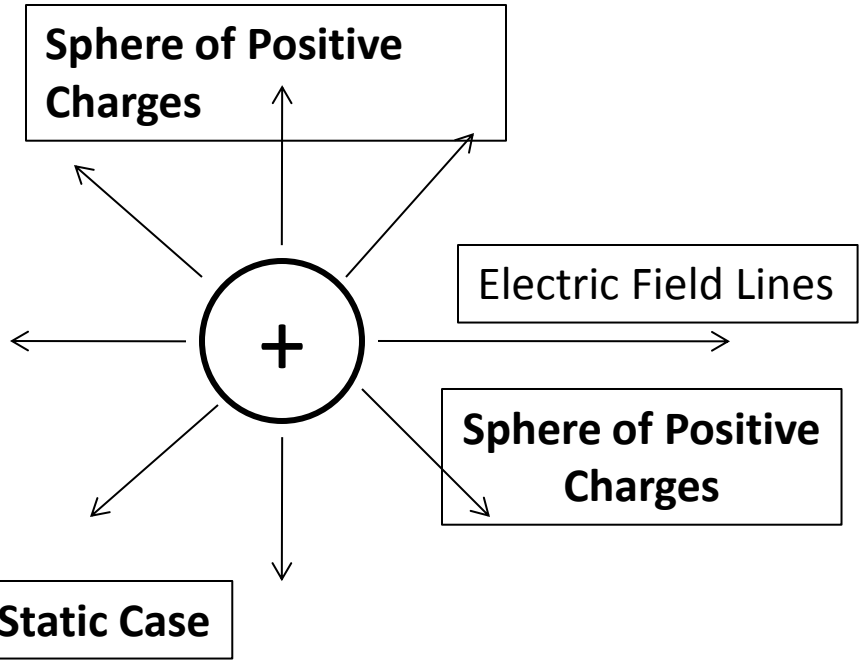
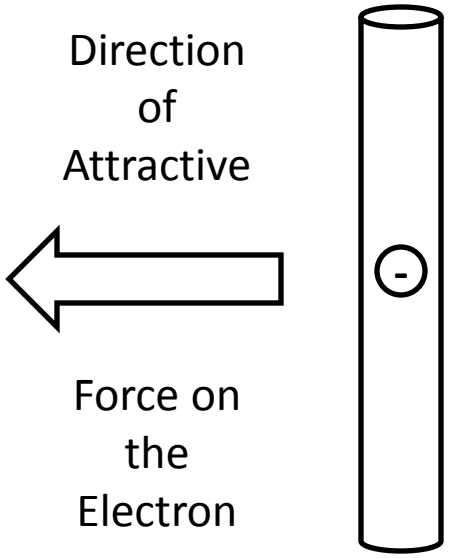
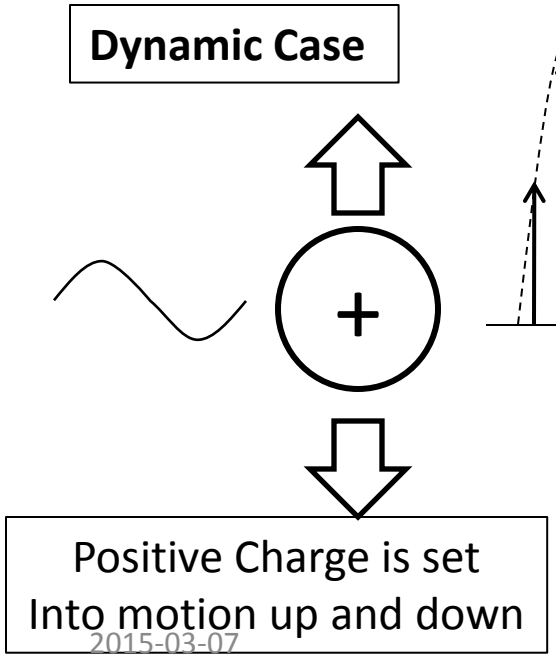
Technician Exam Cram Session Material
Version 4.1 for 2014 Tech Pool

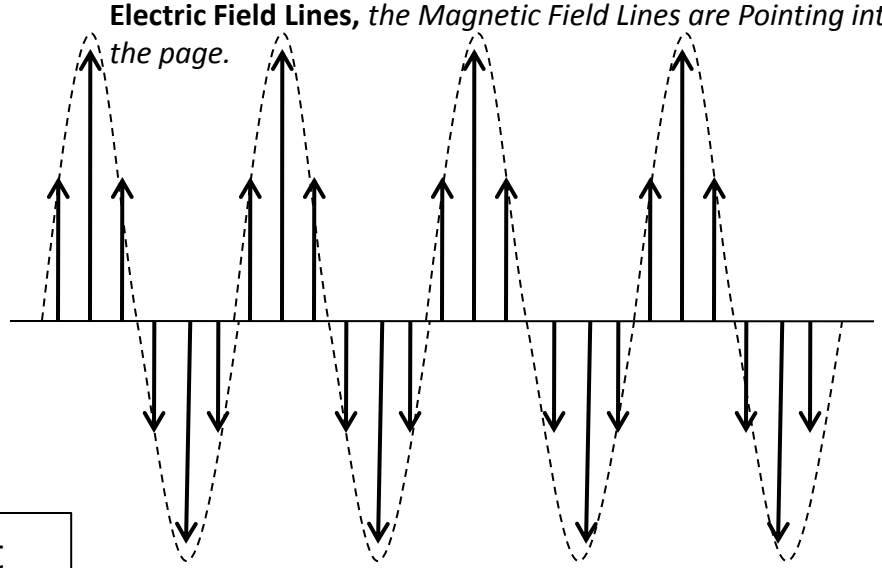
George B. Holubec

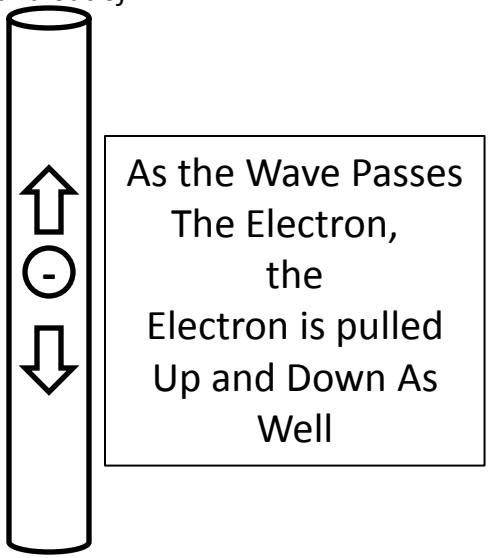
David Sarnoff Radio Club


Sphere of Positive Charges
+
Electric Field Lines
Sphere of Positive Charges
Static Case


Direction of Attractive
Force on the Electron
-
Single Electron In a Filament of Wire

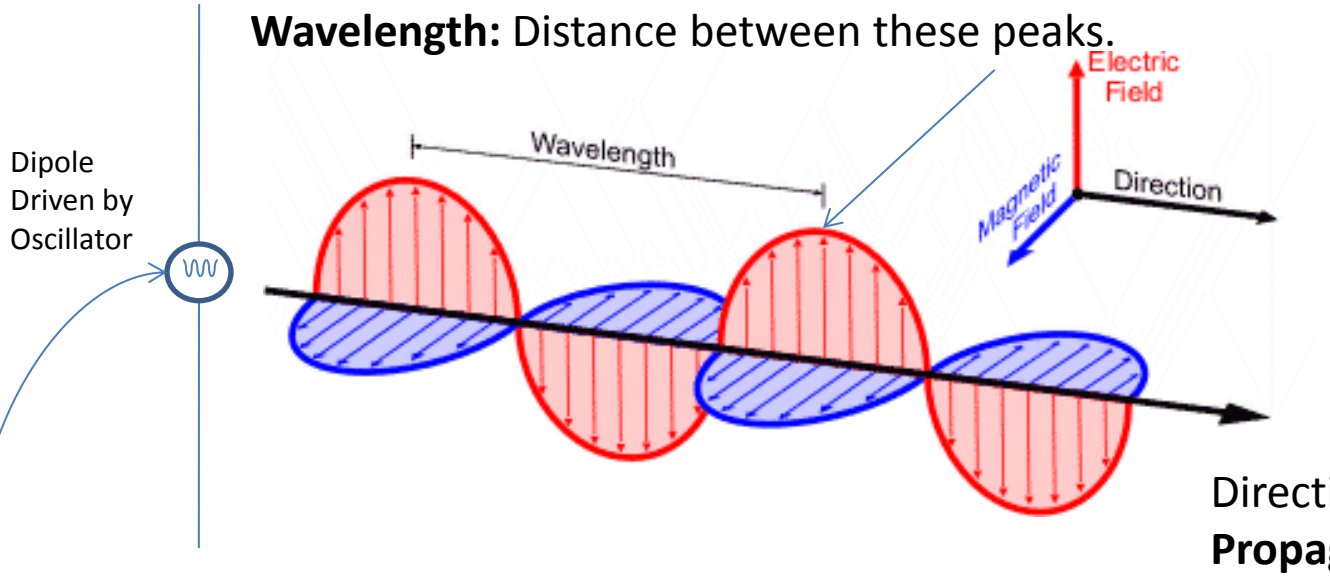

Dynamic Case
+
Positive Charge is set Into motion up and down


Electric Field Lines, *the Magnetic Field Lines are Pointing into and out of the page.*


-
As the Wave Passes The Electron, the Electron is pulled Up and Down As Well

Frequency: The number of times a **peak** passes a given point in space in one second. Measured in units of Hertz abbreviated **Hz.**

Wavelength: Distance between these peaks.



Direction of Travel or **Propagation**

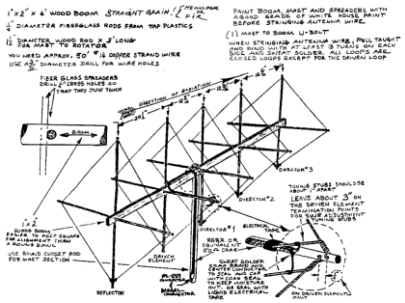
Vertical Dipole: **Both** the **dipole** and the **Electric Field** it generates are ***perpendicular*** to the plane of the Earth**.**

Vertical Polarization: Where the Electric Field Component of an Electromagnetic Wave is *perpendicular* to the plane of the Earth.

Conversely for **Horizontal Dipoles** and **Horizontal Polarizations** , both the Dipole and Electric Field Component generated by it are ***parallel*** to the plane of the Earth.

http://www.srh.noaa.gov/jetstream/remote/remote_intro.htm

Antennas (Part 1)



Quad **Dish** **Yagi**

1) The above are three Examples of **Directional Antennas** Mentioned in the Exam

2) Beam Antenna : Concentrates its signals in a particular direction. (Like a Beam of Light).

3) To resonate a **dipole** at **higher frequency** one **shortens** it.

4) Rubber Duck Antenna is not as **effective** as **a full-size antenna**.

5) Dipole Antenna parallel to the **Earth's surface** is **horizontally polarized.**

6) Vertical Antennas generate an **E-Field perpendicular** to the **plane** of the **earth**

7) Length Feet Half Wave Dipole 468/Freq (mhz)

8)Length Feet Quarter Wave Vertical 234/Freq (mhz)

9) Half Wave Dipole for 6 Meter Band is about 120 inches.

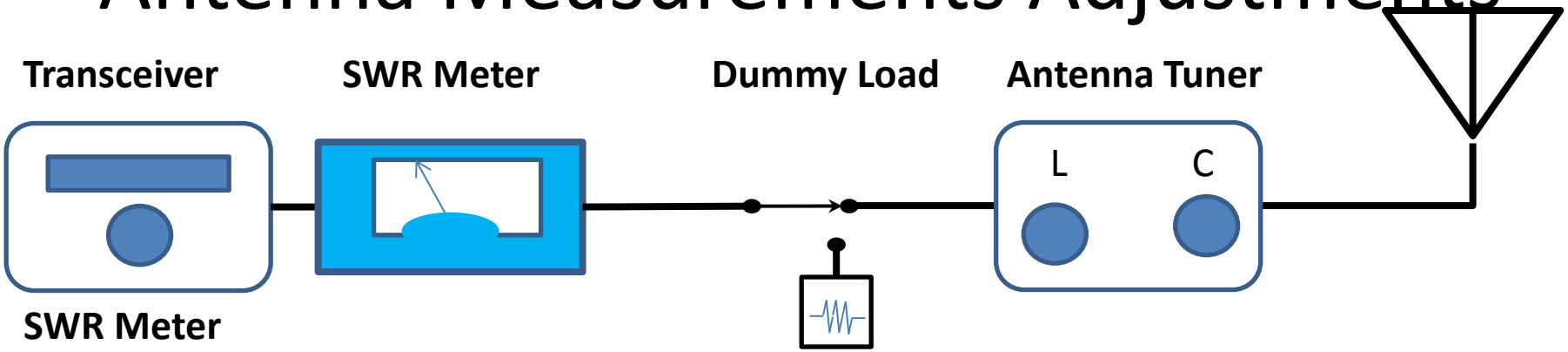
Antennas Part(2) Vhf Mobile Antennas

1) A **5/8 Wavelength Roof Mounted Antenna** offers a **lower angle of radiation** than a similarly mounted **quarter wave vertical**.

2) Mounting a vertical antenna at the **center of the roof provides the most uniform radiation pattern.**

3) Inserting an ***inductor*** in the ***radiating portion of an antenna*** makes it ***electrically longer***.

Antenna Measurements Adjustments



SWR Meter

- SWR is an Indication of how well the Antenna is matched to the transmission Line
- **1:1** indicates a Perfect Match
- **2:1** mismatch is the SWR most transceivers protection circuitry begin limiting output powe
- **4:1** indicates an Impedance Mismatch

Other Instruments that can be used to show equivalent indications

- **Antenna Analyzer** (For antenna measurements can functionally replace both the transceiver an meter in the diagram.)
- **Directional Power Meter** (Can be used in place of the SWR Meter. Often the same instrument can indicate SWR, Forward, and Reflected Power.

The **Dummy Load** prevents the radiation of signals when making tests.

The **Dummy Load** consists of a **non-inductive Resistor**.

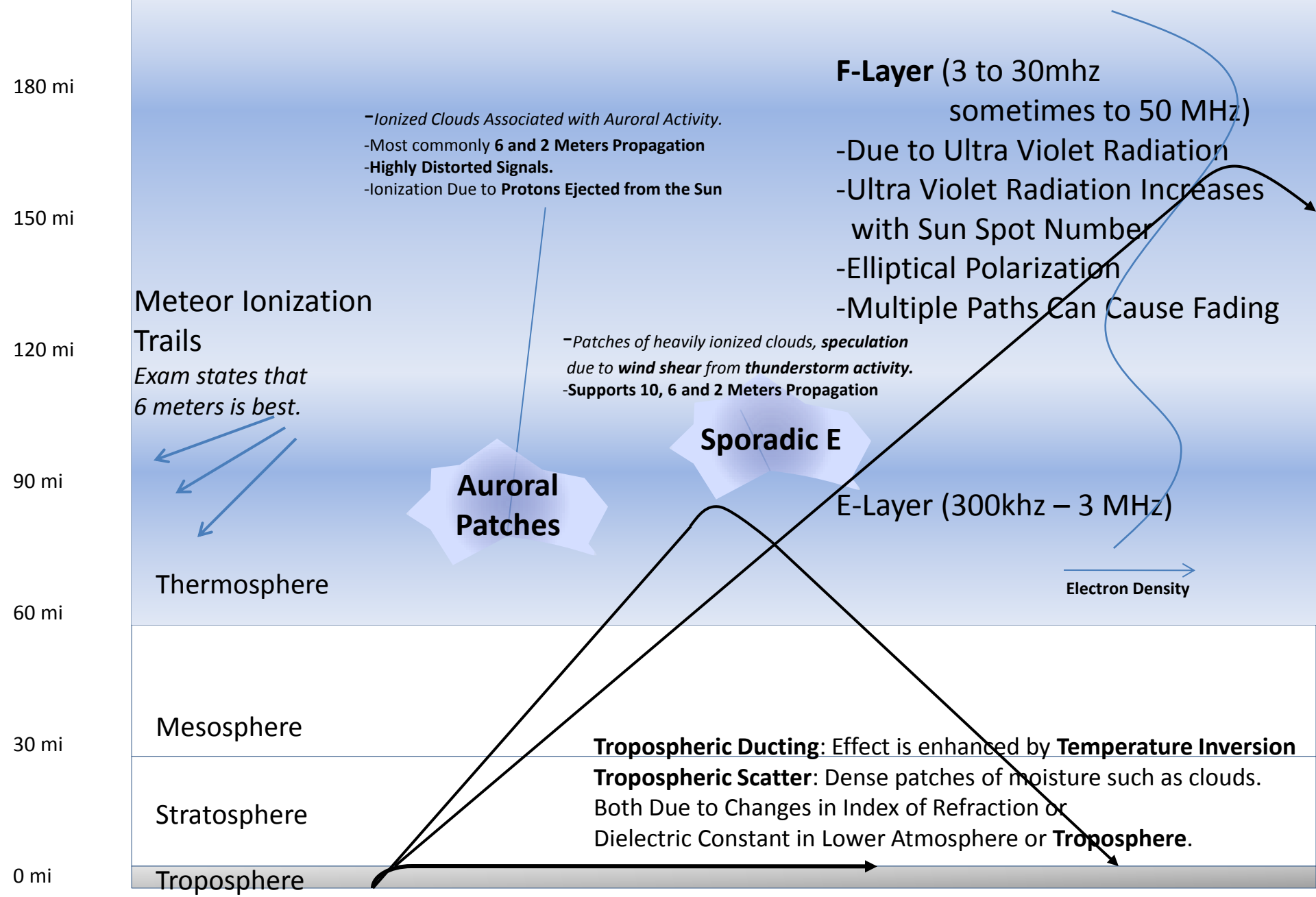
The **Antenna Tuner** is used to match the ***"Antenna's System Impedance to the transceivers' output impedance".*** – ***T9B04 , not quite true but close……. GBH***

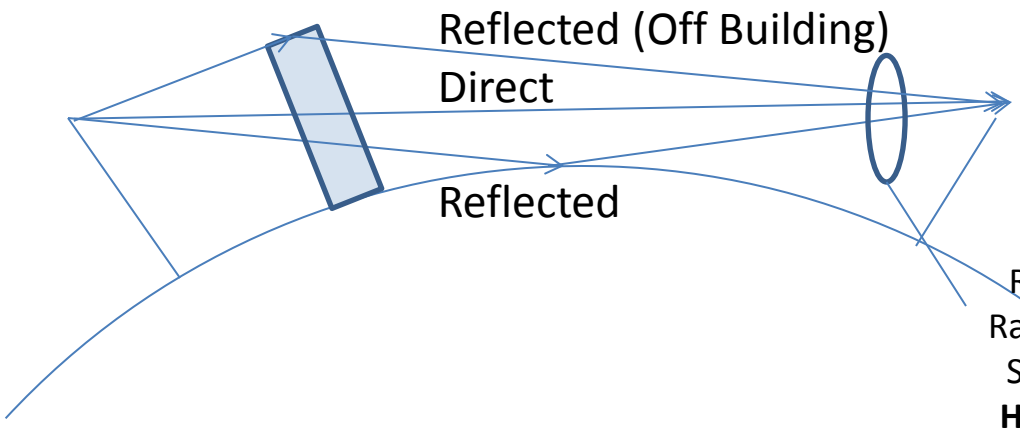
RF Connectors And Coaxial Cable

PL-259 **Used at HF Frequencies but is Unfortunately referred to as a UHF connector.**

Type N **Used at Frequencies above 400 Mhz**

- All Cables should be sealed against water intrusion
- Coaxial Cable should be resistant to UV to prevent damage that would allow water in.
- R-G8 Larger than RG-58
- R-G8 Lower Loss than RG-58
- Challenge of air-core dielectrics are keeping moisture out

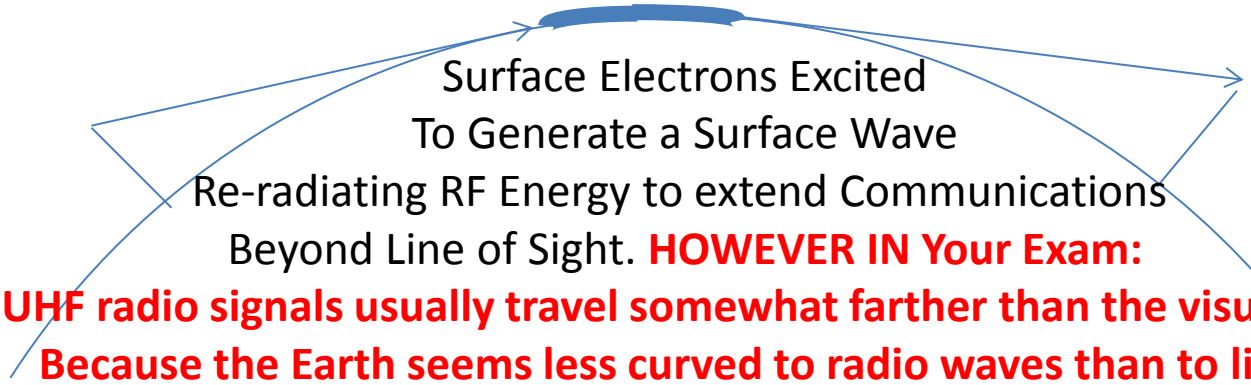

180 mi
150 mi
120 mi
90 mi
60 mi
30 mi
0 mi
-Ionized Clouds Associated with Auroral Activity.
-Most commonly 6 and 2 Meters Propagation
-Highly Distorted Signals.
-Ionization Due to Protons Ejected from the Sun
F-Layer (3 to 30mhz
sometimes to 50 MHz)
-Due to Ultra Violet Radiation
-Ultra Violet Radiation Increases
with Sun Spot Number
-Elliptical Polarization
-Multiple Paths Can Cause Fading
Meteor Ionization
Trails
Exam states that
6 meters is best.
-Patches of heavily ionized clouds, speculation
due to wind shear from thunderstorm activity.
-Supports 10, 6 and 2 Meters Propagation
Sporadic E
Auroral
Patches
E-Layer (300khz – 3 MHz)
Thermosphere
Electron Density
Mesosphere
Tropospheric Ducting: Effect is enhanced by Temperature Inversion
Tropospheric Scatter: Dense patches of moisture such as clouds.
Both Due to Changes in Index of Refraction or
Dielectric Constant in Lower Atmosphere or Troposphere.
Stratosphere
Troposphere



Two or more paths can
Add Either Constructively
To Enhance Signal Strength
Or Destructively to
Diminish Signal Strength.
Rapid variation in a moving Mobile
Radio is referred to as **Picket Fencing.**
Sometimes worthwhile to **move an HT (Handheld Transceiver) a couple Of Feet** to Enhance Transmitted
And Received Signal Strength.

