercial TV

- What SSTV sounds like

Other Special Modes

- Meteor Scatter
  - Reflecting radio signals off of the ionized trail left by meteors
- Moonbounce
  - Reflecting radio signals off the surface of the moon

436

Other Special Modes

- Radio Control (RC)
  - Telecommand
  - 50 MHz band

6-32

437

Questions?

438

Chapter 7.1

Licensing Regulations

Licensing Terms

Working with the FCC

Bands and Privileges

International Rules

Call Signs

7-1

Definitions

- Amateur Service – non pecuniary interest (private and personal, non commercial)
- Amateur Operator – the person holding authorization (license) to operate a amateur radio station
- Amateur Station – equipment capable of transmitting on frequencies authorized for Amateur Service

License Term and Renewal

- The license is free
- The license is good for 10 years
  - Renewable within 90 days of expiration
- Personal identification information is required
  - Federal Registration Number or
  - Tax ID (social security number)
  - Current Mailing Address

The Amateur License

- No age limit or citizenship restrictions
  - One exception – no foreign representatives
- License actually contains two parts
  - Operator License
  - Station License (the Call Sign)
- Three classes of operator privileges: Tech, General, Extra

Examinations

- Preparation
  - Study the content
  - Question Pool
- Taking the exam
  - Proctored exam
  - Multiple choice
- Volunteer Examiners (VEs)
- Volunteer Examiner Coordinators

Responsibilities of Licensure

- Prevent unauthorized operation of your station
- Provide personal information as required – keep a current mailing address on file
- Make your station available for FCC inspection upon request

What can you do with a Technician Class License?

- Use the minimum power required to communicate
- Up to 1500 Watts Peak Envelope Power (PEP)
  - Will generally require an external amplifier
- Some special cases where power is restricted

Chapter 7.2

Licensing Regulations

Licensing Terms

Working with the FCC

Bands and Privileges

International Rules

Call Signs

7-9

Licensing Authority

- Federal Communications Commission
  - Located in Gettysburg, PA
- Amateur Radio operations covered by FCC rules published in Part 97 of Title 47 – Code of Federal Regulations

7-1

FCC ULS Web Site

- www.wireless.fcc.gov/uls
  - Register for on-line access to your license information
  - Make changes to your address and other information
  - Renew your license
  - Search for other station information

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Chapter 7.3

Licensing Regulations

Licensing Terms
Working with the FCC
Bands and Privileges
International Rules
Call Signs

What can you do with a Technician Class License?

- Frequency Privileges
  - Band versus frequency

Given one we can calculate the other:

$$Band = \frac{300}{Freq(MHz)}$$

Band in meters, Freq in MHz

450

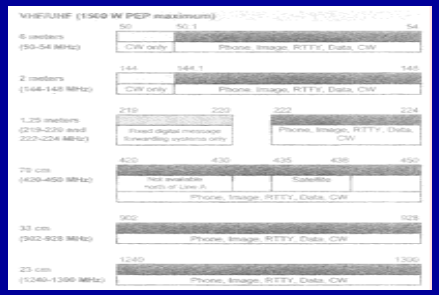
VHF and UHF Technician Amateur Bands
ITU Region 2

Band (Wavelength)	*Frequency Limits*
VHF Range	
6 meters	50 - 54 MHz
2 meters	144 - 148 MHz
1.25 meters	219 - 220 MHz
1.25 meters	222 - 225 MHz
UHF Range	
70 centimeters	420 - 450 MHz
33 centimeters	902 - 928 MHz
23 centimeters	1240 - 1300 MHz
13 centimeters	2300 - 2310 MHz
13 centimeters	2390 - 2450 MHz

