Technician Class Study Guide

Class Course Book for July 2022 to June 2026

K4VRC

The Villages Amateur Radio Club
The Villages, Florida
www.k4vrc.com

Message from The Villages Amateur Radio Club President

Future HAMs,

Amateur radio has been around for a long time and has grown itself into a worldwide community of licensed hams on the airwaves with all sorts of communications technology. Ham radio attracts those who have never held a microphone as well as deep technical experts who grew up with computers. The United States Amateur Service license is required similar to a driver's license and grants you the most wireless communications privileges available to any private citizen anywhere in the world. In the United States, amateur radio licensing is governed by the Federal Communications Commission (FCC) under strict federal regulations. 2012 marked one hundred years of amateur radio operator and station licensing by the United States government. Licenses to operate amateur stations for personal use are granted to individuals of any age once they demonstrate an understanding of pertinent FCC regulations, knowledge of radio station operation and safety considerations. Operator licenses are divided into different classes, each of which correlates to an increasing degree of knowledge and corresponding privileges. Over the years, the details of the classes have changed significantly, leading to the current system of three open classes and two grandfathered but closed to new applicants. Today we have Technician, General and the top US license class is Amateur Extra Class.

The Villages Amateur Radio Club classes are about HAM Radio from mentors in a positive learning environment and welcoming to people who have not been in a classroom for decades. The Technician class license is the entry-level license for new ham radio operators. To earn the Technician license requires passing a written examination totaling 35 questions on radio theory, regulations and operating practices. The license gives access to all Amateur Radio frequencies above 30 megahertz, allowing these licensees the ability to communicate mostly within hundreds of miles. This license includes limited international communication privileges below 30 megahertz, sometimes called "short wave" bands.

Looking forward to congratulating your success,

George K2DM

George Briggs
President
The Villages Amateur Radio Club

PS All amateur radio operators are welcome to use and share this document. Comments about this document can be sent by means of the club website contact form; https://www.k4vrc.com/contact-us.html Please include; a detailed description of the issue with exam question ID and page number.

Table of Contents

Revisions

Graphic and tutorial content simplified based on class feedback - November 21, 2024

2022 – 2026 Question Pool Original Release - June 21, 2022

Chapter 1 - Introduction

Just Enough for Understanding

Studying for your first HAM radio license is not easy for most people and this class is designed to help you with the difficult parts. Normally the class time is used to address the how and why questions. This is not intended to be traditional classroom experience instead you should expect a much more informal discussions about electronics as it relates to HAM radio in non-technical terms not Electrical Engineering. Too bad most of the well-known ham radio license manuals spend way too much content on theory and fail to stay within the scope of the exam. This is not to say just teach the test. A good example is the radio transceiver, you need to know what it does, not make one. You do not need a basic understanding of how radio works. Simply put there is only seven classes (about 15 Hours in class room time) to gain an introductory level understanding of the technology and the Code of Federal Regulations Title 47, Telecommunication. Part 97, Amateur Radio Service. The class format is just enough information for context and essential understanding needed to pass the licensing test.

Less Math for more Comprehension

Historically most HAMs have problems passing the license exam due to the math required. It may relieve some of your concerns to know the question pool has reduced the number of questions requiring calculations in favor of comprehension questions in the last three releases. You still need to use a small amount of math to solve problems but just add, subtract, multiple and divide. This class will focus on thinking through the questions and avoiding the algebra to solve problems. Working the example problems in class will help you be at ease with using the math required. Thinking carefully about the wording of the question will often lead to the only correct answer without any math! This means many multiple-choice questions can be solved logically without doing the math and the discussion from this class will help you avoid selecting the wrong answer.

Seven Classes

The seven classes will meet for about two hours once a week. Each topic begins with an overview of the homework assignment for context followed by review of the questions covered. Understanding is reinforced with your questions and discussion. To prepare for class;

- Reading of chapter prior to class
- Watch KE0OG Videos on YouTube
- Work chapter sample problems prior to class
- Review Class Study Guide to supplement your reading
- In class review of assignment, discussion and help with problems
- Take practice tests (online) at home between classes

Memory Retention

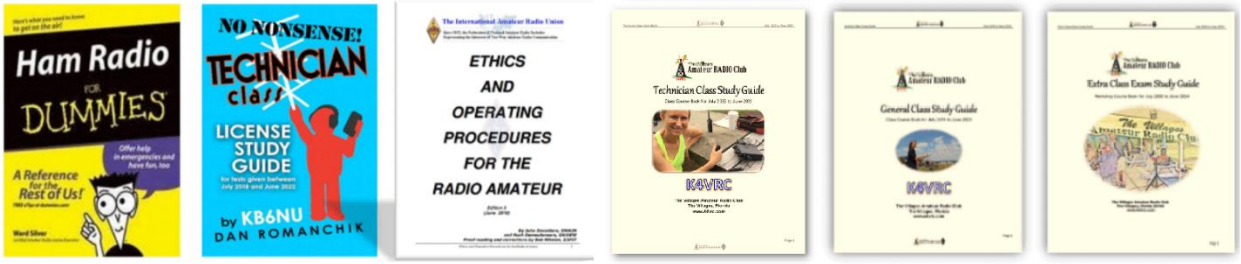
If you attend all classes, keep up with readings, and take practice tests conscientiously, preparing can be a relatively pain-free process. Pain-free does not mean work-free! Take practice tests online from multiple sites or different APPs. Many past students have found that preparing for the exam for 60 minutes per day, five or six days per week, will leave them well-prepared at exam time. Don't cram at the end as hitting hard at the last minute simply don't work for most people and they experience declining returns on their efforts when they attempt to study for two and three hours straight.

Learning Aids

You are encouraged to use every study resource that works for you. In general people retain more details from a hard copy document. Print this study guide so you can take it with you to study, write on it, underline or highlight the text for reference later. Place a copy of this guide on an eReader. Other books are not required but if you do have questions from other sources, they will be discussed during the open review at the end of each class. The following are helpful sources of information;

Class Resources Online
www.k4vrc.com "Interest in becoming a HAM?"

