Amateur Radio Foundation Exam Preparation Cheat Sheet No. 1

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Introduction and Regulations

1. Amateur Radio is intended to facilitate the hobby of Radiocommunications.
2. Examples of Types of Radiocommunications Licenses:

   AMATEUR, CITIZEN BAND, LAND MOBILE, POINT TO POINT, BROADCASTING
3. The Amateur Service ONLY operates within the allocated frequency bands. Amateurs share some frequency bands with users of other services. Other Radiocommunications Services use frequency bands appropriate to their purpose.
4. The LCD for Repeater and Beacon Stations, and the current Amateur Class License were born out of the Radiocommunications Act, 1992 and subsequent Regulations, 1993.
5. An Amateur License authorises activities relating to Radiocommunications; SELF-TRAINING, INTERCOMMUNICATIONS between Amateurs, and TECHNICAL INVESTIGATION
6. Except in distress or emergency situations, intercommunication must only be Amateur to Amateur, and wholly within the allocated Amateur bands.
7. Conditions apply to the transmission of third-party messages as well as to Amateurs in another country; (eg. Business related, DX to China)
8. Emergency and Distress communications:

Situation	Definition	Telephony	C.W.
EMERGENCY	Life in immediate peril	MAYDAY	. . . - - - . . . (SOS)
DISTRESS	Urgent response needed	PAN-PAN	- . . - - . . - (X X)

9. Distress and Urgency calls take priority over <u>all</u> other radio transmissions.
10. You must use your callsign at the beginning and end of every QSO as well as every 10 minutes within it. This includes Test Transmissions.
11. Australian callsigns start with **VK** and use our State-Based numerical code. Islands of Pacific and Indian; **VK9.** Stations in Antarctica; **VK0.** Special Event Callsigns; **VI**, **AX** or **VK100**

12. Individual, three letter callsign suffixes are not now limited based on class of qualification, but still exclude three letter callsigns beginning with **Q.**
13. The transmission of secret coded messages is generally not permitted. Any form of entertainment is not permitted.
14. Maximum Transmission Peak Effective Power:
    Foundation- 10W, Standard- 100W, Advanced- 400W (PEP)
15. You are required to notify ACMA of a change of address.
16. You must not cause harmful interference to other stations. ACMA can give directions or restrict your operation to avoid interference to other services.
17. You must produce your Amateur Radio Qualification for an ACMA Inspector upon request. Laminate a copy and hang it in your shack.
18. Recall these and other conditions from the Amateur Class License Document.
19. An operable Amateur Station must not be accessible to unauthorised people.

Make a colour copy of the chart on the following page.
Laminate it for use in your shack.

Amateur Radio Foundation Exam Preparation Cheat Sheet No. 2

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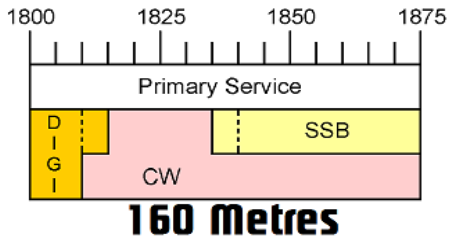
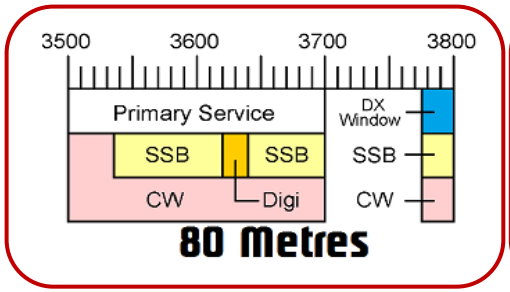


160 Metres



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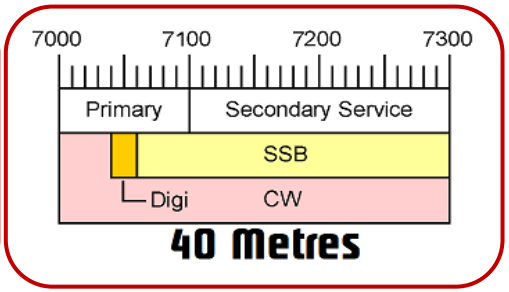
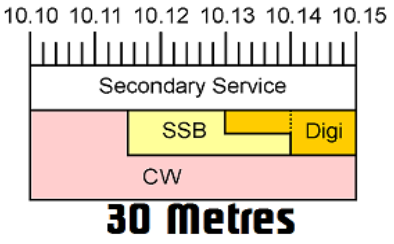