7-10

451

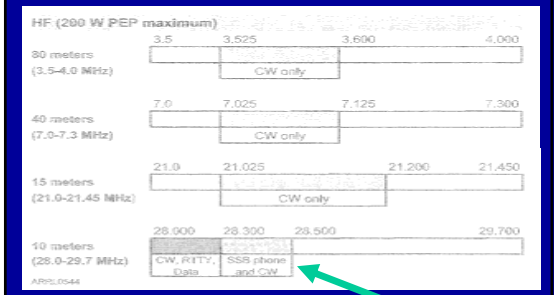
Tech VHF/UHF 1500w. max



7-10

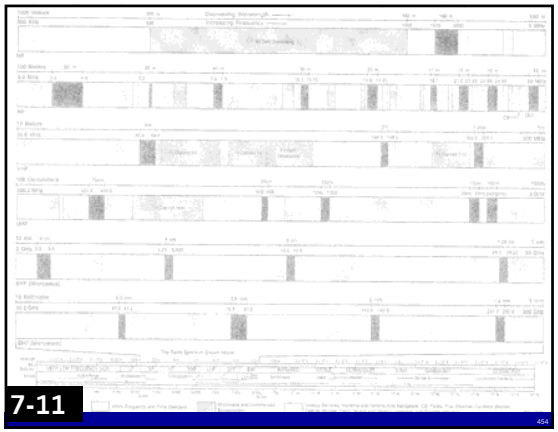
452

Tech HF 200 w. max



7-13 28.3-28.5 Mhz 200 w

453



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- Emission Privileges

Amateur Emission Types

Emission	*Description*
CW	Morse code telegraphy
Data	Computer-to-computer communication modes, usually called *digital modes*
Image	Television (fast-scan and slow-scan) and facsimile or fax
MCW	Tone-modulated CW. Morse code generated by keying an audio tone
Phone	Speech or voice communications
Pulse	Communications using a sequence of pulses whose characteristics are modulated in order to carry information.
RTTY	Narrow-band, direct-printing telegraphy received by automatic equipment, such as a computer or teleprinter.
SS	Spread-spectrum communications in which the signal is spread out over a wide band of frequencies
Test	Transmissions containing no information

7-12

455

Emission Privileges

CW

Data

Image

MCW

Phone

Pulse

RTTY

SS

Test

456

Primary & Secondary Allocations

- Some authorized amateur frequencies are shared
  - Primary Users
  - Secondary Users
- Navigation, Research ...

7-14

457

Band Plans

- Good Practice
- Voluntary
- Different frequencies for different activities
- Don't use CW in the Phone segment

7-15

458

Repeater Coordination

- Frequency Coordinator
  - Fixed Repeater Input frequencies
  - Fixed Repeater Output frequencies
  - Access control tones
  - Distance separation

7-15

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Chapter 7.4

Licensing Regulations

- Licensing Terms
- Working with the FCC
- Bands and Privileges
- International Rules
- Call Signs

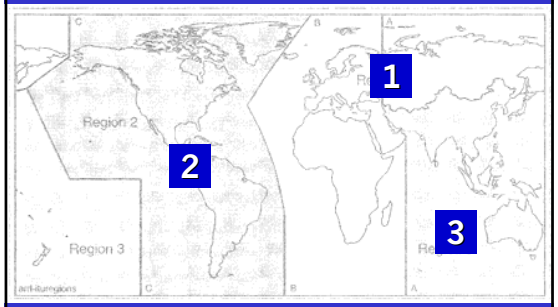
International Rules

- The ITU
- Regions
- Reciprocal Operating Authority
- IARP (N and S America)
- CEPT (most of Europe)

Amateur Radio - Internationally

- International Telecommunications Union (ITU)
  - Regions 1, 2, and 3
- CONUS hams are in Region 2
- Reciprocal Operating Authorization
- There are times when there are restrictions on certain countries that we can contact

ITU Regions



7-17

Third Party Rules

- We will discuss these shortly -- operating regulations
- There are different station identification requirements for third party communications

Chapter 7.5

Licensing Regulations

Licensing Terms
Working with the FCC
Bands and Privileges
International Rules
Call Signs