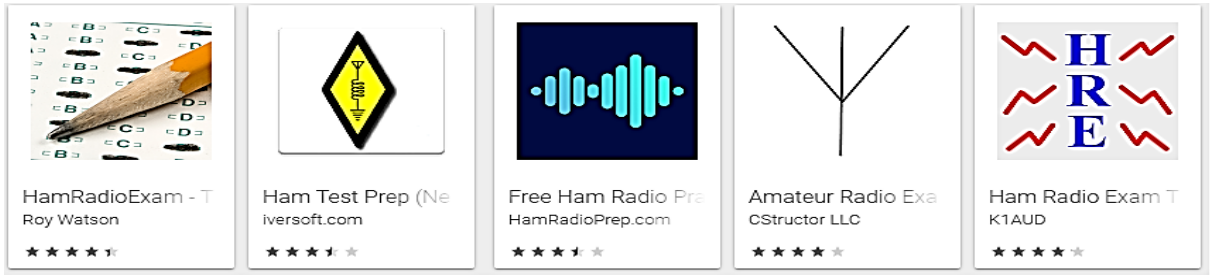
Free Books about HAM Radio and Class Study Guide



Class Resources Online
www.k4vrc.com "Interest in becoming a HAM?"

Practice Exams for this course

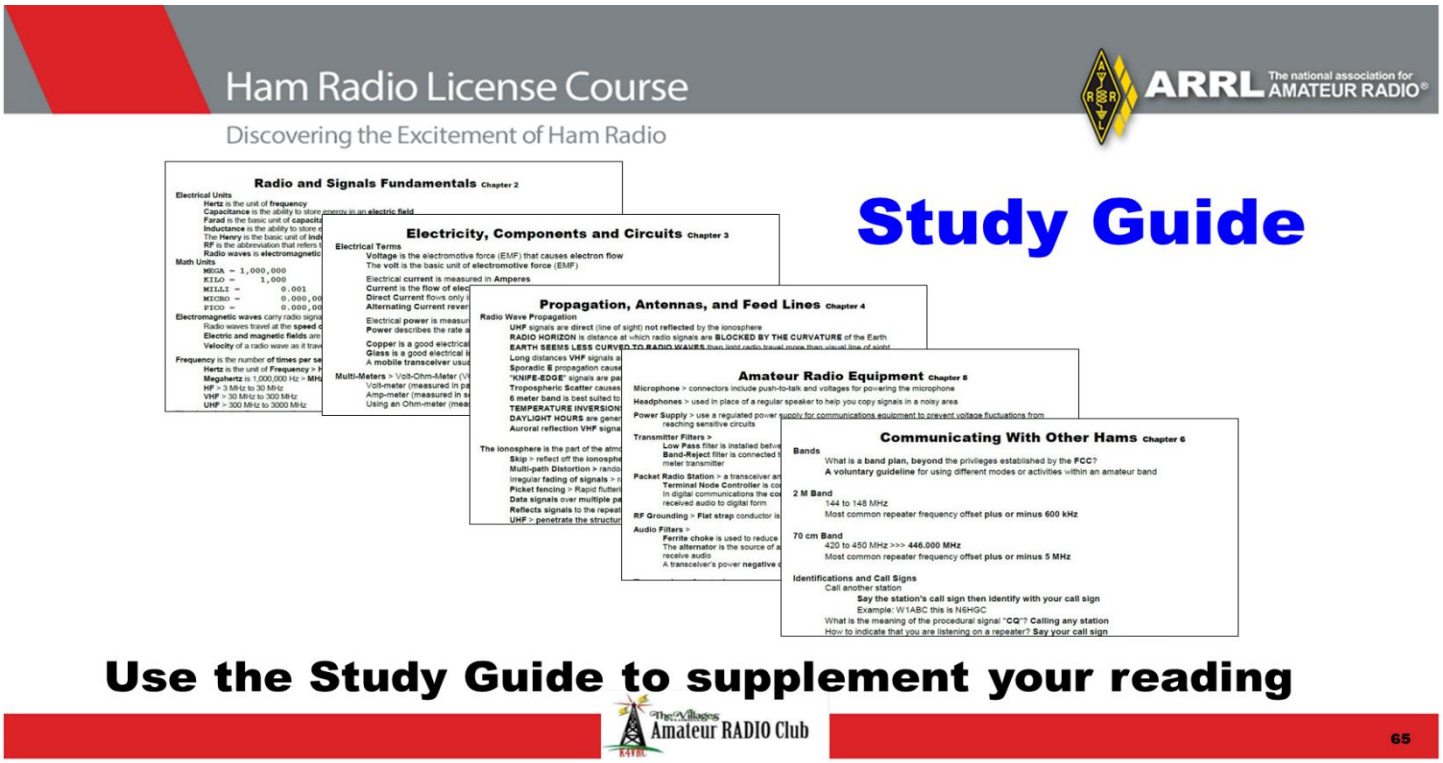
Take online practice tests online, but not more than once a day.



Dave Casler KE0OG Videos lectures are highly recommended.

Dave Casler KE0OG Videos

How to use this Study Guide



How to use this Study Guide

The class uses reading assignments, a staple of classrooms around the world, and the watching the KE0OG videos as a more in-depth reinforcement to get you going in the right direction. If you really want to delve deeply into the details look at the free books listed under Learning Aids. Use this Study Guide to help in keeping your thoughts organized. You need to review each chapter using this guide in your head. The key messages are listed and should give you enough of a sense of it. Sometimes, it's all too easy for things to get disorganized. This guide was prepared to make sure that everything's laid out in a way that makes it simple to find the notes you need.

When taking practice tests, use the Question Cross Reference section in the ARRL Ham Radio License Manual to review questions you answered incorrectly. The Technician Class Question Pool is sorted alphanumerically with the page number where the question is discussed in the text of the ARRL Technician Class License Manual that covered the question. Mark the questions missed, if a question is missed repeatedly be sure to address it during the class discussion.

Just treat this guide like someone had given you their class notes. All the important points from each class are neatly prepared for you by chapter. This Study Guide is one more tool like the text book and videos to help you succeed,

Chapter 2 - Radio and Signals Fundamentals

Math Units

GIGA =	1,000,000,000.0	Billion
MEGA =	1,000,000.0	Million
KILO =	1,000.0	Thousand

MILLI =	0.001	1/ Thousand
MICRO =	0.000,001	1/ Million
PICO =	0.000,000,000,001	1/ Trillion

TO CONVERT ↑ **MOVE DECIAL POINT**

Electromagnetic waves carry radio signals

Radio waves travel at the **speed of light**.