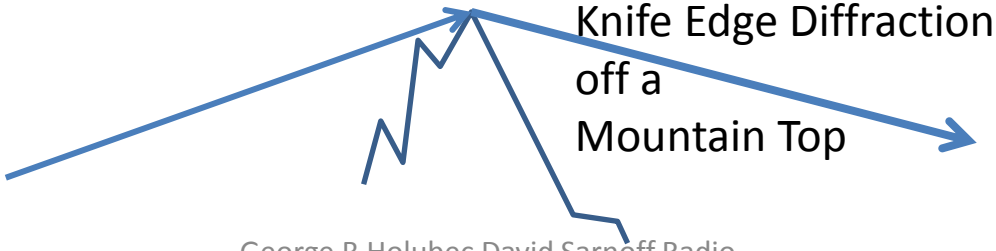
Ground Wave Communications

- Direct Wave or Path, Line of Sight
- Reflected Wave
- Surface Wave **(NOT SUB-SURFACE DUCTING!!!)**



Surface Electrons Excited
To Generate a Surface Wave
Re-radiating RF Energy to extend Communications
Beyond Line of Sight. **HOWEVER IN Your Exam:**

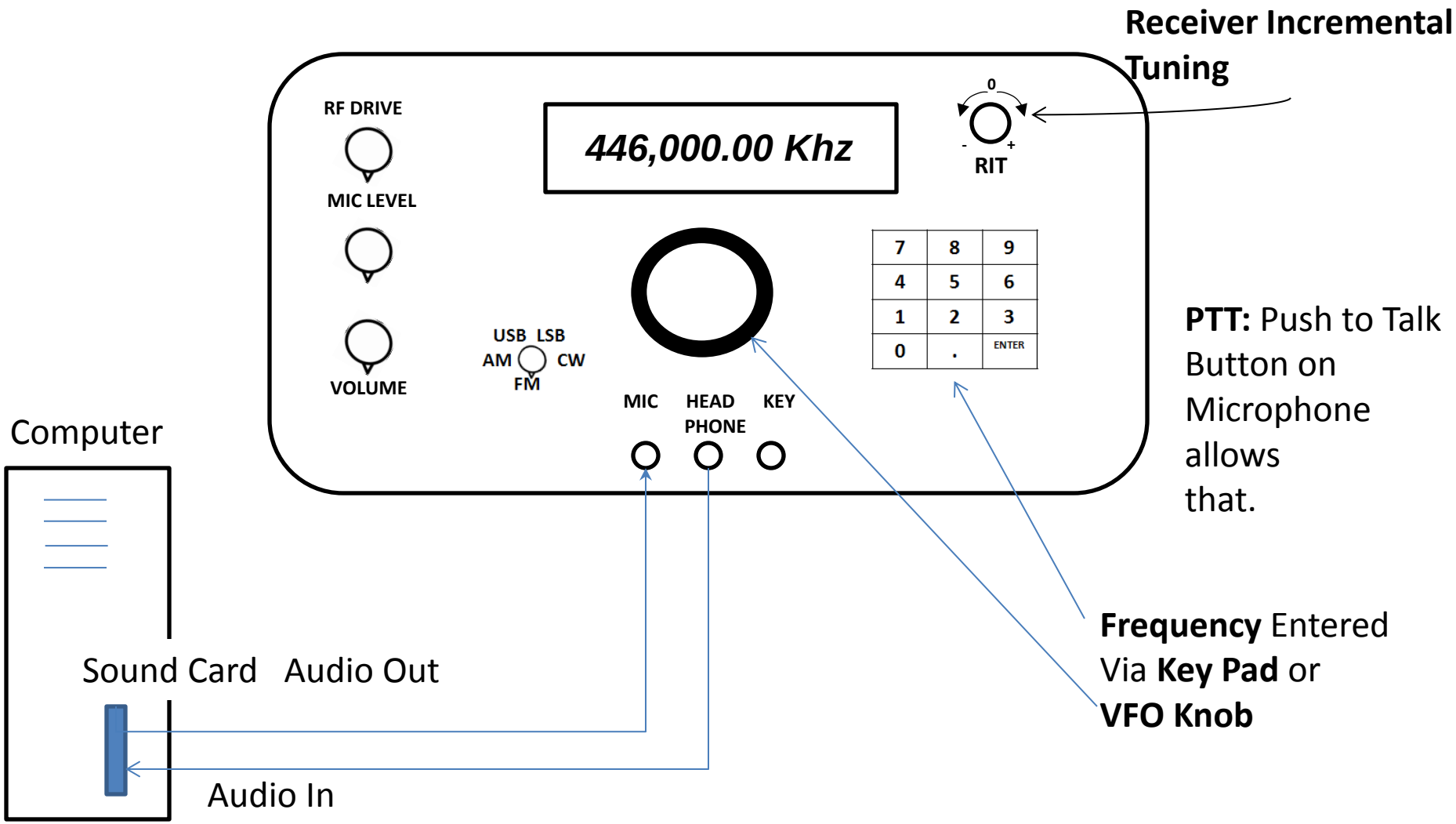
VHF and UHF radio signals usually travel somewhat farther than the visual line of sight Because the Earth seems less curved to radio waves than to light.



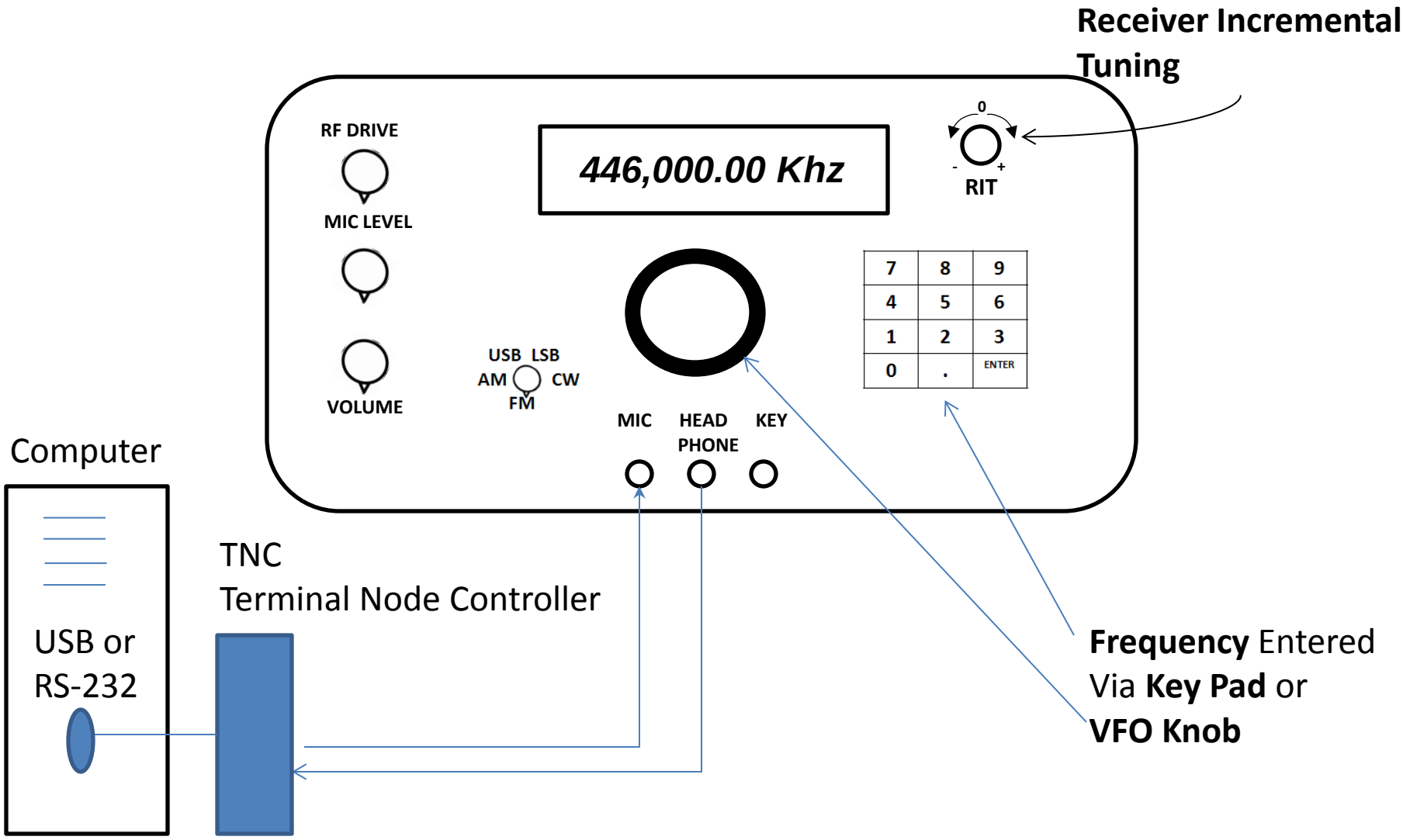
Knife Edge Diffraction
off a
Mountain Top

Transceiver Controls

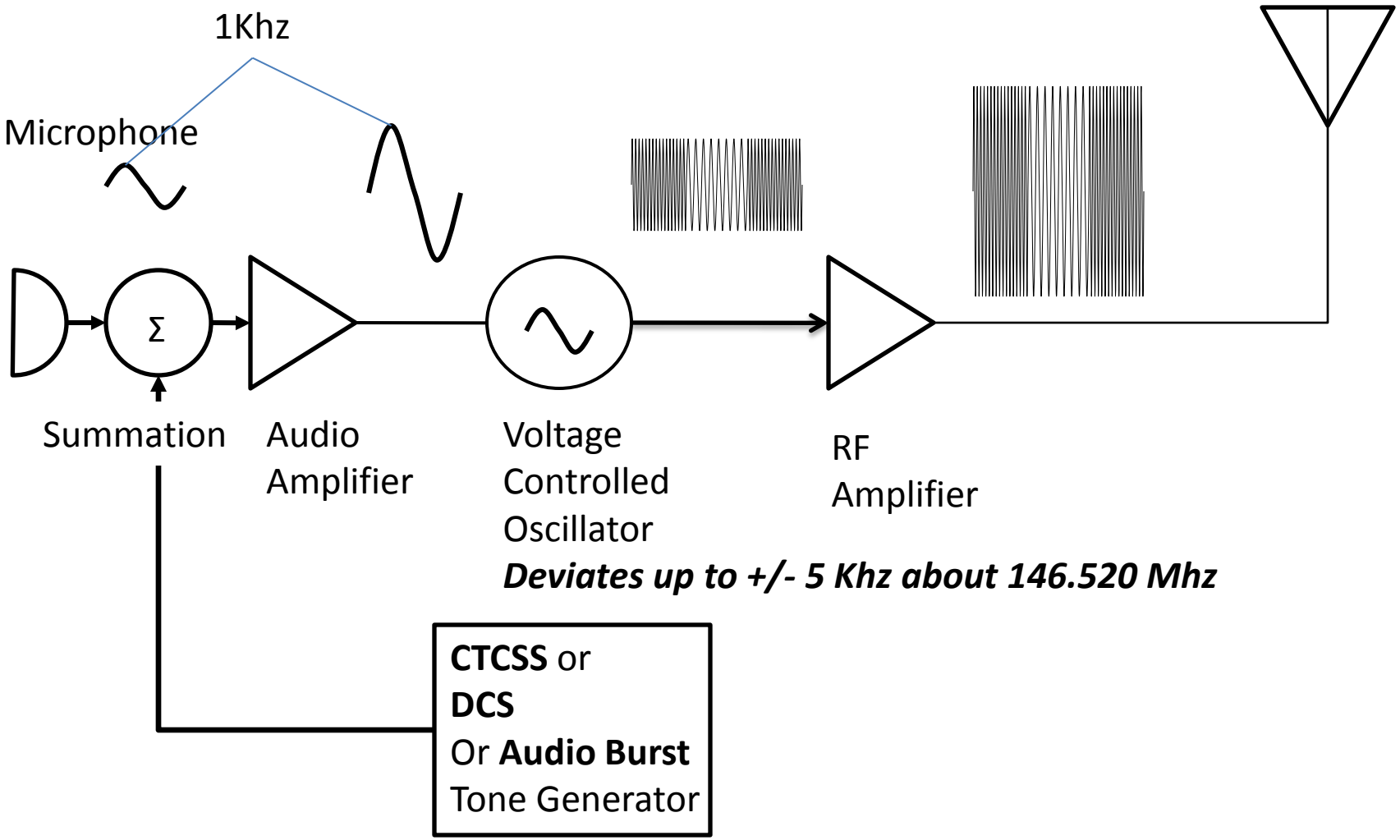
A transciever combines the functions of a transmitter and receiver.