7-19

US Amateur Radio Call Signs

- Other Radio Services have different formats
- Prefix, Number, Suffix

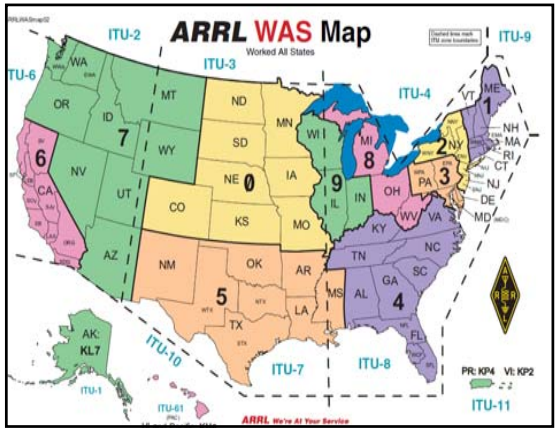
W	3	BSA
WA	4	USB
K	4	BSA
KG	4	RKE

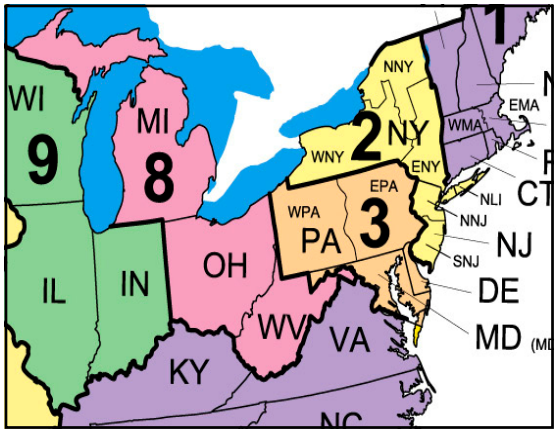
466

Call Signs

- US call signs begin with: K, N, W, and A
- US call sign districts: 0-9
- Other nations have different prefixes

467





US Amateur Radio Call Signs

- **Are unique in the world**

Australia *AX*, *VH–VN*, and *VZ*
Canada *CF–CK*, *CY–CZ*, *VA–VG*, *VO* (Newfoundland and Labrador), *VX–VY*, *XJ–XO*
China *B*, *XS*, *3H–3U*
Indonesia *JZ*, *PK-PO*, *YB-YH*, *7A-7I*, *8A-8I*
Japan *JA–JS*, *7J–7N*, *8J–8N*
Mexico *XA–XI*, *4A–4C*, *6D–6J*
Russia *R*, *UA–UI*
Sweden *SA–SM*, *7S*, *8S*
United Kingdom *G*, *M*, *VS*, *ZB–ZJ*, *ZN–ZO*, *ZQ*, *2*
United States *K*, *W*, *N*, *AA–AL*.

Not on the test

470

You may hear this on the air

Call Signs

- Portable – operating away from primary station location
- If in the different call sign district add:
  - "portable 6" if voice
  - /6 if Morse code or digital
  - Not required just nice to do
- If recent up-grade add "AG" or "AE"

Special Call Signs

- **Club**
- **Special Event** (1x1)

W1J October 20, 2000 to October 22, 2000 PIONEER VALLEY BSA JOTA

- **Vanity Call Signs**

There is a FCC fee every 10 years

Questions?

Chapter 8.1
Operating Regulations

Control Operators
Identification
Interference
Third-Party Communications
Remote and Automatic Operation
Prohibited transmissions

8-1

Control Operator Responsibilities

The FCC's primary concern is that transmissions are made only under the control of a licensed operator

- **Control Operator** – the licensed amateur responsible for making sure transmissions comply with FCC rules

475

Control Operator

- Must have a valid **FCC** issued amateur radio **license**
- Station must operate within the **authorization** of the control operator's license
- Control operator **must be present** at the control point of the station (the on-off switch) or **remotely connected by a control link**

476

Guest Operations

- Unlicensed people can use ham radio but only when a control operator is present
  - The control operator is solely responsible for station operation
- Licensed guests can use the ham radio
  - both the control operator and the guest ham are responsible for station operation

477

Chapter 8.2
Operating Regulations

Control Operators
Identification
Interference
Third-Party Communications
Remote and Automatic Operation
Prohibited transmissions

8-3

Station Identification

- Normal ID
  - Say your call sign every ten minutes during and at the end of the contact
- Use of Tactical Call Signs

Does not substitute for proper station ID

8-3

Every 10 minutes during communications ***and*** at the end of each communication (not each transmission)