Electric and magnetic fields are the two components of a **radio wave**.

Velocity of a radio wave as it travels through free space is **300,000,000 Meters per second**

Electrical Units

Hertz is the unit of **frequency**

RF is the abbreviation that refers to **radio frequency** signals of all types

Radio waves is **electromagnetic waves** that travel through space

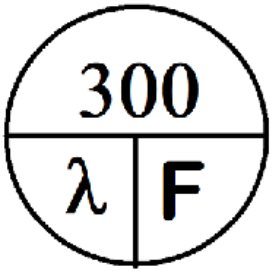
Wavelength is the **distance** a radio wave travels during **one cycle**

The symbol for Wavelength is λ

Wavelength is the inverse of frequency

When the wavelength gets shorter the frequency increases

Higher in frequency the shorter the distance between each wave.



The formula for **converting frequency to wavelength** is;

λ or Wavelength = Speed / Frequency

λ or Wavelength (Meters) = 300 Meters / Freq in Megahertz

λ or Wavelength (Meters) = 300 / Freq (MHz)

λ = 300 / F

300 = λ x F

F = 300 / λ

Frequency bands are the approximate Wavelength of the band: 2 meters; 20 meters; 40 meters, etc

Frequency is the number **of times per second** that an alternating current reverses direction

Hertz is the unit of **Frequency > Hz**

Megahertz is 1,000,000 Hz > **MHz**

HF > 3 MHz to 30 MHz

VHF > 30 MHz to 300 MHz

UHF > 300 MHz to 3000 MHz

Radio Terms

A **transceiver** is a device that combines a receiver and transmitter

Repeater station simultaneously retransmits the signal of another station on a different frequency

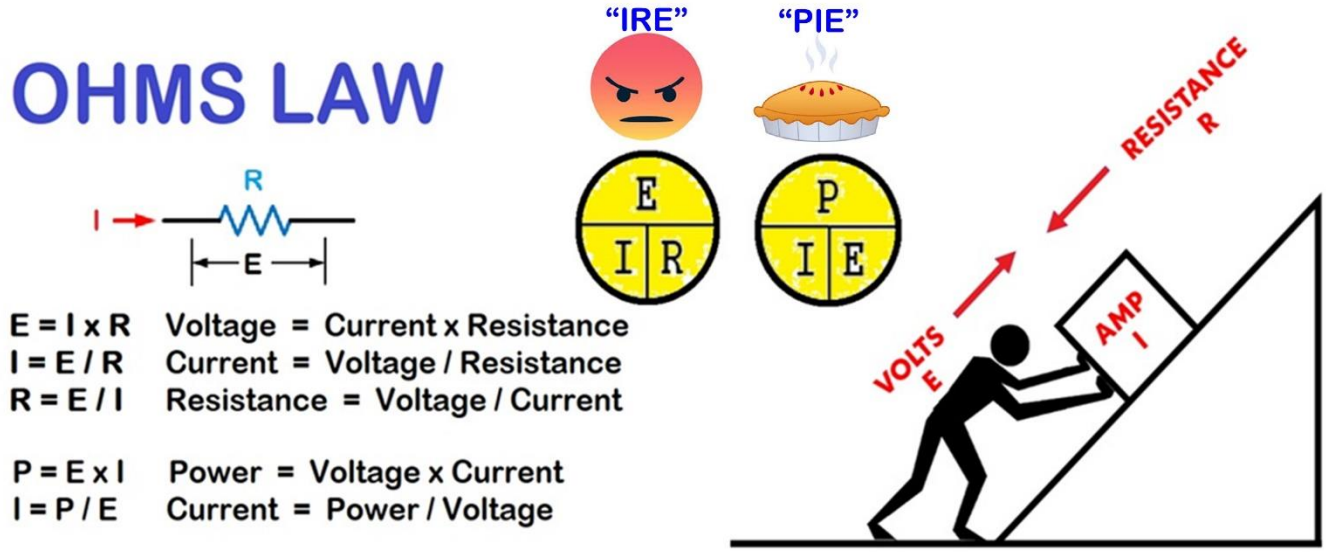
Chapter 3 - Electricity, Components and Circuits

Electrical Terms

Voltage is the electromotive force (EMF)
Electrical **current** is measured in **Amperes**
Current is the **flow of electrons** in an electric circuit
Direct Current flows only in **one direction**
Alternating Current alternates between positive and negative directions
Electrical **power** is measured in **Watts**
Power describes the rate at which electrical **energy** is used
Metals are good conductors as they have many **free electrons**
Glass is a good electrical **insulator**
Farad is the basic unit of capacitance
Inductance is the ability to store energy in a magnetic field
The **Henry** is the basic unit of inductance
Series circuit has the **same DC current** through all components
Parallel circuit has the **same DC Voltage across** all components

Electrical components

Resistance (Resistor) to **oppose the flow** of current in a DC circuit **> Measured in Ohms**
Resistance is controlled by a **potentiometer**
Potentiometer is used as an **adjustable v**olume control
Capacitor stores energy in an **electric field**
Capacitor consists of two or more **conductive surfaces separated by an insulator**
Capacitor is used together **with an inductor** to make a **tuned circuit**
Inductor stores energy in a **magnetic field**
Inductor is usually composed of a **coil of wire**
Impedance opposes the flow of current in an AC circuit > Measured in Ohms
A **Capacitor and Inductor combined make a tuned circuit** in an AC circuit
Switch connects between one of two circuits
SPDT=Single Pole Double Throw Switch
Relay is an electrically controlled switch
Fuse is used to protect other circuit components from **current overloads**
Transformer changes 120 V AC power to a lower AC voltage for other uses



Semiconductors

Transistor can be used as an electronic **switch or amplifier**
Transistor can **amplify** signals
Gain is a transistor's ability to **amplify a signal**
Transistors can provide **power gain**
Regulator controls the amount of **voltage** from a power supply
Transistor is made of three **layers of semiconductor** material
Bipolar transistor has an **emitter**, base & collector electrodes
"FET" stands for **Field Effect Transistor**
Field effect transistor has a gate, drain, and source
Diode forward voltage drop is lower in some diode types
Diode allows current to flow in only **one direction**
Diode's cathode lead usually identified with a **stripe**
Anode and cathode are the names of the two **electrodes of a diode**
Rectifier changes an **alternating current** into a varying **direct current** signal
Integrated circuit combines several semiconductors and other components into one package
"LED" stands for **Light Emitting Diode**
LED is commonly used as a **visual indicator**
Forward current causes an LED to emit light