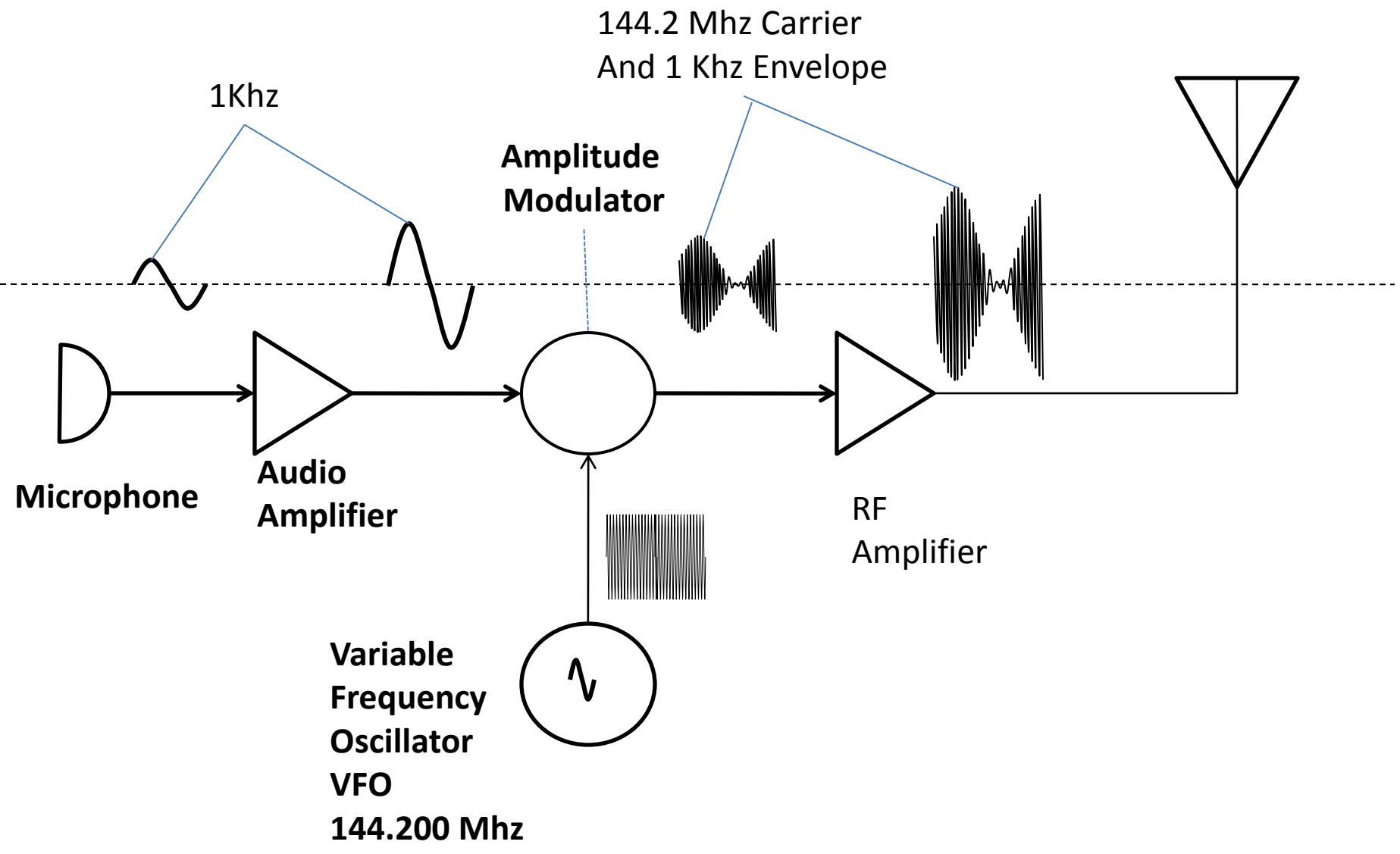
Transceiver Controls



Simple FM Transmitter

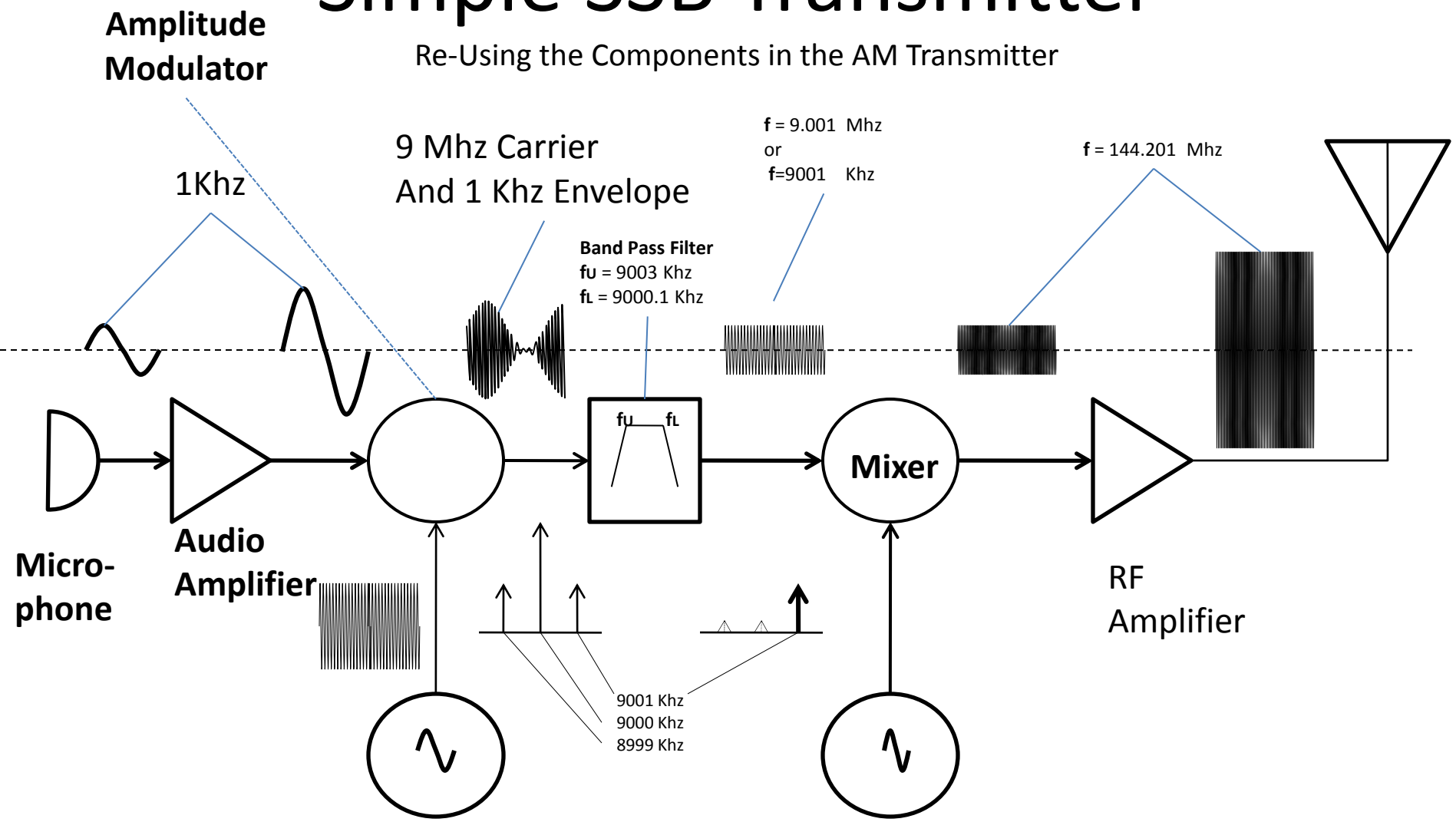


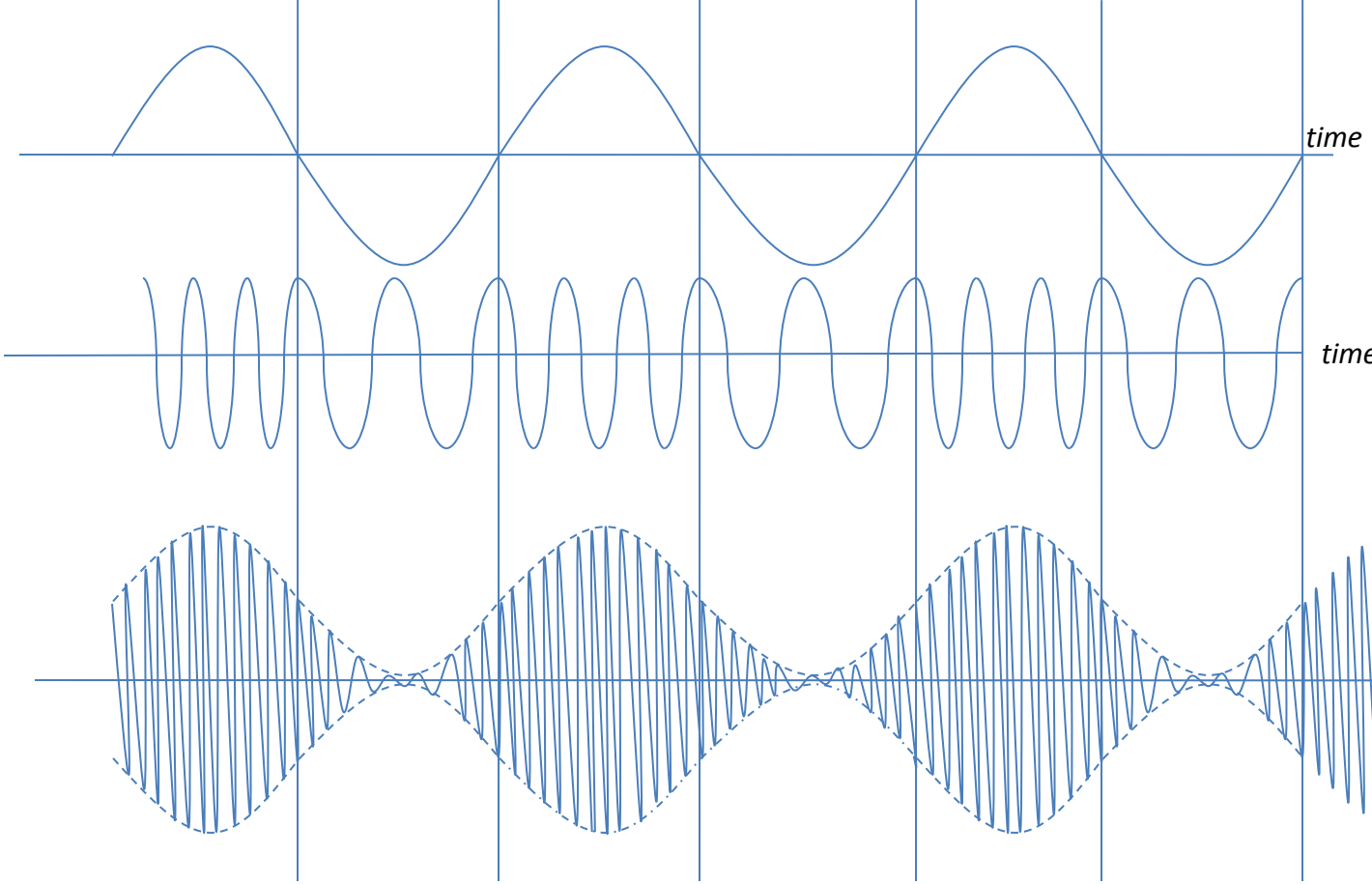
Simple AM Transmitter



Simple SSB Transmitter

Re-Using the Components in the AM Transmitter



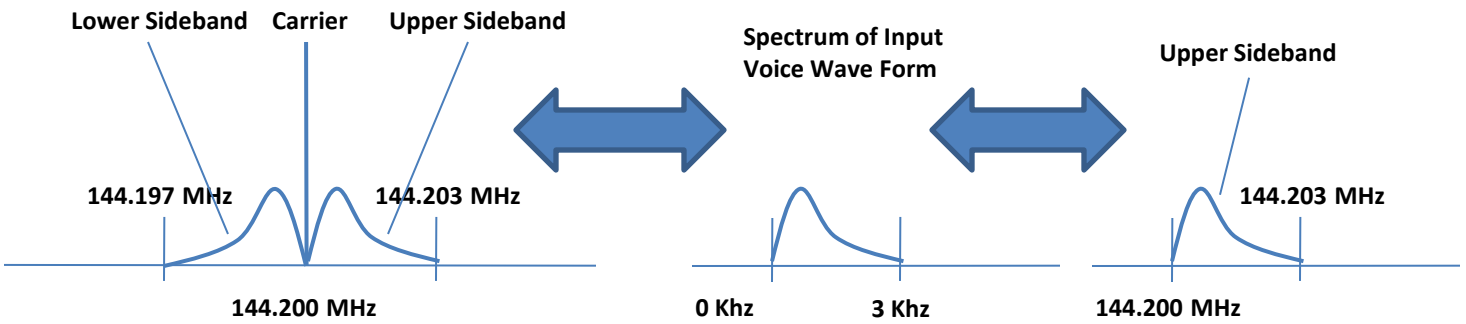


Input Waveform
Single Tone

Frequency Modulated
Waveform

Amplitude
Modulated
Waveform

Frequency = f_c



SSB and AM
Spectrum

AM Spectrum

Input Spectrum

Upper Sideband Spectrum

"Converts a Radio Signal from one frequency to another."

The function of a **product detector** is to **detect CW and SSB signals.**

Preamplifier installed
Between antenna and receiver.

"Generates a Signal of A desired Frequency"

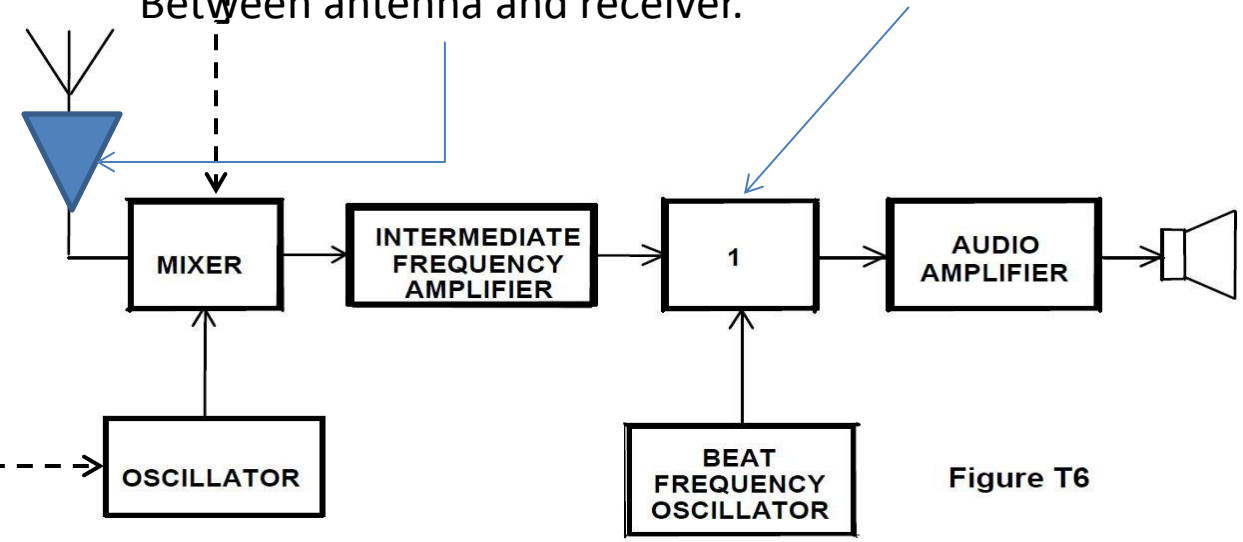


Figure T6

The **receiver** shown is a **Single-conversion superheterodyne**.

The function of the **mixer** in a **superheterodyne receiver** is to **shift the incoming signal** to an **intermediate frequency**.

A Couple of Important Radio Receiver Performance Parameters

- **Sensitivity**: The ability of a receiver to detect the presence of a signal.
- **Selectivity**: The ability of a receiver to ***discriminate*** between multiple signals.

T7A Station radios; receivers, transmitters, transceivers

T7A06 : The device takes the output of a **low-powered 28 MHz SSB exciter** and **produces a 222 MHz output signal** is a **Transverter**

T7A07: PTT means **Push to Talk**

T7A08 : The circuit which **combines** a **speech signal** and **an RF carrier** is a **Modulator**

T7A09 : The device that is most useful for **VHF weak-signal communication** is a **multi-mode VHF transceiver.**

T7A10 : The device **which increases the low-power output** from a handheld **transceiver** is **an RF power amplifier.**

T7A11 : The circuit which **demodulates an FM signals** is a **Discriminator.**

T7A04 : The term which describes the ability **of a receiver to discriminate between multiple signals** is **Selectivity**.

T7A13 : An **RF preamplifier** is installed **between the antenna and receiver**.

T7B **Common transmitter and receiver problems; symptoms of overload and overdrive, distortion, interference, over and under modulation, RF feedback, off frequency signals; fading and noise; problems with digital communications interfac**es (Part1)

T7B01 : If you are told your **FM** handheld or mobile **transceiver** is **over deviating** you can **talk farther away from the microphone.**

T7B02 : F**undamental overload in** reference to a **receiver** is meant to be **Interference caused by very strong signals**.

T7B03 : All of the following may be a **cause of radio frequency interference**
- Fundamental overload
- Harmonics
-**Spurious emissions**

T7B04 : The most **likely cause of interference to a non-cordless telephone** from a nearby transmitter is the **telephone is inadvertently acting as a radio receiver**.

T7B05 : A logical first step when attempting to **cure a radio frequency interference problem in a nearby telephone** is install an **RF filter at the telephone.**
!!Not Low Pass Filter, Not High Pass Filter.!!

T7B06 : If someone tells you that your **station's transmissions are interfering with their radio or TV reception**, you should **first make sure** that your **station is functioning properly** and that **it does not cause interference to your own television.**

T7B07: All of the following **may be useful** in **correcting a radio frequency interference problem**?
- Snap-on ferrite chokes
- Low-pass and high-pass filters
-**Band-reject and band-pass filters**

T7B Common transmitter and receiver problems; symptoms of overload and overdrive, distortion, interference, over and under modulation, RF feedback, off frequency signals; fading and noise; problems with digital communications interfaces (Part 2)

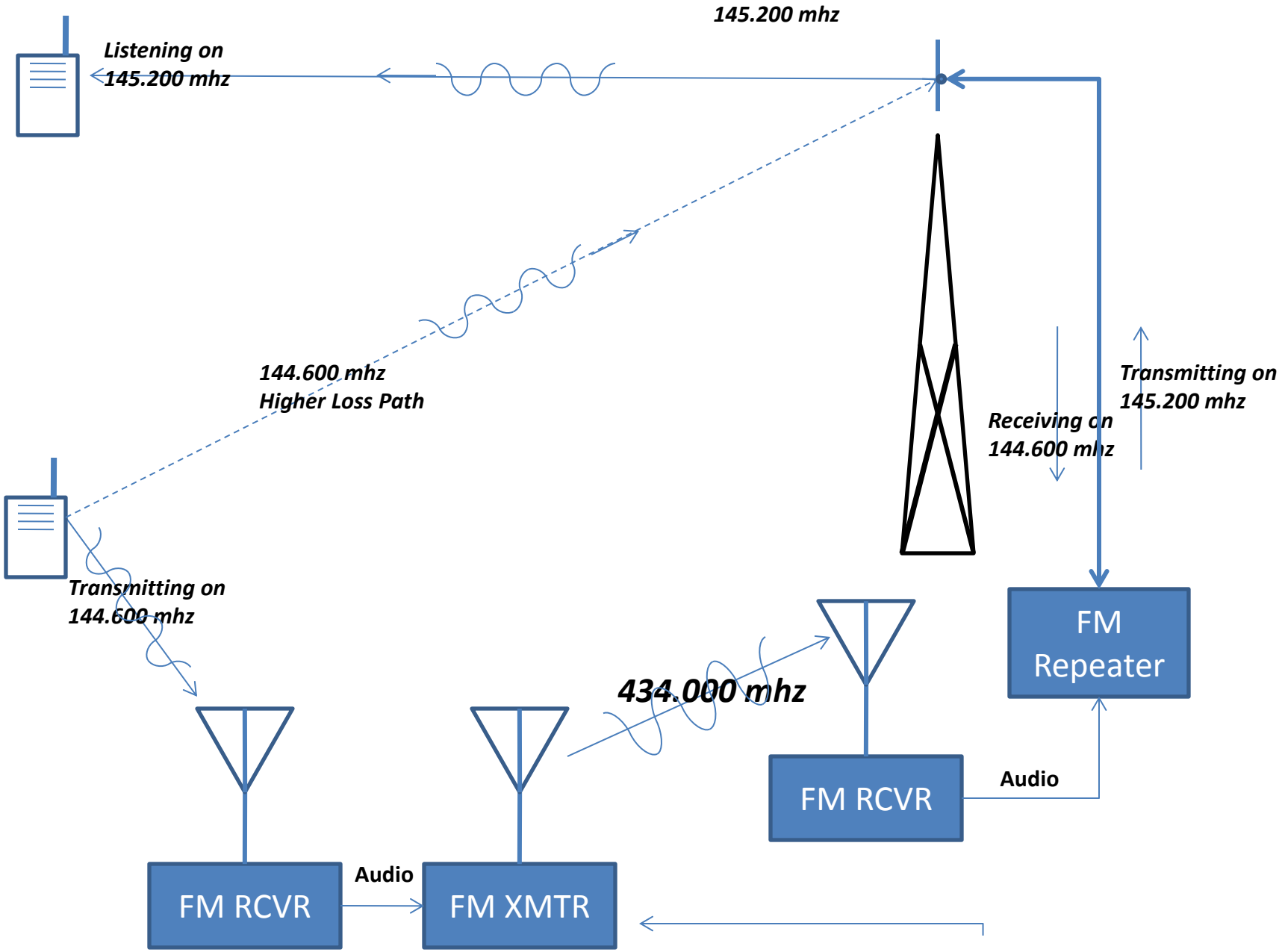
T7B08 : If a "**Part 15" device** in your **neighbor's home** is **causing harmful interference to your amateur station** the **all of the following** are valid things to do:
- **Work with your neighbor** to identify the offending device
- **Politely inform your neighbor about the rules** that require him to stop using the device if it causes interference
-**Check your station** and make sure it meets the standards of good amateur practice

T7B09 : If another operator reports a **variable high-pitched whine on the audio from your mobile transmitter** then
possibly **Noise on the vehicle's electrical system** is being transmitted along with your speech audio.

T7B10 : If you receive a report that **your audio signal through the repeater is distorted or unintelligible** then **all** the following are possible:
- Your **transmitter** may be **slightly off frequency**
- Your **batteries** may be running **low**
-You could be in a **bad location.**

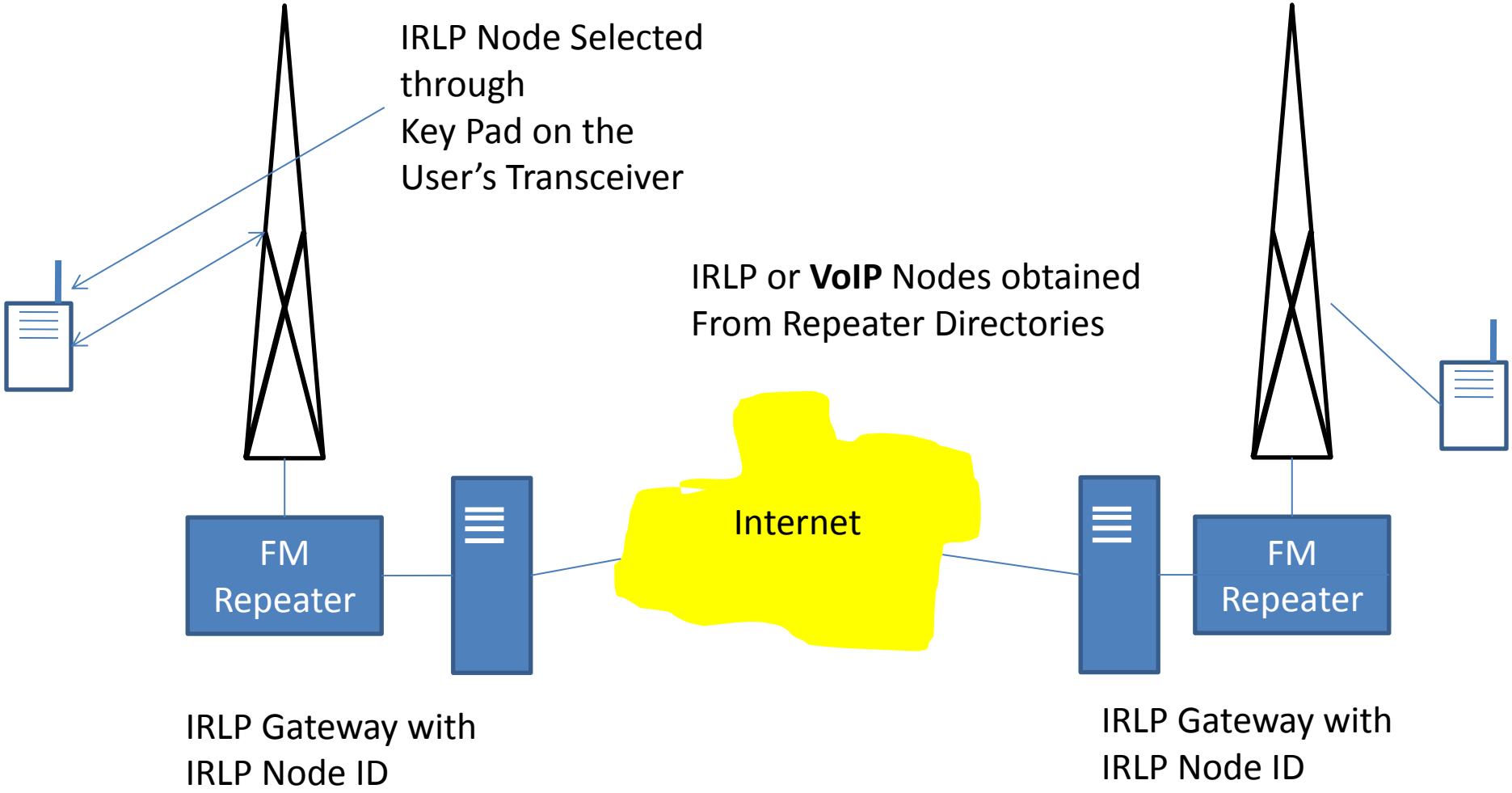
T7B11 : The symptom of **RF feedback in a transmitter** or transceiver is Reports of **garbled, distorted, or unintelligible transmissions.**

T7B12 : The acronym **"BER" means** when applied to digital communications systems **Bit Error Rate.**

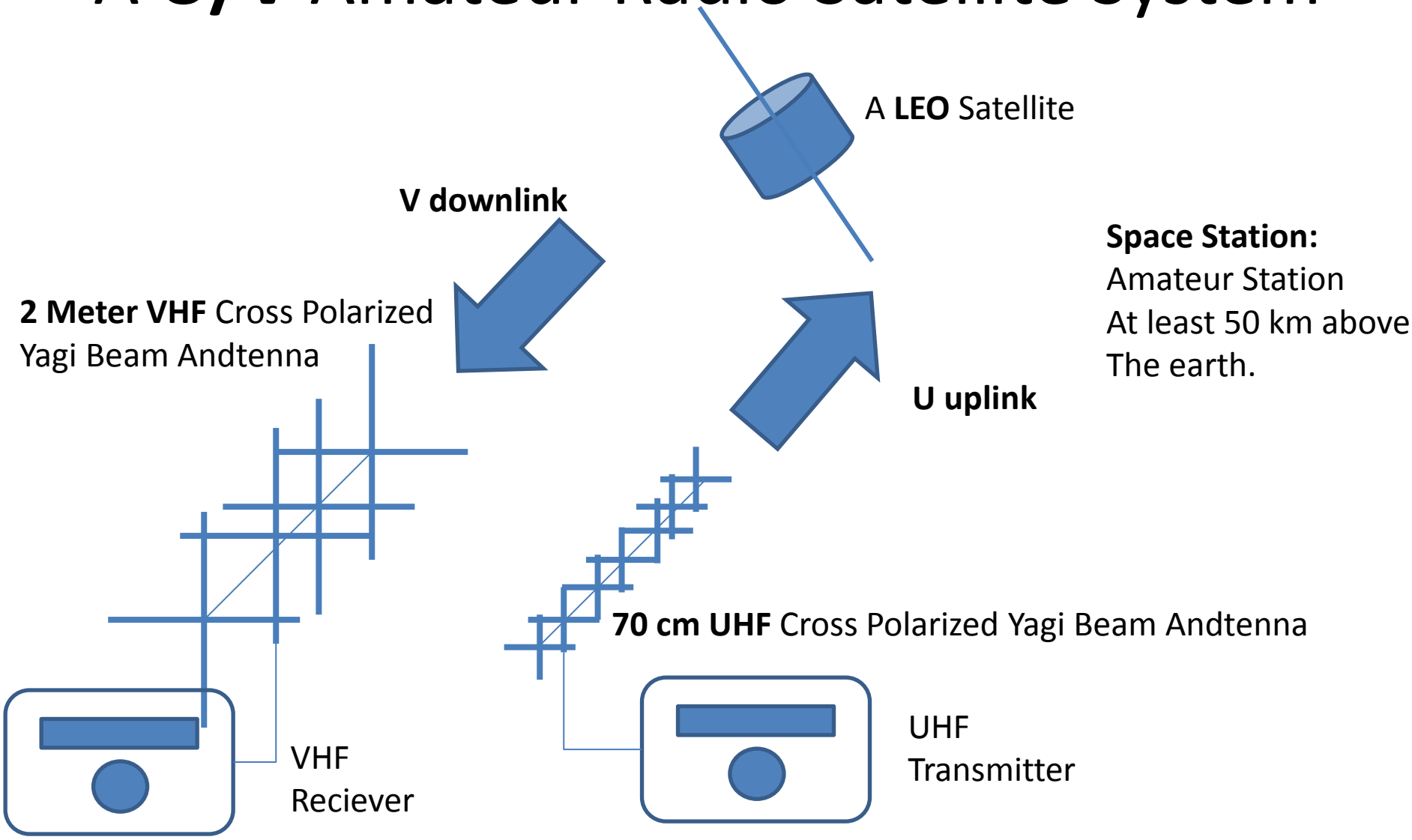


Auxiliary Station using a radio link to replace A connection that could be hardwired.