ID is not required at each over or at the beginning

Be aware of 3rd party rules

Station Identification

- Ham Guests
  - If higher license class and use higher class privileges

Guest's call followed by owners call

"This is K4AB KG4XYZ"

Extra General

Repeaters, Satellites, ISS

- Repeaters must ID using the same 10 minute rule
  - Can be voice or CW (at 20 WPM or less)
- Satellites and ISS have special rules

Repeaters, Satellites, ISS

- Special event calls (ex. W4J)
  - Normal club call or control operator call given once per hour

Chapter 8.3
Operating Regulations

Control Operators
Identification
Interference
Third-party Communications
Remote and Automatic Operation
Prohibited Transmissions

8-7

Types of Interference

- QRN
  - Natural interference (thunderstorms)
  - Man-made (appliances and power lines)
- QRM
  - Interference from nearby signals
  - Other hams or other users of the frequencies

8-6

Prevent Interference

Control operators should prevent interfering with other users of the frequencies

Preventing Interference

- Use common sense and courtesy
- Keep equipment in proper operating order
- **No one owns a frequency**, be a good neighbor and share
- Yield to special operations and special circumstances

487

Interference

- **Harmful**
  - Interference that is disruptive but not intentional
  - Deal with it as best you can and help others avoid harmful interference

488

Willful Interference

Intentionally causing interference

- This becomes a legal and law enforcement issue
- This is rare and there are procedures to deal with this (ARRL Official Observers can help)

489

Chapter 8.4
Operating Regulations

Control Operators
Identification
Interference
Third-Party Communications
Remote and Automatic Operation
Prohibited transmissions

8-9

Third-party Communications

- Third-party means that a non-ham is involved in communication via ham radio
  - Could be actually speaking on the air
  - Could be passing a message on behalf of the non-ham

8-8

Third-party Communications

- Two situations - with different rules
  1. Within the US
  2. Communication that crosses international borders

Third-party within US

- No special rules
- Make sure the message is non-commercial in nature

493

Third-party Across Borders

- Make sure that third-party agreement exists
  - Check for current third-party agreements from FCC sources if in doubt
  - You might be surprised at the countries that we do not have third-party agreements with

494

Third-party Across Borders

- During station identification say both station's call signs

  "DL2XYZ this is K4US"

495

Chapter 8.5
Operating Regulations

Control Operators
Identification
Interference
Third-Party Communications
Remote and Automatic Operation
Prohibited transmissions

Remote and Automatic Control

- Some stations, repeaters and beacons operate without the control operator physically present at the control point
- These stations must still comply with control operator stipulations
  - Local
  - Remote
  - Automatic

Chapter 8.6
Operating Regulations

Control Operators
Identification
Interference
Third-Party Communications
Remote and Automatic Operation
Prohibited transmissions

Prohibited Transmissions

- Unidentified transmissions
  (not giving your call sign)
- False or deceptive signals
  (using someone else's call sign)
- False distress or emergency signals
  (fake calls for help)
- Obscene or indecent speech
  (up to interpretation)
- Music

8-11

499

No Business Communications

- You can not make a profit through the use of transmissions made via ham radio
- The exceptions are teachers using ham radio in their classrooms and certain emergency drills

500

No Encrypted Transmissions

- Encryption involves encoding information for transmission that must be decoded upon reception to interpret the information
- Encryption is okay if:
  - Coding is open source
  - Intention is not to hide the message or deceive

501

No Broadcasting

- Broadcasting is sending one-way transmissions with no expectation of getting a response
  - News, Music
- Exceptions
  - Code practice
  - Ham radio related bulletins
  - Re-transmission of shuttle communications

Special Circumstances

- Ham communication is generally intended for hams
- Emergencies and critical situations create special circumstances
- Special commemorative events may qualify as special circumstances
- Normal rules return when the situation returns to normal

503

Questions?