Schematic Circuit Diagrams

Schematic symbols are standardized **representations of components** in an electrical wiring diagram
The **symbols** on an electrical circuit schematic diagram **represent electrical components**
Schematic diagrams represent the way components are **connected**
A Mixer converts a radio signal from one frequency to another
Oscillator generates a signal at a specific frequency
A Modulator combines speech with an RF carrier signal

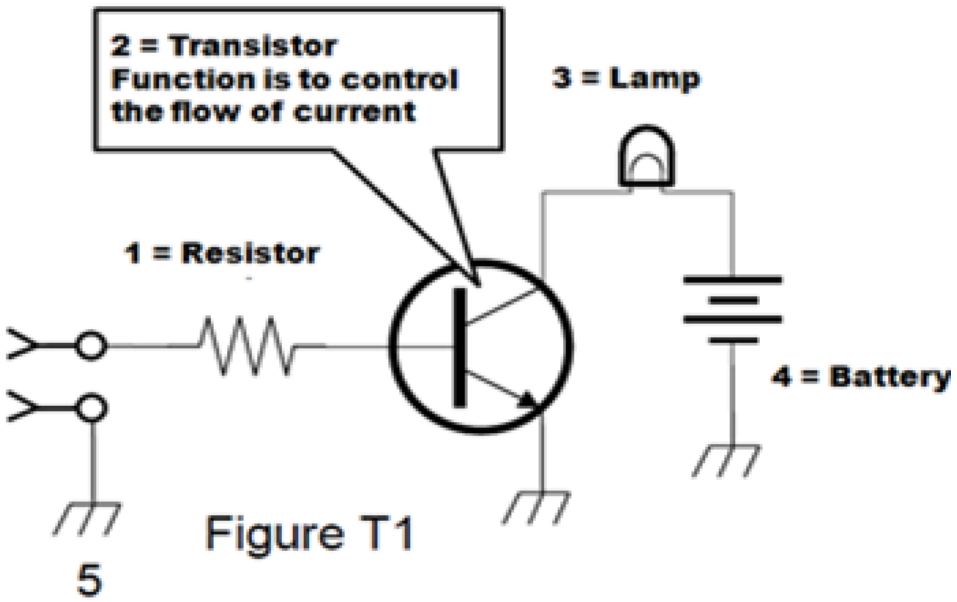


Figure T1

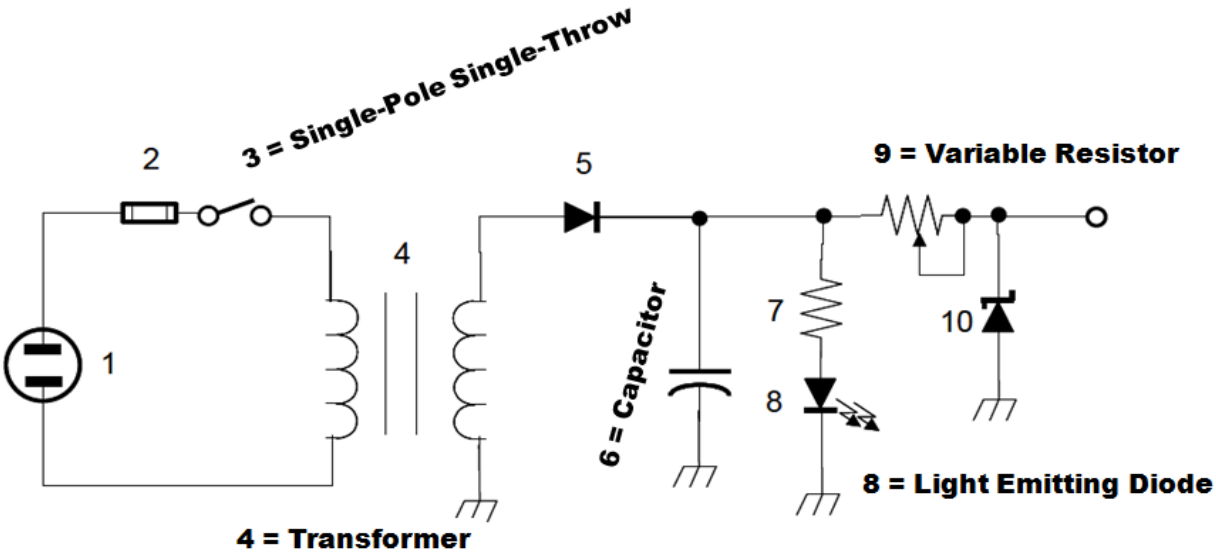


Figure T2

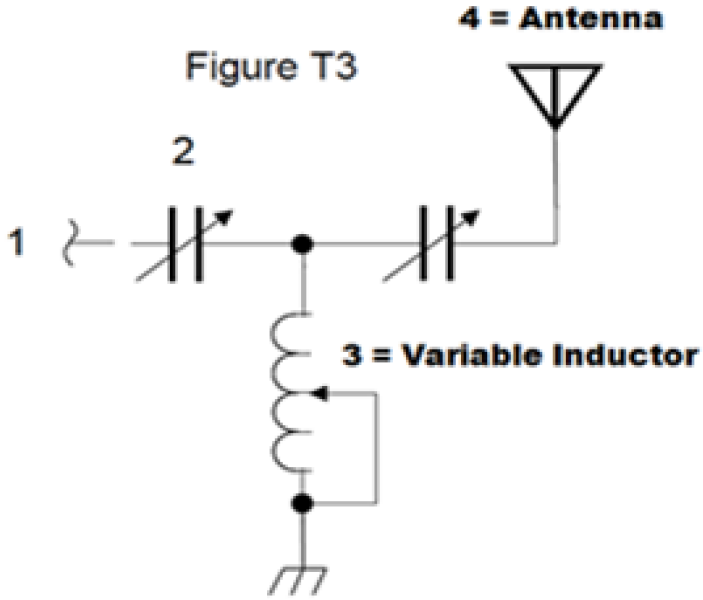


Figure T3

Multi-Meters > Volt-Ohm-Meter (VOM), Digital-Volt-Meter (DVM) Using a;