IRLP
Internet Radio Linking Project



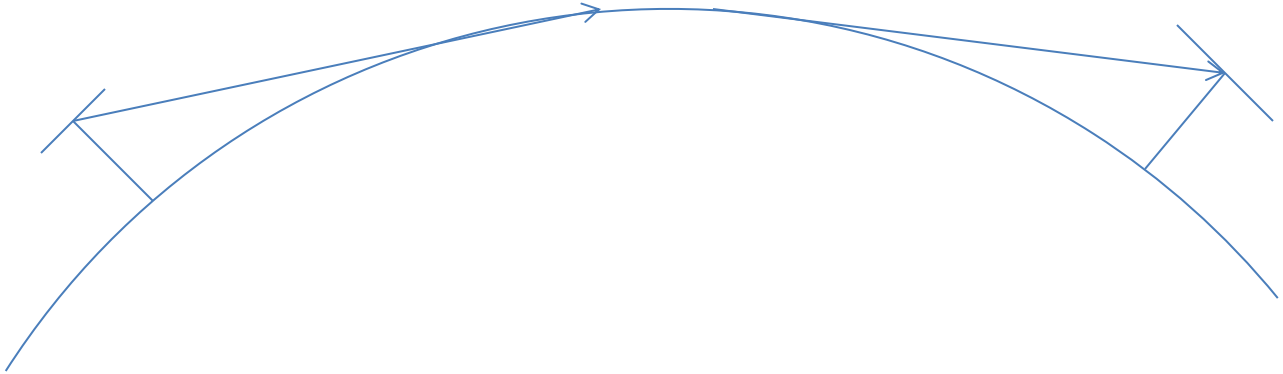
A **U/V** Amateur Radio Satellite System



Amateur Radio Communications Via Satellite

1. With these satellites one can **talk to amateur radio operators in other countries. NO GPS** and **NO Telephone Calls**.
2. **Minimum amount of power needed to complete the contact is used on the uplink.**
3. **Who?? >** Any amateur ***whose license privileges allow them to transmit on the satellite uplink frequency.***
4. **Digital Satellites** Use **FM Packet** as part of a message forwarding system.
5. **U/V** Transponder means that the **uplink is on 70cm** and the **down link is on 2 meters**.
6. **Spin Fading** is due to rotation of the Satellite and its Antenna.
7. **LEO** refers to **Low Earth Orbiting** Satellites. These satellites are ***typically*** visible and available for on the order of tens of minutes at a time or less, some 6 times a day.
8. **Satellite Tracking Programs** software that is used to track the position of a satellite in its orbit and hence **indicate when a satellite is accessible**.
9. **Doppler Shift** : observed ***change in signal*** frequency caused by relative motion between the satellite and the earth station.
10. **Beacon:** A transmission from a space station that contains information about a satellite.
11. **Satellite tracking programs** provide: **Maps showing the real-time position** of the satellite track over the earth, the **time, azimuth, and elevation of the start, maximum altitude, and end of a pass** the **apparent frequency of the satellite transmission**, including effects of Doppler shift.

Over the horizon propagation by: Surface Wave, Tropospheric Ducting or Scatter and Other Propagation Modes.



Weak Signal Activity: What is it?

- VHF UHF and Microwave Bands
- Characterized by Received Signal Strengths Just above noise floor (Low SNR)
- Over the horizon propagation, non-line of sight or direct propagation.

For the Exam Know that Stations involved in Weak Signal Activity:

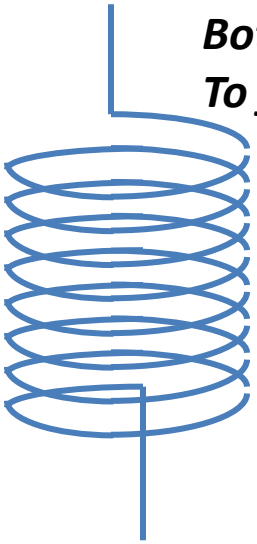
1) Use **Horizontal Polarization**
2) Use **Multi-Mode Transcievers**
3) Most Common Modes are **SSB** and CW

Items Concerning Digital Modes and Data Mentioned In The Exam

- IRLP : Internet Radio Linking Protocol, connects Repeaters via VoIP.
- APRS : Automatic Position Reporting System.
- NTSC : Old style, non-HD Fast Scan Television Standard
- Digital Modes
  - Parity Bit : “Code Element” Used to Detect Errors
  - BER : Bit Error Rate
  - Digital Modes
    - **Packet** : Similar to Datagram Transmission on the Internet: Uses Check Sum for Error Detection, Station Destination Information in the Header, and ARQ for Error Correction (Automatic Repeat Request)
    - **PSK31** : 31 Baud Phase Shift Keying: Low Rate Data Transmission Mode
    - **MFSK** : Multi-Tone Frequency Shift Keying

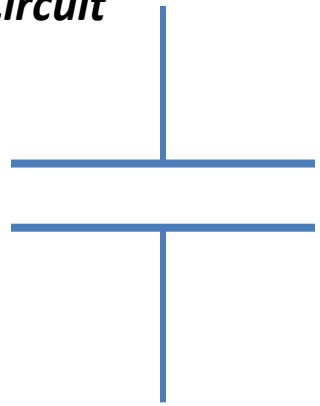
Fundamental Components

Both Can be combined
To form a Tuned Circuit



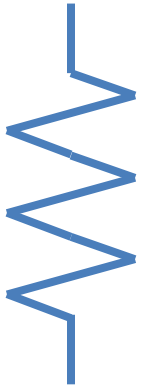
Inductor
Inductance in Units of **Henry**
Stores Energy in Magnetic Field

Optional Knowledge:
Opposes the ***change***
In current
A Low Impedance
to Low Frequencies



Capacitor
Capacitance in Units of **Farad**
Stores Energy in Electric Field

Optional Knowledge:
Opposes the ***change***
In Voltage
A Low Impedance
to High Frequencies



Resistor
Resistance in Units of **Ohm**
Dissipates Energy
Opposes the Flow of Current

Optional Knowledge:
A constant impedance at all Frequencies.

T5C12: Impedance is the opposition to the flow of AC Current.
T5C13: Impedance is measured in units of ohms.

Impedance, Resistance and Reactance

Impedance: -Opposition to Alternating Current.
-Measured in Ohms.
-Function of Frequency
-Has two numbers or dimensions

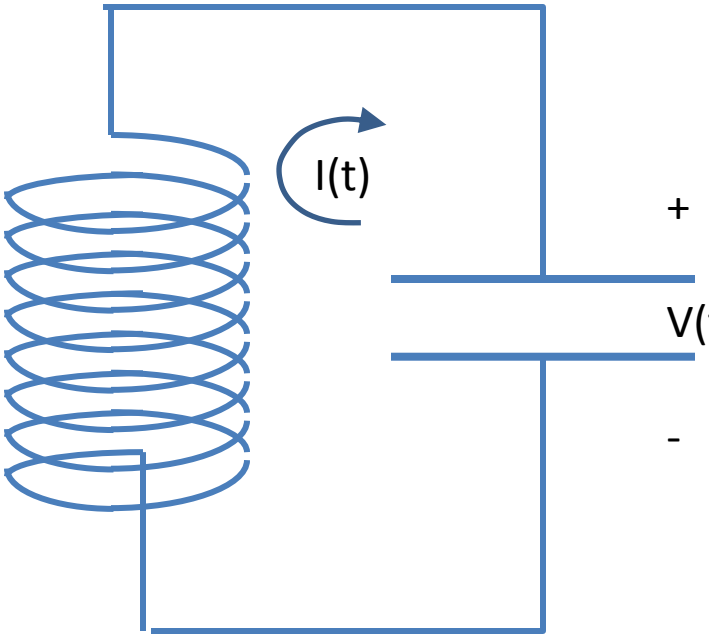
EXAM QUESTION

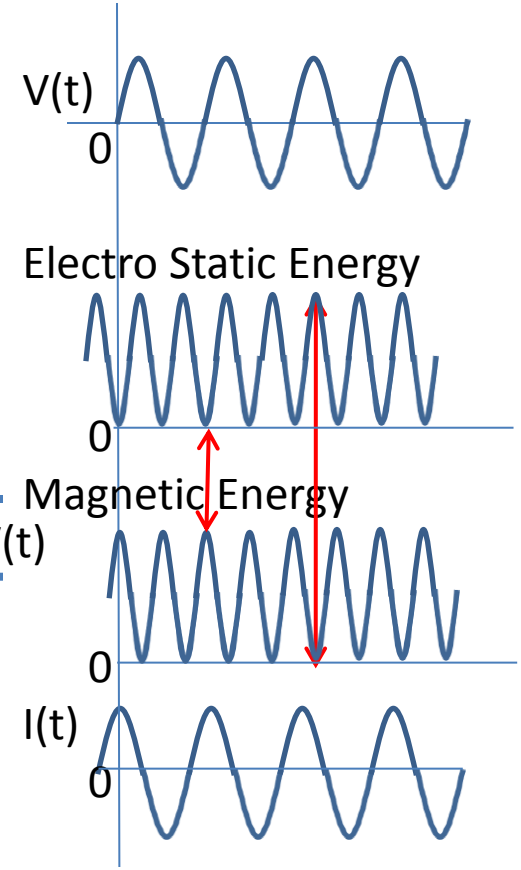
Resistance:
-Voltage ÷ Current In Phase With the Voltage.
-Units of Ohms
-Ideal Resistors are pure resistances i.e. reactance = 0.

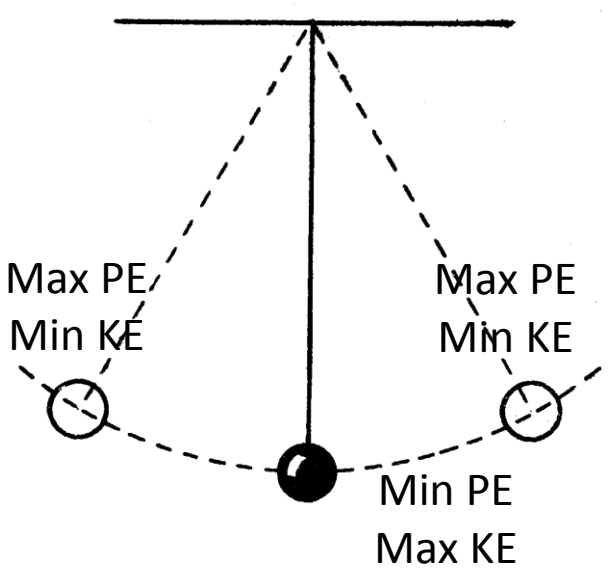
Reactance:
-Voltage ÷ Current Either Leading or Lagging the Voltage by 90 degrees.
-Units of Ohms
-Ideal Inductors and Capacitors are pure reactances i.e. resistance = 0.
-Voltage Leads Current in Inductor by 90^o
-Voltage Lags Current in Capacitor by 90^o

Tuned Circuit

Both Inductor and Capacitor
Can be combined
To form a Tuned Circuit







Equivalent to Relation Between **Kinetic** and **Potential Energy** in Pendulum

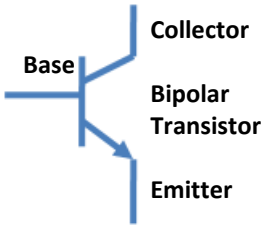
As **Magnetic Energy** in the Inductor increases **Electro-Static Energy** in the Capacitor decreases, Until the **Cycle Reverses** and **Electro-Static Energy** Increases while **Magnetic Energy** Decreases. The Cycle Repeats over and over again. If there were no resistance to remove energy from the system, this oscillation would continue indefinitely.

Other Components

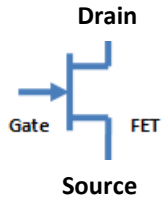
Potentiometer
-Volume Control

Switch
-SPST

Fuse



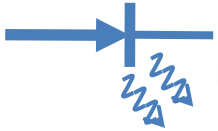
Small Amount of Voltage and Current Controls Large Amount of Current. Used as Amplifier or Switch.

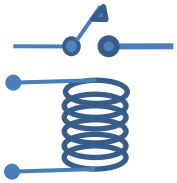


Change In Voltage Controls Current. Used as Amplifier or Switch.

Diode

Allows Current to Flow in only one direction. Also Known as a rectifier.

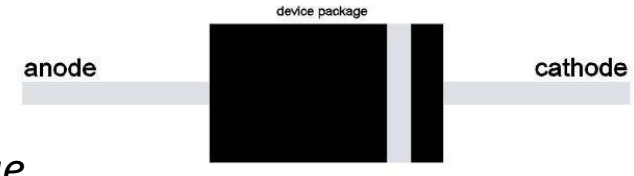




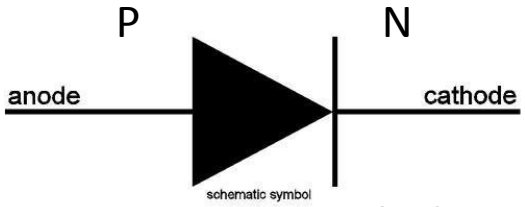
Relay
Electromagnetically Controlled Switch
- Example is SPST

CONVENTION:
The direction of current flow is always indicated in the direction of positive charge even if the mobile charge carrier is an electron.

The Diode

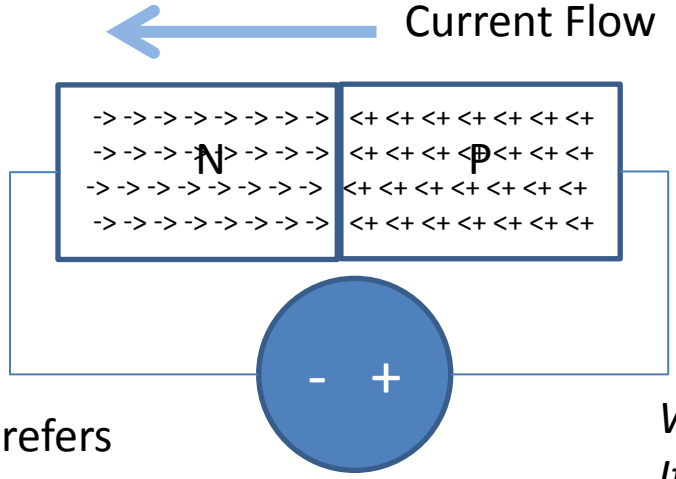


Stripe Indicates The Cathode



Equivalent

Positively Charged Holes Move To the **Left** to **Combine** With **Negatively Charged Electrons** moving to the **Right.**



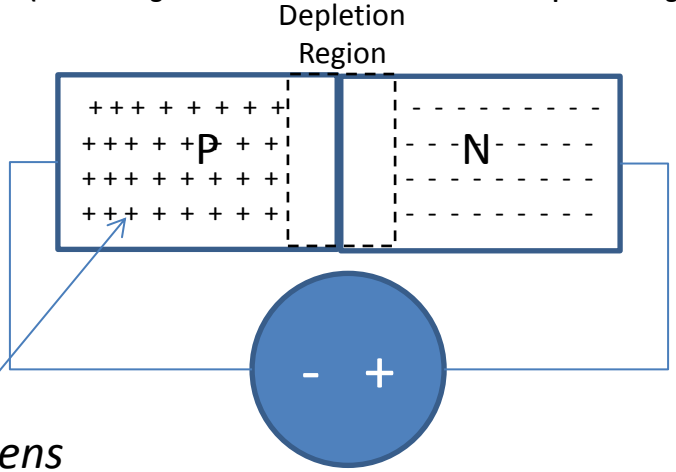
N and **P** refers To the charge Of The **Majority Mobile Charge**.

Forward Bias Current Flows

Positively Charged Holes and **Negatively Charged Electrons** Move away from each other. No combination takes place.

No Current Can Flow.

(Once Charge Carriers are removed from the Depletion Region)



What Happens If Electrons were Injected Here??? ANS: 2 Possibilities.

Reverse Bias No Current Flows

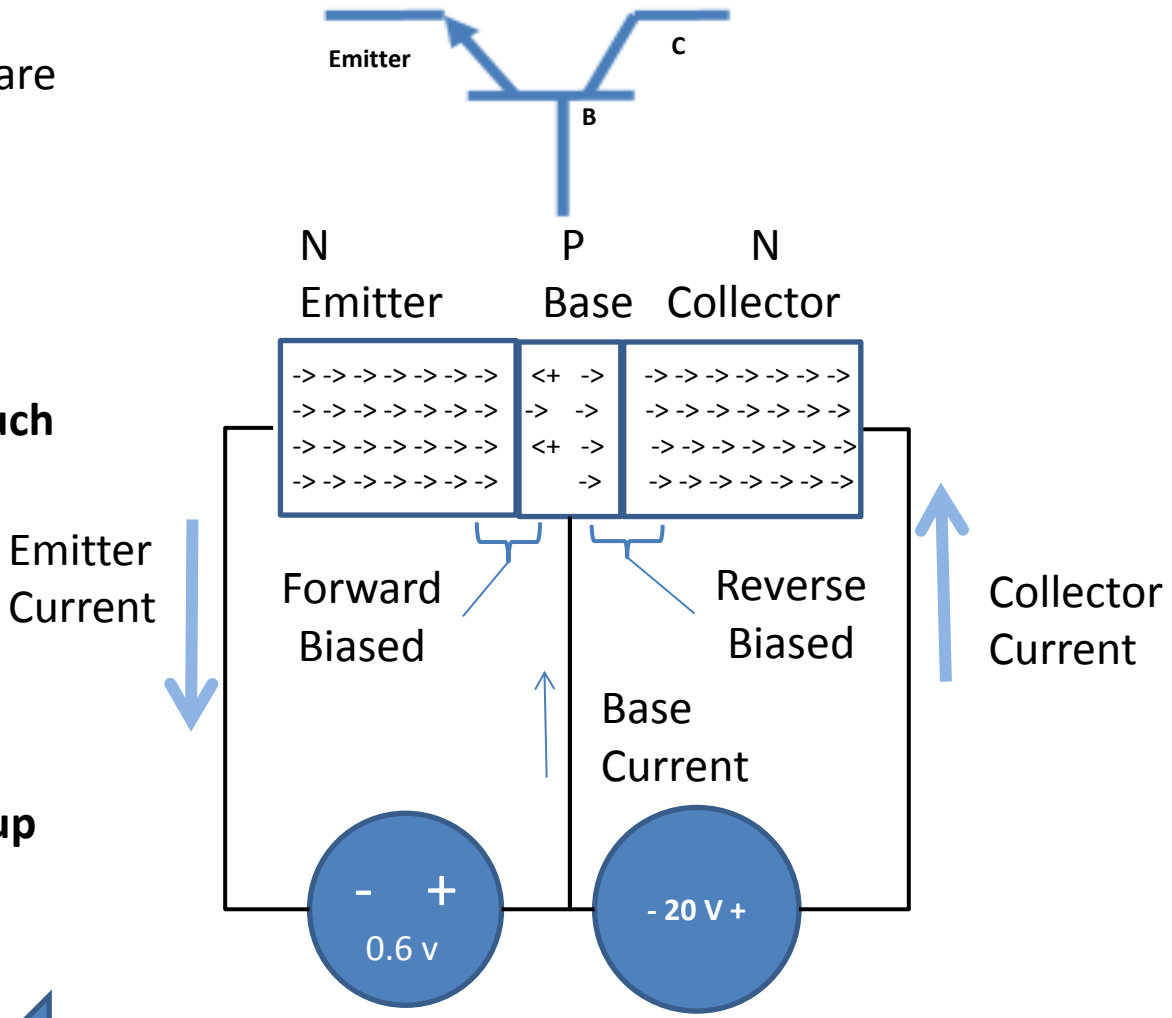
Bipolar Transistor

Instead of Recombining
with the Holes, most electrons are
Swept into the collector

The Time it takes
for an **electron** from
the **emitter** to **transit**
the **base** into the **collector** is **much shorter** than the
average time required
to recombine with a hole
in the **base**.