504

Chapter 9

Electrical and RF Safety

Electrical Safety

RF Exposure

Mechanical

9-1

505

Electrical Safety

- Avoiding contact is the most effective way of practicing electrical safety
- Most modern radio equipment uses currents that are not as dangerous as older equipment but precautions still must be taken

9-1

506

Electrical Injuries

- Shocks
- Burns
- Even small currents can cause problems

Effects of Electric Current in the Human Body

Current	Reaction
Below 1 milliampere	Generally not perceptible
1 milliampere	Faint tingle
5 milliamperes	Slight shock felt; not painful but disturbing. Average individual can let go. Strong involuntary reactions can lead to other injuries.
6-25 milliamperes (women) 9-30 milliamperes (men)	Painful shock, loss of muscular control*; the freezing current or "can't let-go" range.
50-150 milliamperes	Extreme pain, respiratory arrest, severe muscular contractions. Death is possible.
1000-4300 milliamperes	Rhythmic pumping action of the heart ceases. Muscular contraction and nerve damage occur; death likely.
10,000 milliamperes	Cardiac arrest, severe burns; death probable

* If the extensor muscles are excited by the shock, the person may be thrown away from the power source.
Source: W.B. Kouwenhoven, "Human Safety and Electric Shock," Electrical Safety Practices, Monograph, 112, Instrument Society of America, p 93. November 1968.

9-2

507

Effects of Electric Current in the Human Body

Current	*Reaction*
Below 1 milliampere	Generally not perceptible
1 milliampere	Faint tingle
5 milliamperes	Slight shock felt; not painful but disturbing. Average individual can let go. Strong involuntary reactions can lead to other injuries.
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508

Mitigating Electrical Hazards

- **TURN OFF** power when working on equipment (inside the case)
- Make sure the equipment is **PROPERLY GROUNDED** and the circuit is protected by a fuse, breaker, etc.

509

Mitigating Electrical Hazards

- If power is required:
  - Remove jewelry
  - Avoid unintentional touching of circuitry
  - **Never bypass safety interlocks**
  - Capacitors hold a charge even when power is off
  - Storage batteries are dangerous when shorted

510

Mitigating Electrical Hazards

- **Use only one hand so your body does not complete a circuit**
- Leather shoes, dry floor

511

Respond to Electrical Injury

- **REMOVE POWER!**
  - Have ON/OFF switches and circuit breakers clearly marked
- Call for help
- Learn CPR and first aid

512

Electrical Grounding and Circuit Protection

- This is in your best interest
- In the home
- In the car

513

In the home

- Make sure your home is "up to code"
- Most ham equipment does not require special wiring or circuits
  - Use 3-wire power cords
  - Use circuit breakers, circuit breaker outlets, or Ground Fault Interrupter (GFI) breakers
  - Use proper size fuse or circuit breaker
  - Don't overload outlets

514

In the car

- Car batteries hold lots of energy – shorting a battery could cause a fire
- There are many good ways to do it safely

515

Do it SAFELY in the car

- Fuse positive and negative leads
- Connect radio's negative lead to where the battery ground connection is made – not to the battery
- Use grommets or sleeves to prevent chafing
- All metal in the car is not grounded, cars are as much plastic as metal

516

RF Exposure

- Proper Grounding
- Important for protection of
  - Equipment
  - People
  - Wires connected to the radio become part of the antenna - can radiate RF – RF can burn you

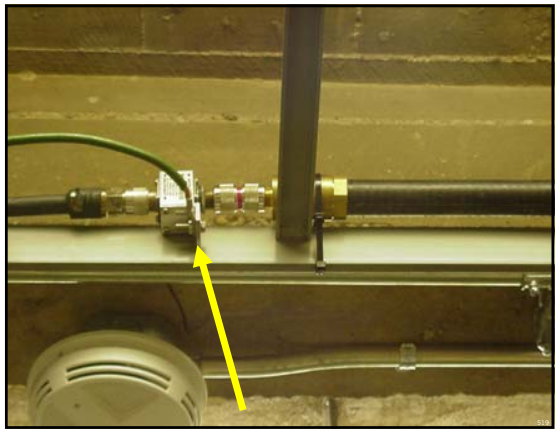
9-5

517

Lightening Safety

- Antennas are not struck more frequently than trees or tall structures
- Ground all antennas
- Use lightening arrestors
- Disconnect antenna cables and power cords during storms
- Disconnect telephone lines from computer modems