Meter displays an electrical quantity as a **numeric value**
Volt-meter (measured in parallel)
Amp-meter (measured in series)
An **ammeter** is used to measure **current**
Attempting to measure voltage when using the resistance setting can damage a multimeter
Using an Ohm-meter (measures resistance WITHOUT power DO NOT DAMAGE METER)
You would use a **VOLTMETER** to measure electric potential or **electromotive force**
Voltage and resistance measurements are commonly made using a **multimeter**
An **ohmmeter** shows low resistance then **increasing resistance** with time the circuit contains a **large capacitor**

Chapter 4 - Propagation, Antennas, and Feed Lines

Radio Wave Propagation

Radio Waves are Electromagnetic (electric and magnetic fields)
Electromagnetic waves have electric and magnetic fields at right angles
RADIO HORIZON is distance at which radio signals are **BLOCKED BY THE CURVATURE** of the Earth
Atmosphere refracts VHF-UHF radio waves **more distant radio horizon** than the visual horizon
VHF-UHF line of sight **signal strength is reduced when polarizations are opposite**
Long-distance ionospheric propagation is far more common on HF than VHF-UHF
TEMPERATURE INVERSIONS in the atmosphere causes "**TROPOSPHERIC DUCTING"**
Fog and light rain will have **little effect** on 10 and 6-meter bands
DAYLIGHT HOURS are generally the best time for long-distance **10 METER BAND PROPAGATION**
Precipitation decrease range at microwave frequencies
Absorption by vegetation reduces the range of **VHF and UHF signals**

The ionosphere is the part of the atmosphere that enables the propagation of radio signals around the world.

UHF signals are usually **not propagated** by the ionosphere
The **ionosphere enables the propagation** of radio signals to bend **on HF & VHF**
Long distances **VHF** signals are being **refracted** from a **sporadic E layer**
Sporadic E propagation causes occasional **strong over-the-horizon** signals on **10, 6, & 2 M** bands
6 & 10 M provide long distance communications during the **peak of the sunspot cycle**
Tropospheric Scatter causes VHF & UHF communications **over-the-horizon** (~300 miles)
6M band is best suited to communicating via **meteor scatter**
Auroral reflection VHF signals exhibit **rapid fluctuations** of strength and often **sound distorted**

Multi-path Distortion > random reflections

Random combining of signals arriving via different paths cause of **irregular fading** of signals
Picket fencing > Rapid fluttering sound from mobile stations
Data signals over **multiple paths > Error rates** increase
Reflects signals to the repeater using a **directional antenna**
VHF signals are **become weak or distorted are multi-path** move a few feet or change direction
"**KNIFE-EDGE**" signals are **partially refracted** around solid objects exhibiting sharp edges

Coaxial Cable > Connection between Antenna and Transceiver

Easy to Use, Requires few special installation considerations Low SWR allows efficient transfer of power
Coax > Damaged by Moisture, UV cracks & leaks water
Power lost in a feed line is **converted into heat**
Commonly **50 Ohms** Impedance,
Loss increases with frequency
RG-58 (smaller) more feedline loss used at HF
RG-213 (bigger) **less feedline loss**
Air-Core (Hard Line) requires special techniques to **prevent moisture** in the cable
Air-Core (Hard Line) **lowest feedline loss** at VHF-UHF
"N" connector types is most suitable for frequencies **above 400 MHz**
PL-259 type coax connectors are commonly used for **HF and VHF**

SWR > Standing Wave Ratio

The **FREQUENCY AND POWER LEVEL** should be considered when selecting an accessory **SWR METER**
SWR is how well a load is **matched** to a transmission line
LOW SWR indicates reduced or **LESS SIGNAL LOSS**
1:1 SWR indicates a **PERFECT IMPEDANCE MATCH**
4:1 SWR indicates an **IMPEDANCE MISMATCH**
Erratic SWR indicates a **loose connection** in the antenna or feed line
TRANSMITTERS REDUCE POWER as SWR increases to protect the output amplifier transistors
RF POWER METER BE INSTALLED IN THE FEED LINE, between the transmitter and antenna
A **DIRECTIONAL WATTMETER** can be used to determine SWR

Decibel (dB) **+3 dB = 2X** **-3 dB = X/2**
+6 dB = 4X **-6 dB = X/4**
+10dB = 10X

Antenna

Antenna gain is the signal strength compared to a reference antenna
A beam antenna concentrates signals in one direction
HF signals propagated by the ionosphere are elliptically polarized (Horz or Vert antenna both work)
Polarization (Horz or Vert) is the orientation of the electric field
A **horizontally polarized antenna** is a dipole oriented **parallel to Earth's** surface
A **horizontally polarized antenna** is used for long-distance CW and SSB on VHF-UHF
Electrically lengthening an antenna by inserting inductors is **ANTENNA LOADING**
HT (**Rubber Ducky)** antennas are **not very efficient**
Wavelengths equal the Speed of Light / Frequency or **(300 Meters / MHz)**
A half-wave **dipole** antenna radiates the strongest signal **broadside to the antenna**
A 5/8 wavelength whip antenna has more gain than a 1/4-wavelength antenna
A **YAGI** antenna has **greater gain**
An **ANTENNA ANALYZER** is used to determine if an antenna is resonant
An **ANTENNA TUNER** matches the antenna impedance to the transceiver's impedance

Chapter 5 - Amateur Radio Equipment

Modulator > Combines speech and RF into transmitted signal

SSB > Single Sideband is a form of Amplitude Modulated (AM) Signal
- Most often used for weak signal VHF and UHF
- The UPPER sideband is normally used for 10M, VHF and UHF SSB
- SSB has a **narrower (3 KHz)** bandwidth than **FM (15 KHz)**

CW > Send Continuous Wave using; a Straight Key, an Electronic Keyer and a Computer Keyboards
- **Morse Code** is used for CW
- CW has the **narrowest bandwidth** (150 Hz)
- An **ELECTRONIC KEYER** is a device that assists in manual sending of Morse code