THERFORE:
Vast majority of electrons end up
In the collector.

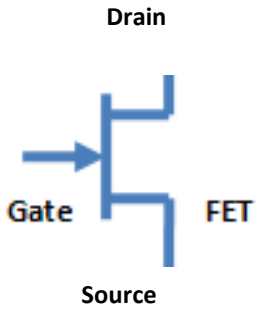
A small change in Base Voltage and Current Controls
A large amount of Collector Current.

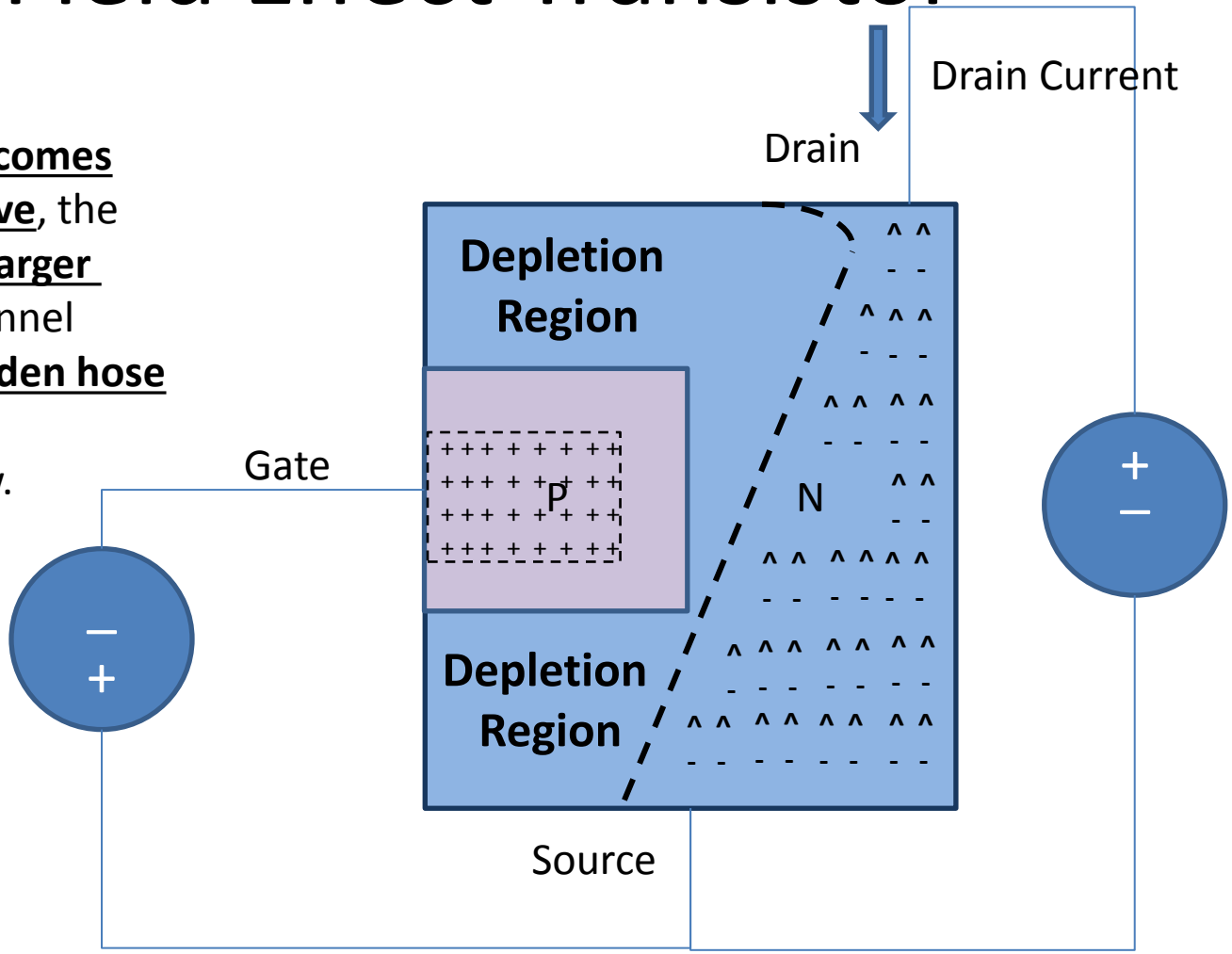


KEY TAKE AWAY

FET Field Effect Transistor

As the **Gate Voltage Becomes more and More Negative**, the **depletion Region gets larger** and larger until the channel is **pinched off like a garden hose** no electrons can move and no current can flow.

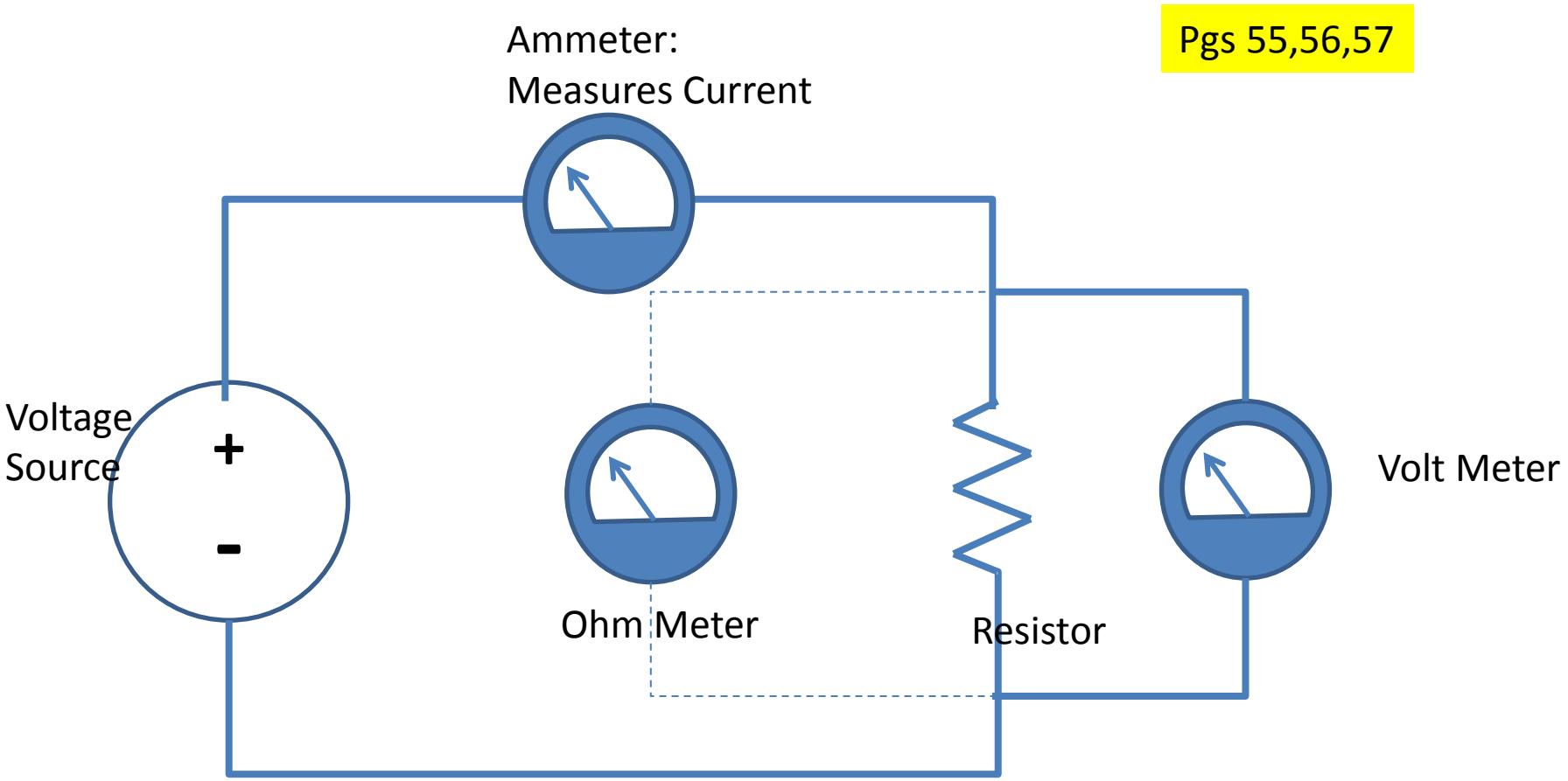


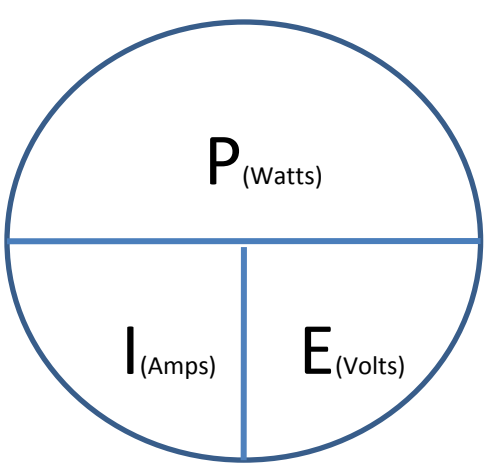


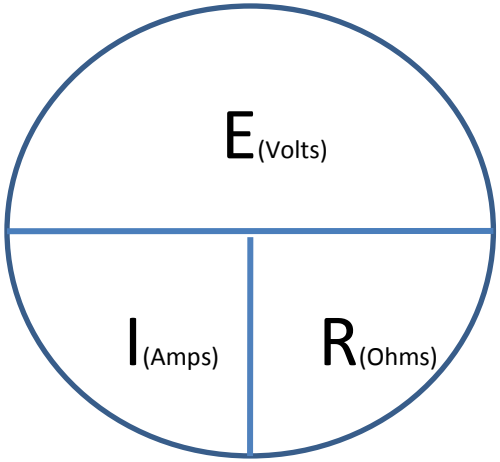
Small Change in Gate Voltage causes a large change in Drain Current.

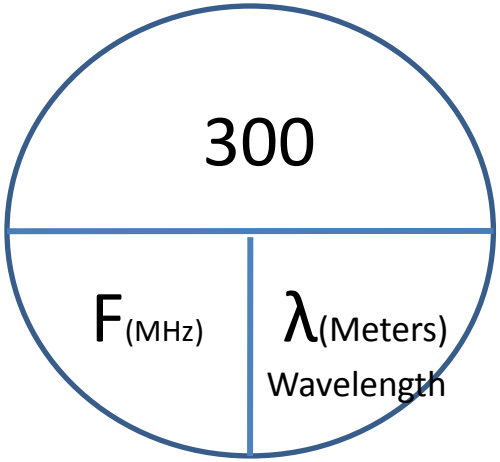
Measurements

Pgs 55,56,57









Power Formula and Ohms Law

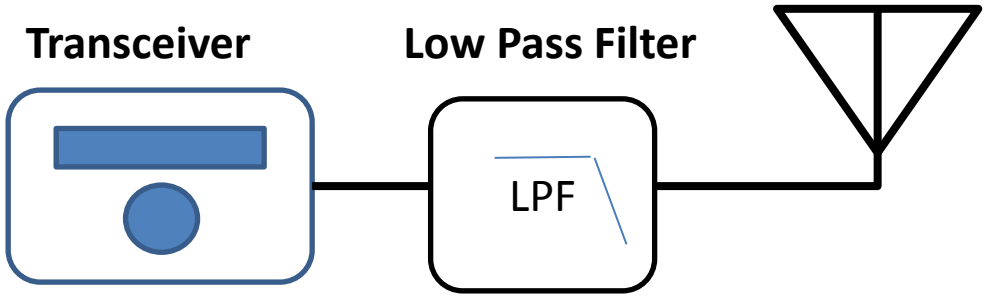
$$P = I \times E$$

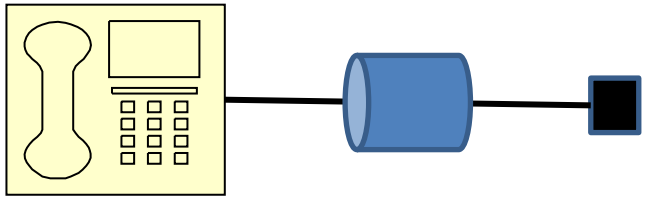
$$E = I \times R$$

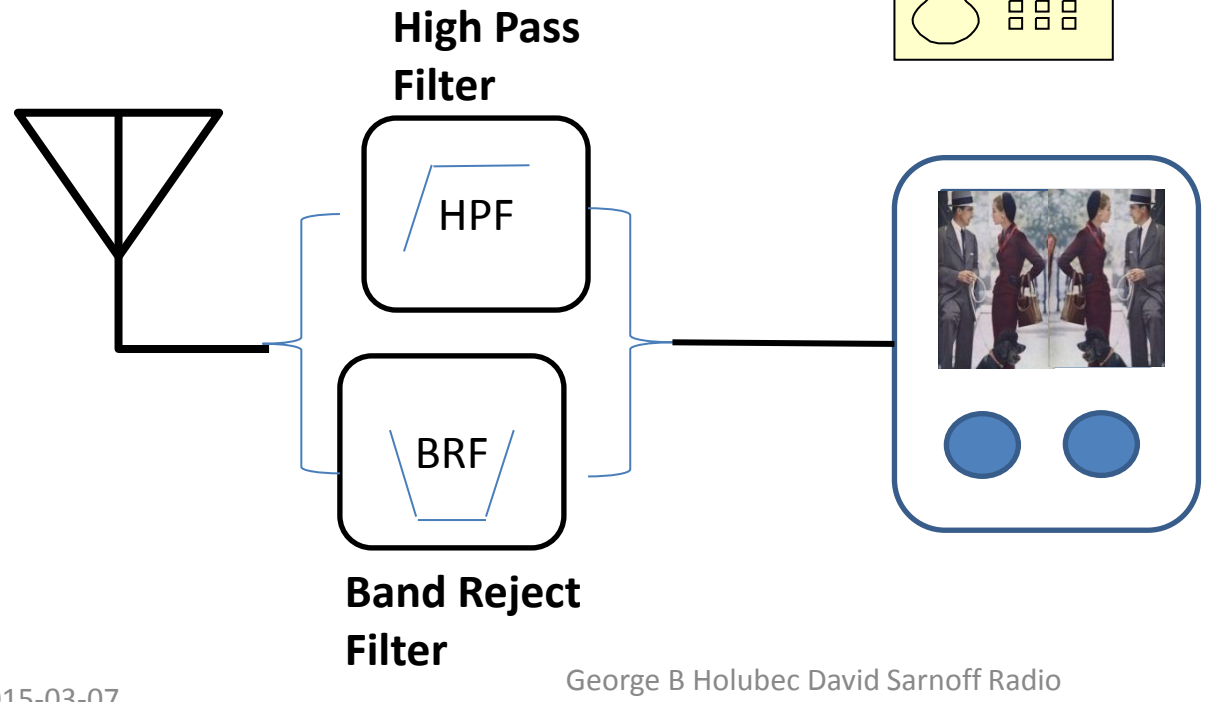
Frequency Formula:

$$\text{Freq}_{\text{MHz}} = 300/\text{Wavelength}_{(\text{Meters})}$$

Some Approaches to RF Interference Mitigation







Part 15 Interference
Automotive Whine

Magic Numbers To Remember

• **300,000,000 Meters/Second :** Speed of light or Radio Wave in Free Space

•**50 MHz** : Frequency with Lowest Maximum Permissible Radiation Exposure Limit
• **50 Watts** : Maximum Power Below which RF Exposure Evaluation is not Necessary at VHF UHF Frequencies

• **30 Volts:** Lowest Voltage that Can Cause Dangerous Shock
• **8 Foot Long:** Length of **Ground Rods** to be connected to the **legs of a tower**
•**10 Feet Away: Minimum Distance** from **fallen antenna** to **power wires**
•**Part 97** of the **FCC rules** contains the rules and regulations **governing the Amateur Radio Service.**
•**50 km above the earth :** for an **amateur station** to be considered a **space station**.
•**Region 2: North American ITU Region.**
•**CW only** is permitted in the mode-restricted sub-bands at **50.0 to 50.1 MHz** and **144.0 to 144.1 MHz**.
• **6 meter, 2 meter, and 1.25 meter** bands have **mode-restricted sub-bands.**

•You are using the **1.25 meter band** if you are transmitting on **223.50 MHz**.
•**1296 MHz** is the **23 cm frequency** is authorized to a Technician Class operator license.
•**443.350 MHz** is the **70 cm frequency** is authorized to a Technician Class license holder operating in **ITU Region 2.**
•You are using the **2 meter band** when your station is transmitting on **146.52 MHz.**

•**10 Year Normal License Term**
•**2 Year Grace Period after Expiration**
•**4 or more members of a club** needed for a **club station license.**

•**446.000 MHz** is the **national calling frequency** for **FM simplex operations** in the **70 cm band.**
•**Plus or minus 600 kHz is** the most common repeater **frequency offset in the 2 meter band.**
•**Plus or minus 5 MHz** is a common **repeater frequency offset** in the **70 cm band.**
•**Only Data maybe transmitted between 219 mhz and 220 mhz.**

•**Sporadic E** is most commonly associated with signals on the **10, 6, and 2 meter bands**.
•**6 Meters** is **best** suited to communicating **via meteor scatter**.

•**2400 Hz is an appropriate receive filter** to select in order to minimize noise and interference **for SSB reception**.
•**3 Khz is the Bandwidth for SSB transmission**

•**500 Hz** is an appropriate **receive filter** to select in order to minimize noise and interference **for CW reception**.
•**150Hz is the Bandwidth of CW Transmission**
•**Between 5 and 15 Khz is the Bandwidth of FM Transmission**

Glossary

amateur station : in Amateur Radio Service and has apparatus for radio communications
amateur station control point: location where control operator function is performed.
Automatic control : is being used for a repeater when the control operator is not present at a control point. NOT Remote control!! , NOT Unattended!!
auxiliary station : transmits signals from a remote receive site to a repeater for retransmission
band plan: is a voluntary guideline for using different modes or activities within an amateur band.
Broadcasting : transmissions intended for reception by the general public
Carrier squelch: muting of receiver audio controlled solely by the presence or absence of an RF signal.
Check (**Message Handling**): a count of the number of words or word equivalents in the text portion of the message
CTCSS: sub-audible tone transmitted with normal voice audio to open the squelch of a receiver.
DCS or Digital-Coded Squelch: superimposes a continuous stream of FSK digital data, at 134.5 baud, on the transmitted signal to open the squelch on a receiver.
Electric and magnetic fields : two components of a radio wave
Electromagnetic wave: carries radio signals between transmitting and receiving stations
Frequency : is the term that indicates the number of times per second that an alternating current reverses direction.
Frequency Coordinator: individual who recommends Transmit & Receive Channels for auxiliary stations and repeaters; selected by operators in a local or regional area
Harmful Interference : man-made interference that seriously degrades, obstructs, repeatedly interrupts Radio Communications
ionosphere: enables the propagation of radio signals around the world.
ITU : United Nations Agency for Information and Communications Tech. Issues ITU Region 2: North America
Local control : is being used when transmitting using a handheld radio.
Multipath: The propagation of a radio-wave over two or more paths from a given source to a given destination.
Picket fencing: is commonly used to describe the rapid fluttering sound sometimes heard from mobile stations that are moving while transmitting.
Preamble (Message Handling): in a formal traffic message is the information needed to track the message as it passes through the amateur radio traffic handling system.
QRM: the "Q" signal used to indicate that you are receiving interference from other stations.
QSY: the "Q" signal used to indicate that your are changing frequency.
RACES and ARES: in common that both organizations may provide communications during emergencies.
Radio Amateur Civil Emergency Service: is the radio service using amateur stations for emergency management or civil defense communications.
radio horizon: the distance at which radio signals between two points are effectively blocked by the curvature of the Earth
Remote control : is used when the control operator is not at the station location but can indirectly **manipulate the transmitter**.
repeater offset : difference between the repeater's transmit and receive frequencies.
Repeater station: simultaneously retransmits the signal of another amateur station on a different channel or channels
RIT: Receive Incremental Tuning; On a transceiver, Allows the operator to keep the transmit frequency constant, while changing the receiver frequency.
Simplex communication: transmitting and receiving on the same frequency.
Space Stations: are more than 50 km above the earth.
Squelch: Receiver circuit which mutes the audio output until a carrier of minimum power level is detected by the receiver. The receiver may also be activated with a CTCSS tone or DCS sequence in addition to the carrier.
Tactical Call : is being used when identifying as "Race Headquarters".
telecommand : one way transmission to initiate, modify or terminate functions of a device
telemetry: one way transmission of measurements from an instrument.
Wavelength : distance a radio wave travels during one complete cycle.

Technician Class Sub Elements

Sub Element	Num Questions	Num Sub Groups	Description
T1	6	6	FCC Rules, descriptions and definitions for the amateur radio service, operator and station license responsibilities
T2	3	3	Operating Procedures
T3	3	3	Radio wave characteristics, radio and electromagnetic properties, propagation modes
T4	2	2	Amateur radio practices and station setup
T5	4	4	Electrical principles, math for electronics, electronic principles, Ohm's Law
T6	4	4	Electrical components, semiconductors, circuit diagrams, component functions
T7	4	4	Station equipment, common transmitter and receiver problems, antenna measurements and troubleshooting, basic repair and testing
T8	4	4	Modulation modes, amateur satellite operation, operating activities, non-voice communications
T9	2	2	Antennas, feedlines
T0	3	3	AC power circuits, antenna installation, RF hazards
Totals	35	35	

NGOs

US Federal Government
Executive Branch

United Nations

ARRL

FCC

FCC Makes Use of ITU Rules and Standards **In Particular The List of *Countries* that US Amateur Radio Operators** can communicate with.