518



519

RF Exposure

- Exposure to high levels of RF can cause problems
- If equipment is operated properly, RF exposure is minimal and not dangerous
- RF energy can heat body tissues
  - Heating depends on the RF intensity and frequency

9-5

520

RF Intensity

- Power Density
  - Transmitter power
  - Antenna gain and proximity
  - Mode and duty cycle

521

RF Intensity

- Power Density
  - Actual transmitter power
    - Higher power is higher risk

522

RF Intensity

- Power Density
  - Antenna gain and proximity
    - Beam antennas focus available energy
    - Being physically close or standing in the beam direction increases risk

523

RF Intensity

- Power Density
  - Mode and duty cycle
    - The more time the power output is at a high level, the higher the risk
    - CW, Voice, RTTY

524

We are concerned about

- Where the antenna is located
- How close can people get to the antenna
  - Controlled Environment
  - Uncontrolled Environment

525

Antenna Proximity

- Controlled Environment
  - You know where people are standing in relation to your antenna and you can do something about it
  - More power is allowed because you can make adjustments if needed

526

Antenna Proximity

- Uncontrolled Environment
  - You have no idea or control of people near your antenna
  - Less power is allowed because you have to assume the worse case scenario

527

Mode and Duty Cycle

- The more time the transmitted power is at high levels, the greater the duty cycle, and the greater the exposure risk

528

Mode and Duty Cycle

Operating Duty Cycle of Modes Commonly Used by Amateurs

Mode	Duty Cycle	Notes
Conversational SSB	20%	1
Conversational SSB	40%	2
SSB AFSK	100%	
SSB SSTV	100%	
Voice AM, 50% modulation	50%	3
Voice AM, 100% modulation	25%	
Voice AM, no modulation	100%	
Voice FM	100%	
Digital FM	100%	
ATV, video portion, image	60%	
ATV, video portion, black screen	80%	
Conversational CW	40%	
Carrier	100%	4
Digital (PSK31, RTTY)	100%	

Note 1: Includes voice characteristics and syllabic duty cycle. No speech processing.
Note 2: Includes voice characteristics and syllabic duty cycle. Heavy speech processor employed.
Note 3: Full-carrier, double-sideband modulation, referenced to PEP. Typical for voice speech. Can range from 25% to 100%, depending on modulation.
Note 4: A full carrier is commonly used for tune-up purposes.

9-8

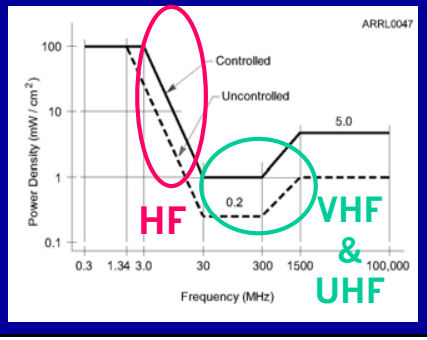
529

RF Exposure and Frequency

- Body parts are like antennas - absorb RF energy at certain frequencies (wavelengths) more efficiently
- RF exposure risk varies with frequency
  - More caution is required at some frequencies than others

530

Maximum Permissible Exposure



9-6

531

Physical Safety

- Mobile Installations
  - Secure all equipment
  - Location, location, location
- Antenna installation
  - Clear of trees and power lines
  - If it falls it won't hit anyone or cross power lines
- Tower climbing considerations

532

Questions?

533

Copyrights and Distribution

Practice Exams

- On Line
- CD based
- How did you do?
- What are you going to do this week?

February 14 Exam

- Please bring the following:
- 1) Picture ID or a DMV "child's ID" which looks like a drivers license.
  OR a parent with the same last name and address AND info that only a parent would have such as a birth certificate - parent ID IS NOT the preferred ID
- 2) SSN

536

Please let me know if need to have the exam read to you and allow extra time

Must have SSN (card is not required) or FRN

Must have Picture ID - Government, Student, or parent with same last name - School ID with picture will work

Forms must be done in black or blue ink (we will have pens)

537

February 14 Exam

- If you hold any FCC license and have a FRN please bring that also
- Such as GMRS