Modulation vs Bandwidth

CW	150 Hz
SSB digital	500 to 3000 Hz
SSB voice	2 to 3 kHz
AM voice	6 kHz
AM broadcast	10 kHz
FM voice	10 to 15 kHz
FM broadcast	150 kHz
AM Fast TV	6 MHz

FM > Frequency Modulation
- Commonly used for VHF and UHF voice (phone) repeaters
- Commonly used for VHF packet
- FM has a **10 to 15 KHz** bandwidth

FM Modulation & Deviation
- Only one FM signal can be received at a time compared with SSB (FM Capture Effect)
- Talk farther away from the microphone if you are told your FM transceiver is **OVER-DEVIATING**
- Audio Distortion is the result of tuning an FM receiver above or below a signal's frequency

Transceivers
- **Sensitivity** is the ability of a receiver to detect the presence of a signal
- **Selectivity** is the ability of a receiver to discriminate between multiple signals
- **Transverter** converts the RF input and output of a transceiver to another band
- A **DUMMY LOAD** prevents transmitting signals over the air when making tests
- A **DUMMY LOAD** is a non-inductive resistor mounted on a heat sink
- An **RF PREAMPLIFIER** is installed between the antenna and receiver
- An **RF POWER AMPLIFIER** increases the transmitted output power from a transceiver
- SSB/CW-FM switch on a VHF power amplifier sets the proper mode

Transceiver Controls
- **PTT (push-to-talk) function switches between receive and transmit**
- **VFO** > The keypad or VFO knob can be used to **enter** the operating **frequency** on a modern transceiver
- **Microphone Gain** > If a transmitter microphone gain set **too high**, output signal becomes **distorted**
- **Talking to Loud** causes your FM transmission audio to be **distorted**
- **Squelch** > The squelch control is used to **mute** receiver output **noise** when **no signal** is not present
- **Channel Memory** > A way to enable quick access to a **favorite frequency** on your transceiver
- **Receive Incremental Tuning** > **RIT** or clarifier is used if the **voice pitch** of a SSB signal seems too high or low
- **Bandwidth Control** > permits noise or interference reduction by selecting a bandwidth matching the mode
  - **2400 Hz** is an appropriate receive filter to minimize noise and interference for **SSB** reception
  - **500 Hz** is an appropriate receive filter to minimize noise and interference for **CW** reception

Computer operation of Transceivers
- A computer Microphone or **line input** is connected to a **transceiver's speaker** digital modes
- **Computer sound card** provides audio to the radio's mic input and converts received **audio to digital**
- **Receive audio, transmit audio, and push-to-talk (PTT)** are connected to a computer for digital modes
- A **GATEWAY** is an amateur radio station that connects other amateur stations to the internet

Digital Communications > Packet, PSK31, IEEE 802.11, WSJT (JT65, FT4, FT8) are digital communications
- **PSK31** > A low-rate data transmission mode (**Phase Shift Keying)**
- **Packet** digital communications includes;
  - Check Sum for error detection and automatic repeat requests
  - The Header includes the call sign of the intended station
  - **ARQ** is an Automatic repeat request in case of error
- **WSJT** is used for Earth-Moon-Earth, Weak-signal propagation beacons and Meteor scatter
- **FT8** Is a digital mode capable of low signal-to-noise operation

Automatic Packet Reporting System > **APRS**
- **GPS position, text messages weather data** are transmitted by APRS
- Real-time map showing the **locations of stations**

MESH NETWORK is a high-speed multi data network using Wi-Fi gear with modified firmware

Fast Scan Images > Uses **NTSC** format (1940-90 analog TVs), **6 MHz** bandwidth is used in the **70 cm** band

Power Supply & Batteries
- **13.8 VOLTS @ 12 AMPERES POWER SUPPLY** rating for a typical 50-watt FM transceiver
- A **REGULATOR CIRCUIT** controls the amount of voltage from a power supply
- **OVERHEATING OR OUT-GASSING** is caused by charging or discharging a battery too quickly
- **SHORT, HEAVY-GAUGE WIRES** are used for a transceiver's power to minimize transmit voltage drop
- Divide the battery ampere-hour rating by the average current draw to determine **BATTERY OPS TIME**
- The negative power of a transceiver should be **CONNECTED AT THE 12-VOLT BATTERY GROUND**
- **Rechargeable batteries** are lead-acid gel cell, nickel-metal hydride, and lithium-ion.
- Carbon-zinc and Alkaline batteries are **not rechargeable.**

Chapter 6 - Communicating with Other Hams

Bands

BAND PLAN is more than the privileges established by the **FCC**
BAND PLAN is a voluntary guideline for using different modes or activities within an amateur band
SSB PHONE may be used in at least some segment of bands above 50 MHz

2 M Band >>>> 144 to 148 MHz
National calling frequency for FM simplex **146.520 MHz**
Most common repeater frequency offset **plus or minus 600 kHz**

70 cm Band >>>> 420 to 450 MHz
National calling frequency for FM simplex **446.000 MHz**
Most common repeater frequency offset **plus or minus 5 MHz**

Simplex & Repeaters

Transmitting and receiving on the same frequency >>> **Simplex** communication
Simplex VHF-UHF freq are in band plans so you can **COMMUNICATE WITHOUT TYING UP A REPEATER**
Sub-audible tone transmitted with normal voice audio to open the squelch of a receiver >>> **CTCSS**
DTMF commands use pairs of audio tones
Listening on a repeater's **input freq** is a use for **"reverse function"** function on VHF/UHF TxRx
Linked repeater network is signals received by one repeater are repeated by all the repeaters
Digital mode **HOT SPOTS** communicate voice or data systems via the internet
A **"talk group" on a DMR digital repeater is** a way for **"GROUP'S ID"** users to share a channel
DMR users to share a channel at different times **WITHOUT HEARING OTHER USERS (TDMA)**
There are 15 **COLOR CODES** used to designated **DMR "GROUP'S ID"**
CODE PLUGS are the term for the information needed to access **DMR "GROUP'S ID"**
Your **CALL SIGN** must be programmed into a **D-STAR** digital transceiver before transmitting
ECHOLINK enables transmission through a repeater without a radio
Register your **call sign and proof of license** is required before using **ECHOLINK**

I can hear but not access a repeater even when transmitting with the proper offset?