ITU

Identifies

ARES

RACES

Organizations Providing Emergency Communications Services Through Amateur Radio In the USA

Part 97
Rules Governing Amateur Radio Operations

OET Bulletin 65
Practices Governing the Safe Operation of Radio Transmitters with Respect to EM Radiation

Part 15
Rules Governing Non-Licensed Low Power Devices e.g. **Cordless Phones**

North America
ITU Region 2
US Possessions and Maritime Mobiles outside
ITU 2 may have different Freq. Assignments.

Local Government

Building/Electrical Code
e.g. Tower Grounding Requirements

T1A ***Amateur Radio services; purpose of the amateur service, amateur-satellite service, operator/primary station license grant, where FCC rules are codified, basis and purpose of FCC rules, meanings of basic terms used in FCC rules***

Amateur Radio intended for persons with:

-interest in **advancing technical skills in the Radio Art**

- **with a personal aim**

-**no pecuniary** interest

-**to enhance international good will**.

-FCC regulates via **rules** in **Part 97** the **Amateur Radio Service** in USA

-Harmful Interference :

-**seriously degrades**

-**obstructs**

-**repeatedly interrupts -> Radio Communications**

-Willful Interference is never permitted.

-Radio Navigation Services are Protected from Interference From Amateur Radio Signals

-Frequency Coordinator:

- recommends Transmit & Receive Channels for auxiliary stations and repeaters

-selected by operators in a local or regional area

-Space Stations: are more than **50 km above the earth.**

-telecommand : one way transmission to **initiate, modify or terminate functions** of a **device**

-telemetry: one way transmission of **measurements from an instrument.**

-amateur station : in **Amateur Radio Service** and has **apparatus for radio communications**

-auxiliary station : transmits signals from a **remote receive site** to a **repeater for retransmission**

-ITU : *United Nations Agency* for **Information and Communications Tech. Issues**

-ITU Region 2: North America

-As a Secondary Service in the 70cm band, in some states near the Canadian border one must avoid interference to services with a primary designation in this same band.

T1B

Authorized frequencies; frequency allocations, ITU regions, emission type, restricted sub-bands, spectrum sharing, transmissions near band edges

Notes From The Exam	Band	Example in the Exam	CW Sub Bands From The Exam	Lower Frequency	Upper Frequency
Has Mode Restricted Sub-Band	6 meter	52.525 MHz	50.0 - 50.1 MHz	50 MHz	54 MHz
Has Mode Restricted Sub-Band	2 meter	146.52 MHz	144.0 - 144.1 MHz	144 MHz	148 MHz
Has Mode Restricted Sub-Band	1.25 meter	223.5 MHz		219-220*	222-225*
	70 cm	443.350 MHz		420 MHz	450 MHz
	23 cm	1296 MHz		1240 MHz	1300 MHz
				*Note the Split	

Formula that Can Be Used:

Wave Length (meters) = 300 / Frequency (MHz)

TRICK QUESTION:

T1B03 : 52.525 MHz is within the **6 meter band.**

!!49.00 MHz is not within the 6 meter band!!

Do not **set your transmit frequency to be exactly at the edge of an amateur band or sub-band.**

- To **allow for calibration error**
- **modulation sidebands do not extend beyond the band edge**
- To **allow for transmitter frequency drift**

-When an **amateur frequency band** is **available** on a ***secondary basis***, Amateurs **may not cause harmful interference** to ***primary users***.

T1C Operator classes and station call signs; operator classes, sequential, special event, and vanity call sign systems, international communications, reciprocal operation, station license licensee, places where the amateur service is regulated by the FCC, name and address on ULS, license term, renewal, grace period.

Call Signs:

- **special event call sign** has a **single letter** in **prefix** and **suffix.**
- **W3ABC** is a **valid** US amateur radio station **call sign.**

!!***Not: KMA3505, KDKA, 11Q1176!!***

- **K1XXX is a valid Vanity call sign for Technician Class Licensee to select.**
- Any Class of Licensee may request a vanity call sign.

==========

International Operations

-**International communications permitted** by **FCC :**

-Pertain to the **purposes of the amateur service**

-**remarks of a personal character**

!!***Not Business or items normally permitted by an international broadcast station.!!***

-**Allowed to operate in a foreign country** when the **foreign country authorizes it.**

-**Stop operating** or **eliminate the harmful interference** if on **23 cm band** and **interfering radiolocation station outside the US.**

-**FCC-licensed amateur station may transmit,** from **any vessel or craft** located in **international waters** and **documented or registered in the United States.**

==========

Must Keep Your Mailing Address Current with FCC

-**Correspondence from the FCC returned as undeliverable** may lead to **revocation** of the **station license** or **suspension of the operator license.**

==========

License Term 10 Years and Grace Period 2 Years:

- **Ten years** is the **normal term for** an FCC-issued **primary station/operator license**

-**Two years** is the **grace period** following the expiration of an amateur license within which the license may be renewed.

==========

ULS Data Base

- **Three Classes of Licensee**: Technician, General and Extra

- **As soon as** your **name and call sign appear** in the **FCC's ULS database** you may **operate a transmitter on an amateur service frequency.**

- **License has expired** and is still **within the allowable grace period transmitting is not allowed until** the **ULS database shows** that the **license has been renewed.**

T1D Authorized and Prohibited Transmissions

Prohibited from communications with countries whose **administration has notified the ITU** that it **objects to** such **communications.**

==========

During an **Armed Forces Day Communications Test** an FCC-licensed **amateur station** may **exchange messages with a U.S. military station**

==========

Only Time Ciphers are Permitted :

-When **transmitting control commands to space stations or radio control craft** is the

==========

Only Time Music is Permitted :

When incidental to an **authorized retransmission of manned spacecraft communications.**

==========

Only Time Sales are Permitted on the Air :

To notify of **availability of equipment for sale or trade** when the **equipment is normally used in an amateur station** and activity **not conducted on a regular basis.**

==========

Obscene and Indecent Words or Language <- Prohibited (No list maintained by FCC).

==========

Ok **to retransmit automatically signals** by either a 1) **auxiliary,** 2) **repeater,** or 3)**space station.**

==========

may receive compensation for **operating the station** when the communication is **incidental to classroom instruction** at an **educational institution.**

==========

authorized to transmit signals related to **broadcasting, program production, or news gathering,** only when ***immediate safety of human life or protection of property*** is involved.

==========

Broadcasting : transmissions intended for reception by the general public.

Transmissions to make **station adjustments** are **permitted** in the Amateur Radio Service.

!!NOT retransmission of entertainment programming or material from a commercial station or communications that can be furnished on a regular basis by other radio services.!!

===== Controlling Model Aircraft does not require the amateur station to transmit his call sign.

= A Control Operator is always required for transmission.

Tech Exam Concept of "Control"

Almost always in the exam: *The capability of turning an amateur radio transmitter on and off.*

- **Control Operator:** Individual who performs the control function.(*i.e. turns the transmitter on and off.)* Required when the station is transmitting. Designated by the **Station Licensee.**
- **Control Point:** Location where the Control Function is performed.
- **Automatic Control:** Control operator to be at a location other than the control point. For example: ***the control of a repeater***.
- **Local Control:** Performance of the control function at the station or transmitter site. For example when using a ***hand held radio***.
- **Remote Control:** The capability of operating a transmitter remotely or performing the "control function" remotely. The exam speaks of remotely making transmitter adjus
- **Telecommand:** Used to control the operation of a model Craft or Space Station. What most individuals think of as remote control.

T1E **Control operator and control types; control operator required, eligibility, designation of control operator, privileges and duties, control point, local, automatic and remote control, location of control operator.**

-station must have a control operator only when the station is **transmitting**.

-**control operator** can be a person for whom

- **license grant appears in the FCC database**
- authorized for **alien reciprocal operation**

-The **station licensee** must **designate** the **station control operator**.

-**Class of operator license control operator** -> **transmitting privileges of an amateur station**.

-**The FCC presumes** the **station licensee to be the control operator** of an amateur station, **unless documentation to the contrary is in the station records.**

==========

- amateur station control point: location where **control operator function is performed**.

-Under **automatic control** it is **permissible** for the **control operator to be at a location other than the control point.**

!!NOT Remote control!!

-The **control operator** and the **station licensee** are **equally responsible** when the **control operator** is **not** the **station licensee**.

==========

Three kinds of Control in the Exam : 1) **Automatic control** 2) **Local control** 3) **Remote control**

-Automatic control : is being used **for a repeater** when the **control operator is not present at a control point.**

!!NOT Remote control!! **,** ***NOT Unattended!!***

-APRS Digipeaters like all repeaters operate under Automatic control.

-Local control : is being used **when transmitting using a handheld radio** or whenever the operator is at the **control point**.

-Remote control ; is used when the **control operator is not at the station location** but can **indirectly manipulate** the **operating adjustments of a station**. An example of **remote control** is **remote operation of a station over the internet.**

======

Technician Class Operator is not allowed to be the Control Operator of a station operating in an exclusive Extra Class band

==========

NOTES: Think of the **control point** as the place where at the very least the **transmitter can be turned on or off**.

Remote Control -> **Control Point** is away **from the Station**

Automatic Control -> **Operator** is away from the **Control Point**

T1F - Station identification and operation standards; special operations for repeaters and auxiliary stations, third party communications, club stations, station security, FCC inspection

Tactical call : **is being used** when identifying as **"Race Headquarters"**.
When using **tactical identifiers**, your **station must transmit** the station's **FCC-assigned call sign every ten minutes**
-**required to transmit its assigned call sign**
-at **least every 10 minutes** during
-and at the **end of a contact**
- **English language** is an **acceptable language** for **station identification** in *a* phone sub-band.
- CW or phone emission is required for phone signals for **call sign identification.**
==========
NOTES: ***Examples of an Alaskan Station indicating that they are operating in the Third Call Area.***
All of the following formats of a **self-assigned indicator** is acceptable when identifying using a phone transmission:
- KL7CC **stroke** W3
- KL7CC **slant** W3
- KL7CC **slash** W3
T1F07: A **self-assigned call sign indicator must not conflict** with any other **indicator specified by the FCC rules** or with any **call sign prefix assigned** to another **country**.
==========
-**A Non-Licensed Individual** May Be allowed to **speak** with an Amateur Radio **operator in a Foreign Country** only if the USA has a **third party agreement** allowing such communications with that country. (***Motivated by TELCOs***).
-A **Repeater station**: simultaneously **retransmits the signal** of another amateur station **on a different channel or channels.**
- The **control operator of the originating station** is **accountable** should a repeater inadvertently **retransmit communications that violate the FCC rules.**
- FCC rules authorize the transmission of non-emergency **third party communications to any foreign station** whose **government permits such communications**.
- **At least 4 persons to be members of a club** for a **club station license.**
- **Any time upon request** by an **FCC representative** the station licensee **must make the station and its records available for FCC inspection.**
- One's call sign must be appended with **/KT, /AE or /AG to indicate an upgrade to a higher class license** prior to the appearance of the upgrade in the ULS data base.

T2A –

Station operation; choosing an operating frequency, calling another station, test transmissions, use of minimum power, frequency use, band plans

Parameter	Value
2 Meter Band Repeater Offset	+/- 600 KHz
70 cm Band Repeater Off Set	+/- 5 MHz
70 cm Band Simplex Frequency	446.000 MHz

- to **call another station on a repeater -> ** Say the **station's call sign then identify with your call sign**
- when **responding to a call of CQ - > Transmit the other station's call sign followed by your call sign**.

- The meaning of the **procedural signal "CQ"** is **calling any station**.
-**Say**ing your **call sign** is often used **in place of "CQ" to indicate** that **you are listening on a repeater**.
-Choosing a frequency before calling CQ by: **Listening for others, asking if frequency is in use, making sure you are in your assigned band.**

==========

An amateur operator **must properly identify the transmitting station** when **making on-air transmissions to test equipment or antennas**. When making a **test transmission, station identification** is required at **least every ten minutes** during the test and **at the end.**

==========

- A **band plan:** is a **voluntary guideline** for using **different modes or activities** within an **amateur band**.
- An amateur must use **the minimum transmitter power necessary** to **carry out the desired communication** while not **exceeding the maximum permissable power.**
-

T2B – VHF/UHF operating practices; SSB phone, FM repeater, simplex, frequency offsets, splits and shifts, CTCSS, DTMF, tone squelch, carrier squelch, phonetics

- Simplex communication: **transmitting and receiving on the same frequency.**
-CTCSS: sub-audible tone transmitted with normal voice audio to **open the squelch of a receiver**.
-Carrier squelch: muting of receiver audio controlled solely by the **presence or absence of an RF signal**.
==========
-The **amplitude of the modulating signal** determines the **amount of deviation of an FM signal**.
-When the **deviation of an FM transmitter is increased** its **signal occupies more bandwidth.**
-Microphone gain set too high can cause over deviation causing interference to stations on nearby frequencies

==========
-All of the following common problems might cause you to be able to hear but not access a repeater even when transmitting with the proper offset:

When the **repeater receiver requires**:
- **audio tone burst**
- **a CTCSS tone**
- **a DCS tone sequence for access.**

-If your station's **transmissions** are **causing splatter or interference on nearby frequencies -> check your transmitter** for **off-frequency operation** or **spurious emissions**.
-If your station's **transmission unintentionally interferes** with another station, **properly identify** and **move to a different frequency.**
-When **two stations transmit on the same frequency** : **Common courtesy should prevail**, but **no one has absolute right to an amateur frequency**.
==========

The **FCC Encourages** you to **identify your station** when **using phone** through the use of a **phonetic alphabet**.
EXAMPLE: Alpha, Bravo, Charlie,…., Yankee,Zulu
==========

QRM is the **"Q" signal** used to indicate that you are **receiving interference from other stations.**

QSY is the **"Q" signal** used to indicate that your are **changing frequency.**
==========
Consider **using simplex rather than a repeater** when one **can communicate directly** without need for the repeater**.**
SSB is **permitted in at least some portion of all amateur bands above 50 mhz**.

T2C

Public service; emergency and non-emergency operations, message traffic handling

Jurisdiction over Amateur Radio Rules

-FCC Rules always apply **when using amateur radio** at the **under all circumstances**.

==========

Two Amateur Radio Public Service Organizations

-RACES and ARES: in **common** that **both** organizations **may provide communications during emergencies.**

-ARES: Amateur Radio Operators who voluntarily register their qualifications and equipment for availability to the public service.

-**Radio Amateur Civil Emergency Service**: is the **radio service using amateur stations and amateur radio frequencies for emergency management** or **civil defense communications.**

==========

On the Air Etiquette for Emergency Nets

- Begin with **"Priority**" or **"Emergency" followed by** your **call sign** is common practice during net operations **to get the immediate attention of the net control station when reporting an emergency**?

-To minimize disruptions to an **emergency traffic net** once you have checked in **do not transmit on the net frequency until asked** to do so **by the net control station.**

==========

Traffic Handling:

-Passing messages exactly as written, spoken or as received is usually considered to be the **most important job of an amateur operator** when handling **emergency traffic messages.**

-Words (especially proper names and unusual words) should be spelled out using a standard phonetics alphabet. (Alpha, Bravo,…..,Zulu)

-Preamble: in a **formal traffic message** is **the information needed to track the message** as it **passes through** the amateur radio **traffic handling system**.

-Check: a count of the number of words or word equivalents in the text portion of the **message**

==========

George B Holubec David Sarnoff Radio Club-Trenton Computer Festival

Escape Clause:

-When **normal communications systems are not available**

an amateur station may use **any means of radio communications** at its disposal **including operation outside of amateur radio frequencies** for essential communications **in connection with immediate safety of human life and protection of property.**

T3A

Radio wave characteristics; how a radio signal travels; distinctions of HF, VHF and UHF; fading, multipath; wavelength vs. penetration; antenna orientation

-Electromagnetic wave: **carries radio signals** between transmitting and receiving stations.

==========

PROPAGATION of Reflecting Surfaces

-UHF signals are **often more effective** from **inside buildings than VHF signals**
because **the shorter wavelength allows them to** more easily **penetrate the structure of buildings.**

-When **using a directional antenna** your station might be **able to access a distant repeater if buildings or obstructions are blocking the direct line of sight path** by **find**ing a **path that reflects signals to the repeater.**

==========

MULTIPATH

-If another operator reports that **your station's 2 meter signals were strong just a moment ago, but now they are weak or distorted try moving a few feet**, as **random reflections may be causing multi-path distortion**.

-Picket fencing is commonly used to describe **the rapid fluttering sound** sometimes heard **from mobile stations that are moving while transmitting.**

-The random **combining of signals arriving via different path lengths is the cause of irregular fading of signals** from distant stations during times of generally good reception.

-If **VHF or UHF data signals** propagate **over multiple paths Error rates** are **likely to increase.**

- Signals maybe transmitted and received **despite obstructions between the transmitting and receiving stations** because of **Knife-edge diffraction**.

==========

POLARIZATION

-Horizontal antenna polarization is normally used **for** long-distance **weak-signal CW** and **SSB contacts** using **the VHF and UHF bands.**

-Signals could be **significantly weaker** if the **antennas** at opposite ends of a VHF or UHF line of sight radio link **are not using the same polarization.**

-Since **skip signals are refracted from the ionosphere are elliptically polarized**, **either vertically or horizontally polarized antennas may be used** for transmission or reception.

==========

- **ionosphere:** enables the propagation of radio **signals around the world.**

T3B - Radio and electromagnetic wave properties; the electromagnetic spectrum, wavelength vs. frequency, velocity of electromagnetic waves

Wavelength : **distance a radio wave travels** during **one complete cycle**.
Frequency : is the term that indicates **the number of times per second** that an **alternating current reverses direction**.
Electric and magnetic fields : **two components of a radio wave**
-A **radio wave** travels **through free space** at the **speed of light.**

==========

- The **wavelength gets shorter** as the **frequency increases**.
-The **formula** for converting **frequency to wavelength in meters** is
Wavelength in meters equals 300 divided by frequency in megahertz.
- The **approximate wavelength** is the property of radio waves **used to identify the different frequency bands**.

==========

Wavelength : **distance a radio wave travels** during **one complete cycle**.
Frequency : is the term that indicates **the number of times per second** that an **alternating current reverses direction**.
Electric and magnetic fields : **two components of a radio wave**

==========

- 300,000,000 meters per second is the approximate **velocity of a radio wave** as it travels through **free space.**

Wavelength$_{(meters)}$ = **300/Frequency** $_{(megahertz)}$ ⇔ **Frequency** $_{(megahertz)}$ = **300/Wavelength**$_{(meters)}$

T3C

Propagation modes; line of sight, sporadic E, meteor, aurora scatter, tropospheric ducting, F layer skip, radio horizon

-**"Direct" *(not via a repeater)* UHF signals** are **rarely heard** from stations **outside your local coverage area** because **UHF signals are usually not reflected by the ionosphere**.
-The **radio horizon** is the **distance** at which r**adio signals between two points** are **effectively blocked** by the **curvature of the Earth**.
-**VHF and UHF radio signals** usually travel somewhat **farther than** the visual **line of sight** distance between two stations because the **Earth seems less curved to radio waves than to light.**
-**"Knife-edge" propagation signals** are partially refracted **around solid objects exhibiting sharp edges.**

==========

SPORADIC E (Ionospheric Propagation)
-Sporadic E is most commonly associated with **occasional strong over-the-horizon** signals on the **10, 6, and 2 meter bands**.
-The following ***might be*** happening **when VHF signals are being received from long distances** signals are being ***refracted*** from a **sporadic E layer.**
!!No such thing as sub-surface ducting!! ---------- *Don't confuse with* ***tropospheric ducting****.!!*

==========

TROPOSHERIC DUCTING And SCATTER
-"**tropospheric ducting**" is caused by **temperature inversions** in the atmosphere.
-**Tropospheric scatter** is responsible for allowing **over-the-horizon VHF and UHF communications** to ranges of approximately **300 miles on a regular basis.**

==========

-VHF signals received via **auroral reflection** exhibit **rapid fluctuations of strength** and often **sound distorted.**
- 6 Meters is **best** suited to communicating **via meteor scatter**.
- **During daylight hours** is generally the **best time** for **long-distance 10 meter band propagation**.

-==========

-**6 Meters is the only VHF Band** possibly available for **Long Distance communications via the Ionosphere** during periods of **high sunspot activity**. **(Not 1.25 meters or 70cm or 23cms)**

T4A – Station setup; microphone, speaker, headphones, filters, power source, connecting a computer, RF grounding

- Some microphone connectors include
-push-to-talk
-voltages for powering the microphone.
!!Microphone Connectors across different brands are rarely identical!!

- In place of a regular **speaker** to help you copy signals **in a noisy area** a **set of headphones** could be used.

==========

-**a regulated power supply** : **prevents voltage fluctuations** from reaching sensitive circuits.

==========

- A **low pass filter** must be installed **between the transmitter and the antenna to reduce harmonic emissions**
-A **band reject filter** should be **connected to a TV receiver** as the first step in trying **to prevent RF overload from a nearby 2 meter transmitter**.
--An **SWR Meter** should be **connected between the transmitter and antenna**.

==========

-A **terminal node controller** would be connected **between a transceiver and computer** in a **packet radio station**.
-A **computer's sound card** provides **audio to the microphone input** and **converts received audio to digital form** when **conducting digital communications** using a **computer**.
-A **Computer** maybe used for **Logging**, **Sending and Receiving CW**, and **Generating and Decoding Digital Signals**

==========

- Flat strap conductor is best to use **for RF grounding**.
-You would use a **Ferrite choke** to **reduce RF current** flowing **on the shield of an audio cable** and **microphone cable**.

==========

-The **alternator** is the **source of a high-pitched whine** that **varies with engine speed** in a **mobile transceiver's receive audio**.
-If **another operator reports** a **variable high-pitched whine** on the audio from your mobile transmitter, **noise on the vehicle s electrical system is being transmitted along with your speech audio**.
-A **mobile transceiver's power negative connection** be made at the **battery** or **engine block ground strap.**

Short Digression on Packet Radio

TNC (terminal Node Controller)

A TNC contains a **modem, a computer processor (CPU),** and the associated circuitry required to convert **communications between your computer (RS-232) and the packet radio protocol in use.** A TNC assembles a packet from data received from the computer, computes an error check (CRC) for the packet, modulates it into audio frequencies, and puts out appropriate signals to transmit the packet over the connected radio. It also reverses the process, translating the audio that the connected radio receives into a byte stream that is then sent to the computer.

Most amateurs currently use **1200 bps (bits per second)** for local VHF and UHF packet, and 300 bps for longer distance, lower bandwidth HF communication. Higher speeds are available for use in the VHF, UHF, and especially microwave region, but they often require special (not plug-and-play) hardware and drivers.

What is AX.25?

AX.25 (Amateur X.25) is the communications protocol used for packet radio. A protocol is a standard for two computer systems to communicate with each other, somewhat analogous to using a business format when writing a business letter. AX.25 was developed in the 1970's and based on the wired network protocol X.25. Because of the difference in the transport medium (radios vs wires) and because of different addressing schemes, X.25 was modified to suit amateur radio's needs. **AX.25 *includes a digipeater field* to allow other stations to automatically repeat packets to extend the range of transmitters. One advantage of AX.25 is that *every packet sent contains the sender's and recipient's amateur radio callsign*, thus providing station identification with every transmission.**

From TAPR: http://www.tapr.org/pr_intro.html#AX.25

T4B - Operating controls; tuning, use of filters, squelch, AGC, repeater offset, memory channels

Transmitter Controls
- If **microphone gain set too high** -> **output signal might become distorted**.
- The **keypad** or **VFO knob** can be used -> **to enter the operating frequency on a modern transceiver**?

==========
Receiver Controls
- The **squelch control** on a **transceiver mutes** the **receiver output** noise **when no signal is being received.**
- To **enable quick access to a favorite frequency** on your transceiver **store the frequency in a memory channel.**
- **The noise blanker** would **reduce ignition interference** to a **receiver**.
- The **AGC or Automatic Gain Control** is used to **keep received audio relatively constant**.

- The **receiver RIT or clarifier** could be used if the **voice pitch of a single-sideband signal seems too high or low**.
-The term **"RIT"** means **Receiver Incremental Tuning**.
NOTE: The RIT allows you to change the receiver frequency while allowing the transmit to be fixed.
==========
Receiver IF Filters
-**multiple receive bandwidth choices** permits **noise or interference reduction** by **selecting a bandwidth matching the mode**
-2400 Hz is an appropriate **receive filter** to select in order to minimize noise and interference **for SSB reception**.
-500 Hz is an appropriate **receive filter** to select in order to minimize noise and interference **for CW reception**.

==========
“repeater offset” : **difference between the repeater’s transmit and receive frequencies**.

T5A –

Electrical principles; current and voltage, conductors and insulators, alternating and direct current

Physical Entity	Physical Parameter	Symbol	Units of Measure
Flow of Electrons	Electrical Current	I	Ampere
Rate At Which Electrical Energy is used	Electrical Power	P	Watt
Electro Motive Force	Voltage	E	Volt

Physical Entity	Definition
Alternating Current	Current that Reverses Direction on a Regular Basis
Direct Current	Current that Flows in Only One Direction

Good Electrical Insulators	Good Conductors
Glass	Copper
Wood	Aluminum
Rubber	Mercury

T5A06 : A **mobile transceiver** usually requires a **voltage** of about **12 volts.**

T5A12 : Frequency is a term that describes the **number of times per second that an alternating current reverses direction. WRONG it's really two times the frequency but this is the Answer you have to give for the exam.**

-01: How many milliamperes is 1.5 amperes?
-02: How many kilo-hertz is a radio signal frequency of 1,500,000 hertz?
-03: How many volts are equal to one kilovolt?
-04: How many volts are equal to one microvolt?

-05: How many watts in 500 milliwatts?

-06: If an ammeter calibrated in amperes is used to measure a 3000-milliampere current, what reading would it show?
-07: If a frequency readout calibrated in megahertz shows a reading of 3.525 MHz, what would it show if it were calibrated in kilohertz?
-08: How many microfarads are 1,000,000 picofarads?

Numeric prefix	Prefix Abbreviation	Meaning In Words	Multiplier	Mult. In Decimal	Mult. in Sci. Not.
pico	**p**	One Millionth Millionth	1/1,000,000,000,000	0.000000000001	$1.0x10^{-12}$
micro	**mm** or **µ**	One Millionth	1/1,000,000	0.000001	$1.0x10^{-6}$
milli	**m**	One Thousandth	1/1000	0.001	$1.0x10^{-3}$
None	**None**	One	1	1.0	$1.0x10^{-0}$
kilo	**K**	One Thousand	1,000	1,000	$1.0x10^{3}$
mega	**M**	One Million	1,000,000	1,000,000	$1.0x10^{6}$

==========

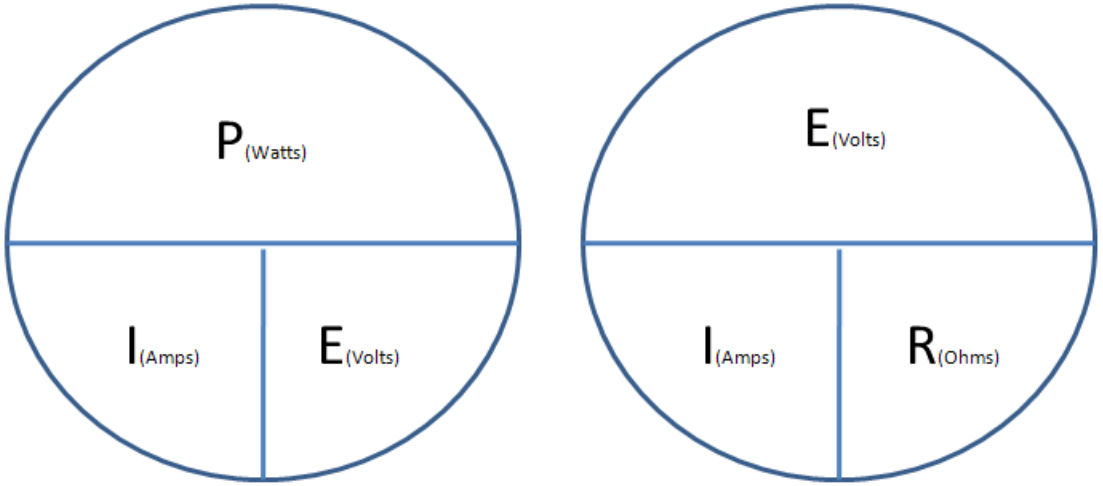
-09: What is the approximate amount of change, measured in decibels (dB),

-of a power increase from 5 watts to 10 watts?
-of a power decrease from 12 watts to 3 watts?
-of a power increase from 20 watts to 200 watts?

Decibels (db)	Multiplier
3	2
6	4
10	10

T5C & T5D

Term	Definition	Units	Typical Multiplier-Unit
Capacitance	Ability to **Store Energy** in an **Electric Field**	**Farad**	micro-farad, pico-farad
Inductance	Ability to **Store Energy** in an **Magnetic Field**	**Henry**	micro-henry, milli-henry
Frequency	Number of times the peak of a periodic Waveform Passes by a Single Point in a Second	**Hertz**	kilo-hertz,; khz, megahertz Mhz



Power Formula and Ohms Law

$$P = I \times E$$

$$E = I \times R$$

T5C & T5D Questions

T5C06 : RF is the abbreviation that refers to **radio frequency** signals of all types.
T5C07 : Radio waves is a usual name for **electromagnetic waves** that travel through space.

T5C08 : The formula used to calculate **electrical power** in a DC circuit
is **Power (P) equals voltage (E) multiplied by current (I).**
T5C12: Impedance is the opposition to the flow of AC Current.
T5C13: Impedance is measured in units of ohms.

T5C09 : How **much power** is being used in a circuit when the applied voltage is **13.8 volts** DC and the **current is 10 amperes**?
T5C10 : How **much power** is being used in a circuit when the applied voltage is **12 volts DC** and the current is **2.5 amperes**?
T5C11 : How **many amperes** are flowing in a circuit when the applied voltage is **12 volts DC** and the **load is 120 watts**?

T5D04 : **What** is the **resistance** of a circuit in which a current of **3 amperes** flows through a resistor connected to **90 volts**?
T5D05 : **What** is the **resistance** in a circuit for which the applied **voltage is 12 volts** and the current flow is **1.5 amperes**?
T5D06 : **What** is the **resistance** of a circuit that draws **4 amperes** from a **12-volt** source?

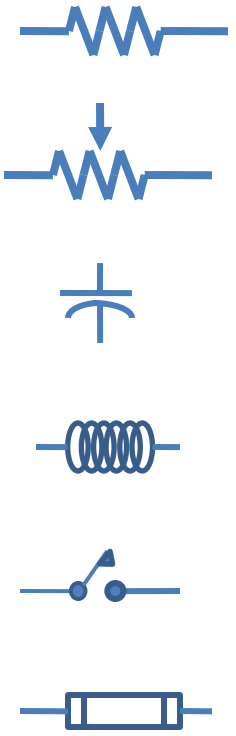
T5D07 : **What** is the current flow in a circuit with an applied voltage of **120 volts** and a **resistance of 80 ohms**?
T5D08 **What** is the **current** flowing through a **100-ohm resistor** connected across **200 volts**?
T5D09 : **What** is the **current** flowing through a **24-ohm resistor** connected across **240 volts**?

T5D10 : **What** is the **voltage** across a **2-ohm resistor** if a current of **0.5 amperes** flows through it?
T5D11 : **What** is the **voltage** across a **10-ohm resistor** if a current of **1 ampere flows through it**?
T5D12 : **What** is the **voltage** across a 10-ohm resistor if a current of **2 amperes flows through it**?

T6A

Electrical components; fixed and variable resistors, capacitors, and inductors; fuses, switches, batteries

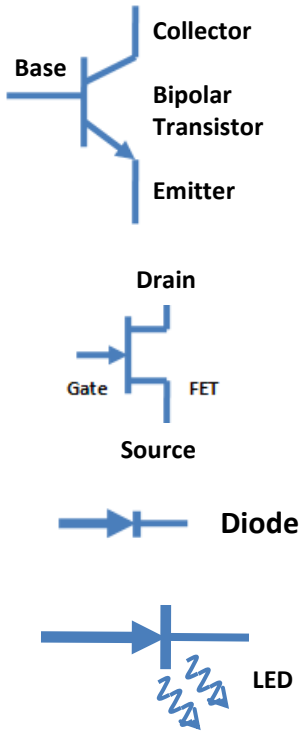
Component	What it Does	Parameter	Applicable Unit	Consists of
Resistor	Opposes the flow of current	Resistance	Ohm	Resistive Material Such as Graphite
Potentiometer	Adjustable Volume Control *or variable resistor*	Resistance	Ohm	Resistive Material Such as Graphite
Capacitor	Stores Energy in Electric Field	Capacitance	Farad	two or more conductive surfaces separated by an insulator
Inductor	Stores Energy in Magnetic Field	Inductance	Henry	Coil of Wire
Switch	Connects or Disconnects Electrical Circuits	Number of poles and number of throws		
Fuse	Protects circuits from Current Overloads			



T6B

Semiconductors; basic principles of diodes and transistors

Component	What it Does	Parameter	Applicable Unit	Consists of
Transistor	Uses **Voltage or Current signal** to **-control Current Flow** **-amplify signals** **-act as electronic switch**	**Gain** or its **ability to amplify signals**		
Bipolar Transistor	Same as Transistor Uses Current to Control Current.			**Three Layers** of **Semiconductor Material** Its Three **Electrodes:** -Collector -Base -**Emitter**
FET **Field Effect Transistor**	Uses Voltage to Control Current			**-Gate Electrode** -Drain Electrode -Source Electrode
Diode				**-Cathode** and **Anode Electrodes** **-Cathode** represented by a **Stripe**
LED "Light Emitting Diode"				**-Cathode** and **Anode** Electrodes.



T6A and T6B

T6A01: The electrical component used to **oppose the flow of current** in a DC circuit is a **resistor**.
T6A02 : The component often used as an **adjustable volume control** is a **potentiometer**.
T6A03 : The **electrical parameter** controlled by a **potentiometer** is **resistance**.
==========
T6A04 : The electrical component which **stores energy** in an **electric field** is a **capacitor.**
T6A05 : The electrical component consisting of **two or more conductive surfaces separated by an insulator** is a **capacitor**.
==========
T6A06 : The electrical component which **stores energy in a magnetic field** is an **inductor.**
T6A07 : The electrical component usually **composed of a coil of wire** is an **inductor**.
==========
T6A08 : The electrical component used to **connect or disconnect electrical circuits** is a **switch.**
T6A09 : The electrical component used to **protect other circuit components from current overloads** is a **fuse.**
==========
T6A10: These battery types is rechargeable: **Nickel-metal hydride**, **Lithium-ion**, **Lead-acid gel-cell.**
T6A11 : The **Carbon-zinc battery** type is **not rechargeable**.
==========

T6B01 : The class of electronic components capable of using a **voltage or current signal** to **control current flow** is the **Transistors**
T6B05 : The electronic components which **can amplify signals** is the **transistor**.
T6B03 : The component which can be used as an **electronic switch** or **amplifier** is the **transistor**.
T6B12 : The term that describes a **transistor's ability to amplify a signal** is **gain**.
==========
T6B04 : The component made of **three layers of semiconductor material** is the **bipolar junction transistor.**
T6B10 : **Bipolar transistor has emitter, base, and collector electrodes.**
==========
T6B08 : The abbreviation "**FET**" stands for **Field Effect Transistor.**
T6B11 : A **Field effect transistor** has **source, gate and drain electrode**
==========
T6B02 : The electronic component allows **current to flow in only one direction** is the diode.
T6B06 : A semiconductor **diode's cathode lead** usually **identified** with a **stripe.**
T6B07 : The abbreviation **"LED"** stands for **Light Emitting Diode**
T6B09 : The names of the **two electrodes of a diode** are the **Anode and cathode.**

T6C01 : The name for **standardized representations of components** in an electrical **wiring diagram** is **Schematic symbols.**
T6C12 : The symbols on an electrical circuit **schematic diagram** represent **Electrical components.**
T6C13 : The **way components are interconnected** is accurately **represented in** electrical circuit **schematic diagrams**.
!!Seldom if ever **Wire lengths** or the **Physical appearance of components.!!**

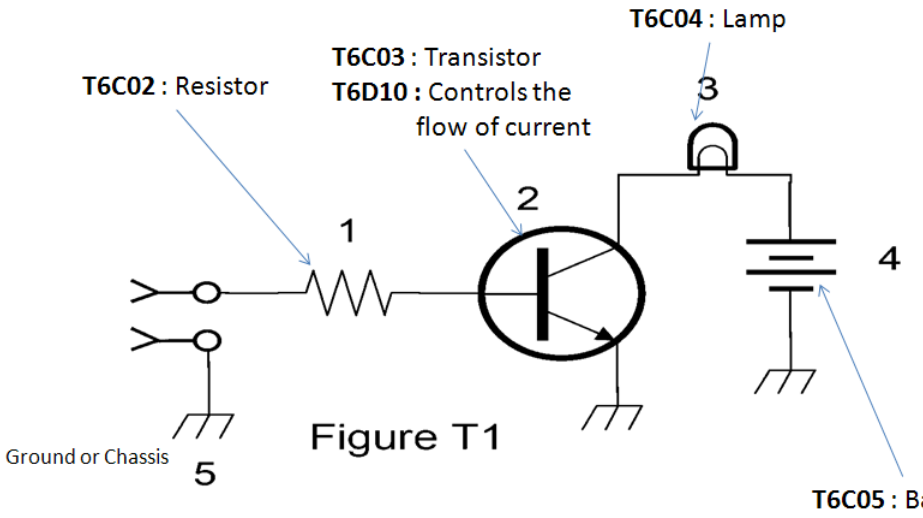


Figure T1

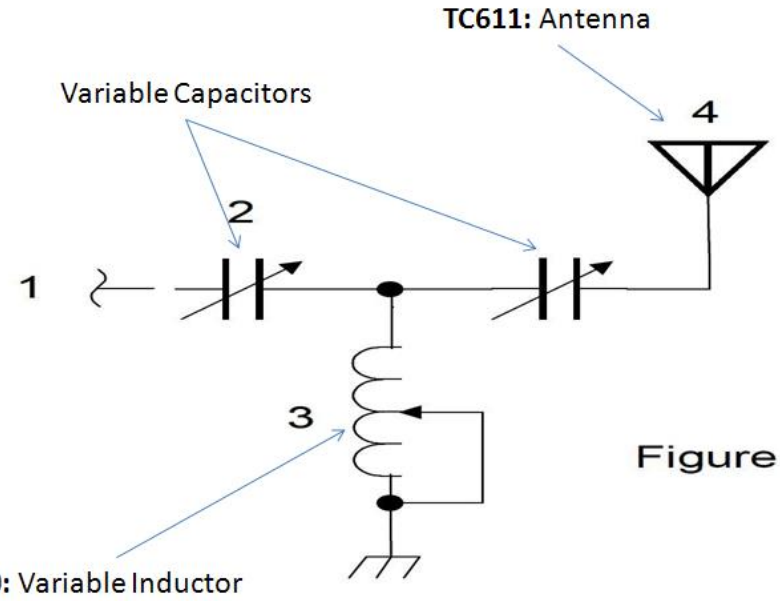


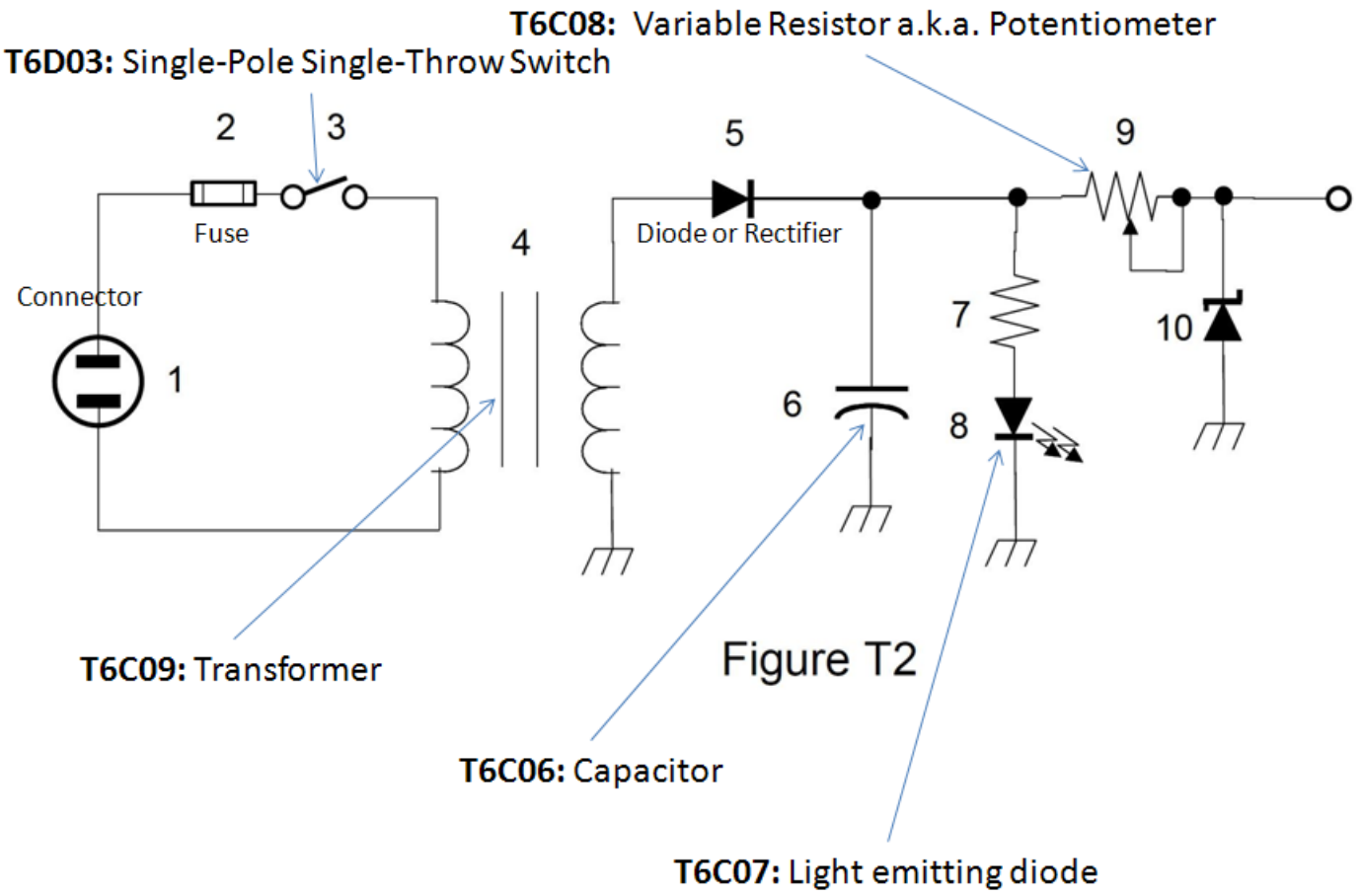
Figure T3

The following **battery types are rechargeable**:

- **Nickel-metal hydride**
- **Lithium-ion**
- **Lead-acid gel-cell**

Carbon Zinc is not **rechargeable**.