A. The repeater receiver requires **audio tone burst** for access
B. The repeater receiver requires a **CTCSS** tone for access
C. The repeater receiver may require a **DCS tone** sequence for access
D. All of these choices are correct

What might be a problem if your audio through an FM repeater is distorted?

A. Transmitter is slightly off frequency
B, Batteries are running low
C. In a bad location
D. All of these choices are correct

Internet Radio Linking Project > IRLP is radio VoIP via a radio GATEWAY
IRLP operators connect to repeaters via the internet using Voice Over Internet Protocol (VoIP)
Voice Over Internet Protocol (VoIP) voice communications over the internet using digital techniques
Select a specific IRLP Node by using your keypad **(DTMF)** to enter the **GROUP'S ID CODE**

Identifications and Call Signs

BEFORE YOU CALL; Check authorized Freq, listen for others then ask is the frequency in use
Call another station
Say the station's call sign then identify with your call sign Example: W1ABC this is KK4XYZ
What is the meaning of the procedural signal "**CQ**"? **Calling any station**
How to indicate that you are listening on a repeater? **Say your call sign**
How to respond to a CQ? Say the **other station's call sign** followed by **your call sign**
What is the "Q" Signal?
Indicates that you are receiving interference from other stations >>> **QRM**
Indicates that you are changing frequency >>> **QSY**

Public Service Communications

What rules applies to your station at the request of public service officials? >>> **Only FCC Rules**
ARES = Amateur Radio Emergency Service
Registered amateur radio volunteers who assist emergency public services
RACES = Radio Amateur Civil Emergency Service >> **FCC amateur radio service for civil defense**
Service using amateur stations for government emergency or civil defense communications
An amateur station may **OPERATE OUTSIDE THE FREQUENCY PRIVILEGES** of their license class in situations involving the **IMMEDIATE SAFETY OF HUMAN LIFE OR PROTECTION OF PROPERTY**

Terms

Direction Finding > A directional antenna is used to find noise interference or jamming (Fox Hunt)
Contest > Contacting as many stations as possible in a specific period of time
Send minimum information for station identification and contest exchange
Grid Locator > A letter-number designator assigned to a geographic location
NTSC is an analog fast-scan color TV signal modulation
SCANNING FUNCTION of an FM transceiver tunes a range of frequencies to check for activity

Formal Traffic Messages

Net Control Station (NCS) calls the net to order and directs communications between stations checking in
"TRAFFIC" is formal messages exchanged by net stations
Passing messages **EXACTLY AS RECEIVED** is a characteristic of **good traffic handling**
What is the **preamble** in a formal traffic message?
Information needed to track the message through the amateur radio traffic handling system
What is the term "**check**" in reference to a formal traffic message? >>> **count of the number of words**
Unless an emergency occurs wait to TX until asked to do so by the net control station
PHONETIC ALPHABET is used to ensure that voice messages are received correctly

Satellites > Use amateur radio satellites to talk to operators in other countries on FM, SSB, CW, Data
An amateur station located more than **50 km above Earth's surface is a space station**
Anyone may receive telemetry from a space station
Any **Technician class or higher license** may contact the **International Space Station (ISS)**
Any amateur whose license privileges transmission on the satellite uplink frequency can be the operator
Always use the **minimum power** to complete the contact
Too much power to may block other users
Correct power means your signal strength on the downlink is about the **same as the beacon**
The **beacon** is a transmission from a space station that contains **Health and status of the satellite**
A **Satellite Tracking Program** gives map, times, doppler freq shift, azimuth, and elevation for the satellite
Keplerian elements are inputs to a satellite tracking program
Doppler Shift is the frequency change caused by the motion of the transmitting station
U/V Mode is the satellite uplink is in the 70 cm band and the downlink is in the 2 meter band
Spin Fade is caused by the rotation of the satellite and its antennas
LEO stands for Low Earth Orbit

Chapter 7 - Licensing Regulations

Amateur Radio Services

Amateur Radio Service is for advancing skills in the technical and communication phases of the radio art
FCC regulates and enforces the rules for the Amateur Radio Service
Volunteer Frequency Coordinator recommends T/R channels/parameters for **repeater stations**
Amateur operators select a **Frequency Coordinator**
The purposes of a **BEACON** is for observing propagation or related experimental activities

Operator Classes and Station Call Signs

Current new **Operator Classes are:** Technician, General, Amateur Extra
Only one operator/primary station license grants may be held by any one person
You may **operate** from any **vessel in international waters** registered in the **US**
FCC requires your **correct EMAIL address** > **Revocation** of license
Operate as soon as your name and call sign appear in the **FCC's ULS database**
Ten years is the normal term for a license
Two years grace period following expiration license to renew
The **ULS DATABASE** proves that the FCC has issued an operator/primary **LICENSE GRANT**
You **cannot operate** during the **grace period** until renewed in the ULS database
A station and its records must be made available for anytime requested by FCC Representative
Amateur radio stations prohibited from communicating with any country who objects to ITU
K1XXX is a valid call sign for a Technician class amateur radio station
Any licensed amateur may request a desired call sign under the **vanity call sign** rules
A club must have at least **four members** for a club license
INTERNATIONAL COMM for purposes of Amateur Radio Service and remarks of a personal character

Authorized Frequencies

Technicians have phone privileges on a subpart of 10M
Technician Phone **28.300 MHz to 28.500 MHz**
52.525 MHz MHz is in the **6 M** band
146.52 MHz is in the **2 M** band
Fixed digital message forwarding on the frequencies 219 and 220 MHz
Only CW permitted on **50.0 to 50.1** MHz and **144.0 to 144.1** MHz
Secondary basis frequency band is available without causing interference
HF Technician are limit to **200 Watts on HF Bands**
HF Technician are limit to **1500 Watts above 30 MHz**