T6C & T6D


T6C08: Variable Resistor a.k.a. Potentiometer
T6D03: Single-Pole Single-Throw Switch
2
3
5
9
Fuse
Diode or Rectifier
4
Connector
7
10
1
6
8
T6C09: Transformer
Figure T2
T6C06: Capacitor
T6C07: Light emitting diode

T6D Component Functions

01 : **Rectifier** devices or circuits changes an **alternating current into a varying direct current signal**.

02 : A **switch controlled by an electromagnet** best describes a **relay**.

04 : A **meter** can be used to **display signal strength** on a **numeric scale**.

05 : A **Regulator** circuit **controls** the amount of **voltage** from a **power supply**.

06 : A **Transformer** is commonly used to **change 120V AC house current** to a **lower AC voltage** for other uses.

07 : A **LED** is commonly used as a **visual indicator**.

08 : A **Capacitor** is used **together with an inductor** to make a **tuned circuit**.

09 : An **Integrated circuit** is the name of a device that **combines several semiconductors and other components** into **one package**.

11 : A simple **resonant** or **tuned circuit is** an **inductor** and a **capacitor** connected in series or parallel **to form a filter.**

12: A **Shielded Wire** is used to **prevent coupling of unwanted signals** to or from the wire.

T7A Transmitter Receiver Odds and Ends

A01: **Sensitivity** describes the ability of a receiver to **detect the presence of a signal.**
A02: A **transceiver combines** the functions of a **transmitter and a receiver**.

A03: A Mixer converts a radio signal from one frequency to another.
A04: **Selectivity** describes the **ability of a receiver** to **discriminate between multiple signals**.

A05: An **Oscillator** is the name of a **circuit that generates a signal of a desired frequency**.
A06: A **Transverter** is a device **takes the output of a** low-powered **28 MHz SSB exciter** and **produces a 222 MHz output signal.**

A07: PTT is known as the **push to talk function** which **switches between receive and transmit**.

A08: Modulation combines **speech with an RF carrier signal**.

A09: A **multi-mode VHF transceiver** is most useful for **VHF weak-signal communication**.

A10: An **RF power amplifier increases the low-power output** from a handheld **transceiver**.
A11: An **RF preamplifier** installed **between the antenna and receiver.**

T7B Dealing with Neighbors and Others.

B01: When told your **FM handheld mobile transceiver** is **over-deviating** you should **talk farther away from the microphone.**
B02: A **receiver unable to reject strong signals outside the AM or FM band can cause a broadcast AM or FM radio to receive an amateur radio transmission unintentionally**.
B03: **Fundamental overload, Harmonics ,** and/or **Spurious emissions** may be a **cause of radio frequency interference**.
B04: Placing a **RF filter on the telephone** is a way to **reduce or eliminate interference by an amateur transmitter** to a nearby telephone.
B05: Blocking the **amateur signal** with a **filter** at the **antenna input of the affected receiver** can eliminate or reduce the overload of a non-amateur radio or TV receiver by an amateur signal be reduced or eliminated.
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B06: When a **neighbor indicates that you are interfering with their radio or TV reception**, **make sure that your station is functioning properly** and **that it does not cause interference to your own radio or television** when **tuned to the same channel.**
B07: Snap-on ferrite chokes, **Low-pass and high-pass filters**, **Band-reject and band-pass filters** may be useful in **correcting a radio frequency interference** problem.
B08 When a **neighbor's home is causing harmful interference** to your amateur station, **work with your neighbor** to identify the offending device, **inform your neighbor about the rules** that prohibit the use of devices which cause interference, **check your station** and make sure it meets the standards of good amateur practice.
B09 A **Part 15 device** is an **unlicensed device that may emit low powered radio signals** on **frequencies used by a licensed service.**
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B10: When you **receive a report** that your **audio signal** through the repeater is **distorted or unintelligible**, your transmitter may be **slightly off frequency,** your **batteries may be running low, you maybe in a bad location**.
B11: Reports of **garbled, distorted, or unintelligible transmissions** may be a **symptom of RF feedback** in a **transmitter or transceiver**.
B12: The **first step to resolving cable TV interference** from your **ham radio** transmission is to be sure all **TV coaxial connectors are installed properly.**

T7C- Antenna Measurements and Troubleshooting; Measuring SWR, Dummy Loads, Feedline Failure Modes

T7C01 : The primary **purpose of a dummy load** to **prevent the radiation of signals** when making tests
T7C02 : An **antenna analyzer** can be used to **determine if an antenna is resonant at the desired operating frequency.**

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T7C03 : In general terms, is **standing wave ratio (SWR)** is a **measure of how well a load is matched to a transmission line.**
T7C04 : A **1 to 1 reading on an SWR meter** indicates a **perfect impedance match** between the **antenna and the feedline**.
T7C05 : 2 to 1 is the **approximate SWR** value above which the **protection circuits** in most solid-state transmitters **begin to reduce transmitter power.**
T7C06 : An **SWR reading of 4:1** means an **impedance mismatch.**

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T7C07 : Power lost in a feedline is converted into heat.
T7C08 : Other than an SWR meter a **Directional wattmeter** could be used to determine if a **feedline and antenna are properly matched**.

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T7C09 : The **most common** cause for **failure of coaxial cables** is **Moisture contamination.**
T7C10 : The **outer jacket of coaxial cable** be **resistant to ultraviolet light** because **Ultraviolet light can damage the jacket** and **allow water to enter the cable**.
T7C11 : A **disadvantage of "air core" coaxial cable** when compared to foam or solid dielectric types **requires special techniques to prevent water absorption.**

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T7C12 : Coaxial Cables are commonly used to **carry RF signals between a radio and antenna**
T7C13: A **dummy load** consists of a **non-inductive resistor and a heat sink.**

T7D-Basic repair and testing; use of a voltmeter, ammeter, and ohmmeter

T7D01 : A **voltmeter** is used to **measure electric potential** or **electromotive force**.
T7D02 : The correct way to **connect a voltmeter** to a circuit is **in parallel with the circuit.**

T7D03 : An **ammeter** is usually **connected** to a circuit **in series with the circuit**.
T7D04 : The instrument used to **measure electric current** an **ammeter**.

T7D06 : Attempting to **measure voltage** when **using the resistance setting** following **might damage a multimeter**.
T7D07 : Voltage and resistance measurements are commonly made using a **multimeter**.

T7D05 : The instrument used to **measure resistance** is an **ohmmeter**
T7D10 : When an **ohmmeter**, connected across a circuit, **initially *indicates a low resistance* and then shows *increasing resistance* with time** the **circuit contains a large capacitor.**
T7D11 : Ensure that the circuit is not powered when **measuring circuit resistance** with an **ohmmeter**.
T7D12 : Ensure that the **voltmeter and leads are rated for use at the voltages to be measured** when measuring high voltages with a voltmeter.

T7D08 : Rosin-core solder is **best for radio and electronic use**.
T7D09 : A grainy or dull surface is the characteristic appearance of a **"cold" solder joint.**

T8A – Modulation modes; bandwidth of various signals

T8A01 : **Single sideband** is a **form of amplitude modulation**.
T8A03 : SSB voice modulation is most often used for **long-distance or weak signal contacts** on the **VHF and UHF bands**.
T8A06 : The **Upper sideband** is normally used for **10 meter HF, VHF and UHF single-sideband communications.**

T8A02 : FM modulation is most commonly used for **VHF packet radio transmissions**.
T8A04 : FM modulation is most commonly used for **VHF and UHF voice repeaters**.

T8A07 : The **primary advantage of single sideband over FM** for voice transmissions is that
SSB signals have narrower bandwidth

T8A05 : CW emission has the **narrowest bandwidth**.

T8A08 : **3 kHz** is the **approximate bandwidth** of a **single sideband voice** signal.
T8A09 : The **approximate bandwidth** of a **VHF repeater FM phone signal** is **between 5 and 15 kHz.**
T8A10 : The typical bandwidth of analog fast-scan TV transmissions on the 70 cm band is **About 6 MHz.**
T8A11 : **150 Hz** is the **approximate maximum bandwidth** required to **transmit a CW signal**.

T8A12 : Satellite tracking programs provide: **Maps showing the real-time position** of the satellite track over the earth, the **time, azimuth, and elevation of the start, maximum altitude, and end of a pass** the **apparent frequency of the satellite transmission**, including effects of Doppler shift.

T8B - Amateur satellite operation; Doppler shift, basic orbits, operating protocols

01 : The **control operator of a station communicating** through an amateur **satellite or space station** may be any **amateur whose license privileges allow** them to **transmit on the satellite uplink frequency.**

02 : Transmitter power should be used on the **uplink frequency of an amateur satellite** or space station the **minimum amount of power needed to complete the contact.**

03 : Using an **amateur radio satellite** one can talk to **amateur radio operators in other countries**
!!Not global positioning information Not telephone calls!!

04 : Any amateur holding a Technician or higher class license|may make contact with an **amateur station on the International Space Station** using **2 meter and 70 cm band** amateur radio frequencies.

05 : A **satellite beacon** is a **transmission from a space station** that contains **information about a satellite.**

06 : Keplerian Elements are input s to A **satellite tracking program**, ***Keplerian*** *elements* ***define the ellipse and the satellites position on that ellipse****, relative to the earth.*

07 : With regard to satellite communications, what is **Doppler shift** is an **observed change in signal frequency** caused by **relative motion between** the **satellite** and the **earth station**

08 : A **satellite is operating in "mode U/V"** the **satellite uplink is in the 70 cm** band and the **downlink is in the 2 meter band.**

09 : "spin fading" when referring to **satellite signals** is caused by **rotation of the satellite and its antennas**

10 : The initials **LEO** tell you about an **amateur satellite** that it is in a **Low Earth Orbit**

11 : FM Packet is a commonly used **method of sending signals** to and from a **digital satellite**.

T8C- Operating activities; radio direction finding, radio control, contests, special event stations, basic linking over Internet

01 : **Radio direction finding** is **used to locate** sources of **noise interference** or **jamming.**
02 : **A directional antenna** would be useful **for a hidden transmitter hunt**.
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03 : **Contesting** is popular operating activity **involves contacting as many stations as possible** during a specified period of time.
04 : A **good procedure** when contacting another station **in a radio contest**
Send only the minimum information needed **for proper identification** and the **contest exchange.**
!!Do not just send the last two letters, do not work the station twice !!
05 : A grid locator is a **letter-number designator** assigned to a **geographic location.**
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06 : An **IRLP node is accessed** by using **DTMF signals. (***i.e. touch tone as found on most microphones attached to a FM transceiver***).**
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07 : The **maximum power** allowed when **transmitting telecommand signals** to **radio controlled models** is **1 watt**.
08 : A **label indicating the licensee's name, call sign and address** must be **affixed to the transmitter** is required **in place of on-air station identification** when sending signals to a **radio control model using amateur frequencies**.

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09 : You might obtain a list **of active nodes that use VoIP from a repeater directory**.
10 : You **select a specific IRLP node** when **using a portable transceiver** by **using the keypad to transmit the IRLP node ID.**
11 : An **amateur radio station** that is **used to connect other amateur stations to the Internet** is a **gateway.**
12: Voice Over Internet Protocol (VoIP) as used in amateur radio, delivers **voice communications over the Internet** using digital techniques
More well known examples: SKYPE and Vonage
13: Internet Radio Linking Project (IRLP) is a technique to **connect amateur radio systems, such as repeaters**, via the **Internet using Voice Over Internet Protocol**.

T8D – Non-voice communications; image data, digital modes, CW, packet, PSK31

01 : **All** of the following is an example of a digital communications method:
- **Packet**
- **PSK31**
- **MFSK**

02 : The term **APRS** means **Automatic Position Reporting System.**

03 : A Global Positioning System receiver is normally used **when sending automatic location reports via amateur radio**.

04 : The **type of transmission** is indicated by the **term NTSC** is an **analog fast scan color TV signal.**

!!Not A Compression Method for TV Signals.!!

05 : APRS (Automatic Packet Reporting System) provides real time tactical digital communications in conjunction with a **map showing the locations of stations**

06 : The abbreviation **PSK** means **Phase Shift Keying.**

07 : PSK31 is a **low-rate data transmission mode.**

08 : All of the **following** may be included **in packet transmissions**.
- A **check sum** which permits **error detection**
- A **header** which contains the **call sign** of the station to which the **information is being sent**
- **Automatic repeat request** in case of error

09 : International Morse code is used **when sending CW** in the amateur bands.

10 : **All** of the following can be used to transmit CW in the amateur bands.: **Straight Key, Electronic Keyer, Computer Keyboard**

11: An **ARQ transmission system** is a digital scheme whereby the **receiving station detects errors and sends a request to the sending station to retransmit the information .** ***TCP is an example of this on the Internet.***

T9A – Antennas; vertical and horizontal, concept of gain, common portable and mobile antennas, relationships between antenna length and frequency

T9A01 : **An antenna that concentrates signals in one direction** What is a **beam antenna**.
T9A06 : The **quad, Yagi, and dish** are **Directional antennas**.

T9A02 : Regarding **vertical antennas,** the **electric field is perpendicular to the Earth.**
T9A03 : **A horizontally polarized antenna** describes a **simple dipole mounted** so the **conductor is parallel to the Earth's surface**.
T9A05 : To make a **dipole antenna resonant on a higher frequency**, **Shorten it**.

T9A04 : A **disadvantage of the "rubber duck" antenna** supplied with most handheld radio transceivers is that it **does not transmit or receive as effectively as a full-sized antenna.**
T9A07 : A good **reason not to use a "rubber duck" antenna inside your car** is that **signals can be significantly weaker than when it is outside of the vehicle.**

T9A08 : The approximate length, in inches, of a **quarter-wavelength vertical** antenna for **146 MHz** is **19.**
T9A09 : The approximate **length, in inches**, of a **6 meter 1/2-wavelength wire dipole** antenna is **112.**
T9A10 : **Broadside to the antenna** is the **direction** in which the **radiation strongest from a half-wave dipole antenna** in free space.
T9A11 : The **gain of an antenna** is the **increase in signal strength in a specified direction** when compared to a reference antenna.

T9A12: A properly mounted **5/8 wavelength antenna for VHF or UHF mobile service**, offers a **lower angle of radiation and more gain** than a 1/4 wavelength antenna and **usually provides improved coverage**.

T9A13 **VHF or UHF mobile antennas** are often mounted in the **center of the vehicle roof** to provide the most **uniform radiation pattern.**

T9A14 **Inserting an inductor in the radiating portion** of the antenna to make it **electrically longer** is a **type of loading** when referring to an **antenna**.

T9B - Feedlines; types, losses vs. frequency, SWR concepts, matching weather protection, connectors

04 : An **antenna tuner** **matches the antenna system impedance** to **the transceiver's output impedance**.

06 : A **Type N connector** is most suitable for **frequencies above 400 MHz**.
07 : PL-259 type coax **connectors** **are commonly used at HF frequencies.**
08 : Coax connectors exposed to the weather be **sealed against water intrusion** to **prevent an increase in feedline loss.**
09 : Erratic changes in SWR readings might cause a **loose connection** in an **antenna** or a **feedline.**

01: It is **important to have a low SWR** in an **antenna system** that uses **coaxial cable feedline** to allow the **efficient transfer of power and reduce losses**.
02 : 50 ohms is the **impedance of the most commonly used coaxial cable** in typical amateur radio installations.
03 : Coaxial cable is **used more often** than any other feedline for amateur radio antenna systems because it **is easy to use and requires few special installation considerations.**
05 : As **the frequency of a signal passin**g through coaxial cable is **increased** **The loss increases.**
10 : The electrical **difference between** the **smaller RG-58** and **larger RG-8** coaxial cables is that the **RG-8 cable has less loss at a given frequency.**
11 : The feedline which has the **lowest loss at VHF and UHF** is **Air-insulated hard line.**

T0A – AC power circuits; hazardous voltages, fuses and circuit breakers, grounding, lightning protection, battery safety, electrical code compliance

01 : **Shorting the terminals of a 12-volt storage battery** is a safety hazard **that can cause burns, fire, or an explosion.**

02 : Current flowing through the body can cause a **health hazard** because of
all of the following:
- **heating tissue**
- **disrupting the electrical functions of cells**
- **involuntary muscle contractions**

03 : **Safety ground** is connected to the **green wire** in a **three-wire electrical AC plug**.

04 : The **purpose of a fuse** in an electrical circuit is to **interrupt power in case of overload.**
05 : It is **unwise to install a 20-ampere fuse in the place of a 5-ampere fuse** because **Excessive current could cause a fire.**
06 : **All** of the following is a good way **to 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**
-Use a **circuit protected** by a **ground-fault interrupter**

07 : The following **precaution** should be taken when installing **devices for lightning protection in a coaxial cable feedline:**
•**Ground all of the protectors to a common plate** which is **in turn connected to an external ground**.

08 : **A fuse or circuit breaker in series with the AC hot conductor** is safety equipment should always be included in **home-built equipment** that is powered from 120V AC power circuits.

09 : The **hazard** presented **by a conventional 12-volt storage battery** is **Explosive gas can collect if not properly vented**
10 : If a **lead-acid** storage **battery** is **charged or discharged too quickly the battery could overheat and give off flammable gas or explode.**

11 : When **installing ground wires on a tower** for **lightning protection, Ensure that connections are short and direct.**
12 : The **hazard** that might exist in a **power supply when it is turned off** and **disconnected**, you might receive an electric **shock from stored charge in large capacitors.**
13 : **A fuse or circuit breaker in series with the AC "hot" conductor** is the safety equipment
that **should always be included** in home-built **equipment that is powered from 120V AC power circuits.**

T0B – Antenna installation; tower safety, overhead power lines

01: Members of a **tower work team should wear a hard hat and safety glasses** **at all times** when **any work is being done on the tower.**
02 : A good precaution to observe **before climbing an antenna tower** is to **Put on a climbing harness and safety glasses.**

03 : It is **Never safe to climb a tower without a helper or observer**.

04 : An important safety precaution to observe **when putting up an antenna tower** **Look for and stay clear of any overhead electrical wires**
09 : You should **avoid attaching an antenna to a utility pole** because **the antenna could contact high-voltage power wires**.

05 : The purpose of a **gin pole** is to **lift tower sections or antennas**
06 : The **minimum safe distance from a power line to allow** when installing an antenna is such that **if the antenna falls unexpectedly, no part of it can come closer than 10 feet to the power wires**

07 : An important safety rule to remember when using **a crank-up tower** is this type of tower **must never be climbed unless it is in the fully retracted position.**

08 : Separate eight-foot long ground rods for each tower leg, bonded to the tower and each other is considered to be a **proper grounding method for a tower**.
T0B10 : Sharp bends must be avoided when concerned with **grounding conductors used for lightning protection.**
T0B11 : Local electrical codes establishes **grounding requirements for an amateur radio tower or antenna**.
T0B12 : When installing **ground wires on a tower for lightning protection** ensure that **connections are short and direct.**

T0C - RF hazards; radiation exposure, proximity to antennas, recognized safe power levels, exposure to others

01 : VHF and UHF radio signals are **Non-ionizing radiation**

02 : Of the following frequencies **50 MHz** has the **lowest Maximum Permissible Exposure limit.**
03 : The **maximum power level** that an amateur radio station may use **at VHF** frequencies
before an RF exposure evaluation is required **is 50 watts PEP at the antenna.**

04 : All of the following factors **affect the RF exposure** of people **near an** amateur station **antenna**:
- Frequency and power level of the RF field
- Distance from the antenna to a person
- Radiation pattern of the antenna
05 : Exposure limits vary with frequency because The **human body absorbs more RF energy at some frequencies than at others**
06 : All of the following is an acceptable method **to determine that your station complies with FCC RF exposure regulations**?
- By calculation based on **FCC OET Bulletin 65**
- By calculation based on **computer modeling**
-**By measurement of field strength** using calibrated equipment.

07 : If a person **accidentally touched your antenna while** you were **transmitting They might receive a painful RF burn.**
08 : Amateur operators might **Relocate antennas to prevent exposure to RF radiation in excess of FCC-supplied limits.**

09 : By **re-evaluating the station whenever an item of equipment is changed** to
make sure your **station stays in compliance with RF safety regulations**.

10 :Duty cycle is **one of the factors** used to **determine safe RF radiation exposure** levels because
It **affects the average exposure** of **people to radiation**.
11 : "duty cycle" when referring to RF exposure is **the ratio of on-air time to total operating time**
of a **transmitted signal**
12: RF Radiation unlike **ionizing radiation can not cause genetic damage.**
13: If the **averaging time for exposure is 6 minutes**, how much power density
is permitted if the **signal is present for 3 minutes and absent for 3 minutes**
rather than being present for **the entire 6 minutes**?
A. 3 times as much
B. 1/2 as much
C. **2 times as much**
D. There is no adjustment allowed for shorter exposure times