Chapter 8 - Operating Regulations

Control Operator

A station must have a **control operator** when **transmitting**
A **license** appears in the **FCC database** is eligible to be the **control operator**
Control Operator determines the transmitting privileges of an amateur station
The station licensee **must designate** the station **control operator**
FCC presumes the **station licensee** to be the control operator unless in logged differently
The **control operator and station licensee are equally** responsible for the operation
The station **control point** is the location at which the **control operator function** is performed
Local control is being used when transmitting using a handheld radio
Remote control is when the control operator can **indirectly manipulate a station (over internet)**
Remote control requires a **CONTROL OPERATOR AT ALL TIMES TO OPERATE** (indirectly) controls
Repeater operation is **Automatic control**
Control operator of the **originating station is accountable for repeater** TX violation

Station Identification & Misc

English is used for station ID use of a **phonetic alphabet is encouraged**
A station required to **ID every 10 minutes and at the end of TX**
CW or phone ID is required for a station transmitting phone signals
Phone ID must be in ENGLISH
Identify the transmitting station when making on-the-air **TEST TRANSMISSIONS**
Acceptable Phone ID: " KL7CC stroke W3" or " KL7CC slant W3" or "KL7CC slash W3"
A station may **transmit without ID** when transmitting signals to control model craft
Tactical call is used when identifying a station as "Race Headquarters"
When using tactical identifiers, you must **ID your station every ten min** & end TX
A **Technician cannot be the control operator** in exclusive Extra Class segment bands
TX of **third party communications is authorize** to foreign stations permitted by that govt
At least **4 persons** are required for a **club station license**
Repeater station simultaneously retransmits the signal of another station
Upon request the station licensee make the station / records available for **FCC inspection**

Authorized and Prohibited Transmissions

Operator may receive compensation when incidental … **A SCHOOL TEACHER**
Stations may **sell or trade amateur equipment** but not on a regular basis
Amateurs can TX **NEWS** related to **immediate** safety of human **life** or protection of **property**
Music maybe TX when incidental to retransmission of **manned spacecraft** comm
Automatically retransmit signals from an **auxiliary, repeater, or space station**
Codes or Ciphers allowed only controlling **space stations** or **radio control** craft
When transmitting control signals **model craft station ID is not required**
NO one has the right to an amateur frequency, **STATIONS SHOULD NEGOTIATE** use of the frequency
3rd Party message from a station on behalf **of another person**
3rd Party message must be **permitted by the foreign country**
Transmissions that contain **obscene language are prohibited**
Willful interference is prohibited
Definition **Broadcasting** (FCC rules) is TX intended for the **general public** is prohibited

Chapter 9 – Safety / RF Exposure Hazard

Antenna Tower Safety

Always have **TOWER CLIMBING SAFETY TRAINING** before climbing
Put on a **CLIMBING HARNESS AND TIE-OFF** before climbing an antenna tower
Always have an observer or helper when climbing a tower
A **crank-up tower must never be climbed** unless it is in the fully retracted position
SAFETY WIRE THROUGH A TURNBUCKLE prevents loosening of the guy line from vibration
Never attach an antenna to a utility pole the antenna could contact high-voltage wires
10 feet to the power wires is the min safe distance from a power line when installing an antenna
Look for and **stay clear of any overhead electrical wires** when putting up an antenna tower
Ground a tower with separate **EIGHT-FOOT LONG GROUND RODS FOR EACH TOWER LEG**
GROUND COAX Cable feed to **LIGHTNING PROTECTION** / external ground at building penetration
Bond ground rods with heavy wire or conductive strap
Sharp bends must be avoided in grounding conductors used for lightning protection
Local electrical code establishes grounding requirements for an amateur radio tower or antenna

Electrical Hazards

Electric current in the body causes tissue **heating, disrupts cell functions, involuntary contractions**
Electric shock can occur from **capacitors in power supply** when it is turned **off**
Guard against electrical shock at your station
Use three-wire cords and plugs for all AC powered equipment
Connect all AC powered station equipment to a common safety ground
Install mechanical interlocks in high-voltage circuits

A **fuse interrupts power** in case of overload
A120V AC **"HOT"** conductor is connected to the **BLACK WIRE** in a three-wire electrical AC plug
A120V AC **"HOT"** conductor **fuse / circuit breaker** in should always be in home-built equipment
Shorting a 12-volt storage battery can cause burns, fire, or an explosion
FLAT COPPER STRAP conductors are preferred for **RF BONDING**

Radio Frequency Radiation Exposure Hazard

Radio signals are **NON-IONIZING RADIATION**
RF radiation does NOT have sufficient energy to cause genetic **(DNA)** damage
The **LICENSEE IS RESPONSIBLE** for ensuring that no person is exposed to RF exposure limits
50 MHz has a low **Maximum Permissible Exposure limit**
Frequency, RF Power, Distance & Radiation Pattern of the antenna affect the RF exposure
Human body absorbs more RF energy at some frequencies than at others
FCC OET Bul 65, computer model or field strength meter determine complies with RF
A painful **RF SKIN BURN** could happen if a person accidentally touched your antenna
Relocating antennas might prevent exposure to RF radiation in excess of FCC limits
Re-evaluating the station whenever equipment is changed to ensure RF safety
Duty Cycle affects the average exposure of people to radiation **over 6 Minute Average**
DUTY CYCLE is the ratio of transmit time compared to total time
DUTY CYCLE changes from **100%** to **50%**then the max **EXPOSURE LEVEL DOUBLES**

Radio Frequency Interference

Causes of radio frequency interference;
- Fundamental overload
- Harmonics
- Spurious emissions

When a receiver is **unable to reject strong signals outside its band** it may receive amateur TX unintentionally

Cable TV interference from your Tx maybe caused by **loose TV coaxial connectors**

Correct **OVERLOAD** of a non-amateur receiver with a **FILTER** at the antenna input of the affected receiver

BAND-REJECT FILTER can reduce **OVERLOAD** to a VHF transceiver from a nearby FM broadcast station

If something in a neighbor's home is causing harmful interference;
- Work with your neighbor to identify the offending device
- Check your station and make sure it meets the standards of good amateur practice
- Inform your neighbor rules that prohibit the use of devices that cause interference

If a neighbor tells you that your station's transmissions are interfering make sure that your station is functioning properly and that it does not cause interference to your own radio or television

Reports of **garbled, distorted, or unintelligible** voice transmissions maybe **RF feedback**

Use **SHIELDED WIRE TO PREVENT COUPLING** of unwanted signals to or from the wire

Use a **FERRITE CHOKE** to cure distorted audio caused by RF current on the shield of a microphone cable