40 Metres



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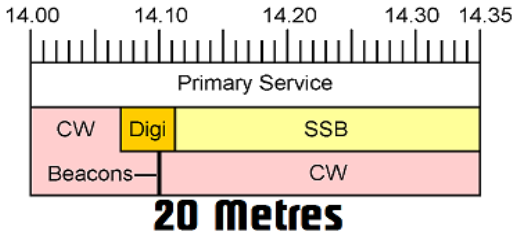
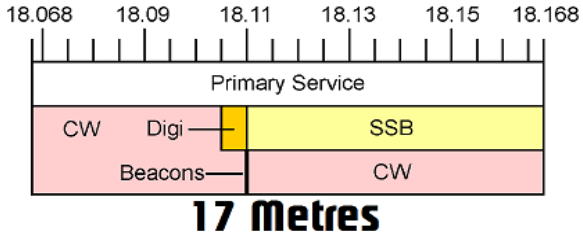
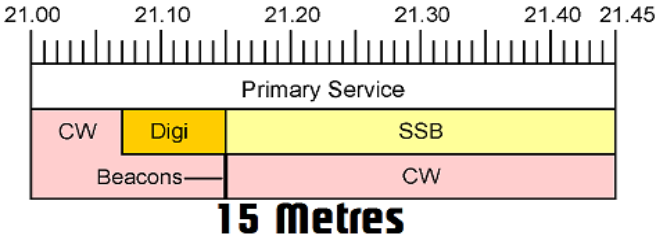


20 Metres



17 Metres



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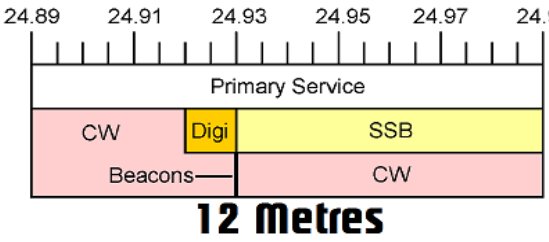
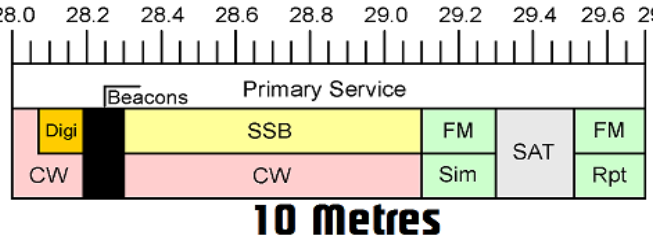


12 Metres



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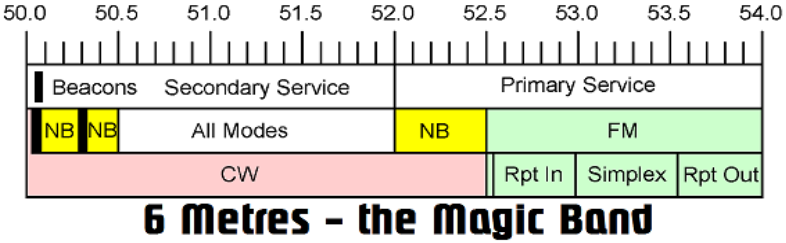
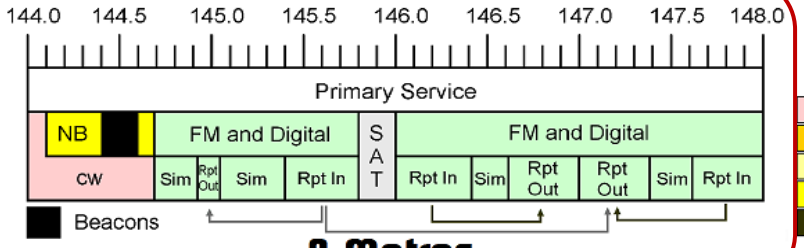


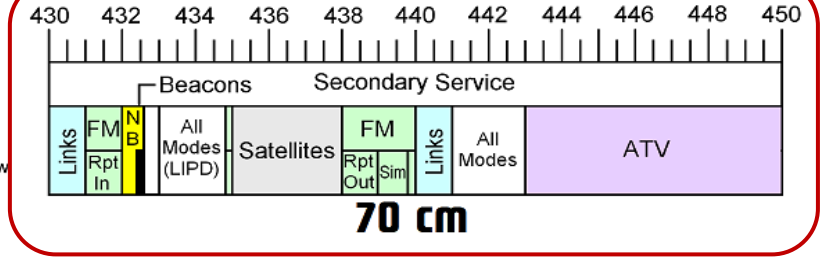
6 Metres – the Magic Band



2 Metres

Key to the Colours used in the Band Plan Diagrams

- CW
- NB Digi
- SSB
- All NB Modes
- Beacons
- FM
- Digital Voice
- Wide Band
- ATV
- All Modes
- Links
- Satellites
- DX Window
- Restricted Segment



70 cm

WIA AU Amateur Band-plan 160M-70cm wallchart by VK6DVR 11Feb2016 23:15

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Mathematics and Units of Measure

1. Use Addition, Subtraction Multiplication and Division; and the proper Order of Operations.

Order	Symbols	Other terms	Example
Brackets:	( )	"First do…"	2 x (6 + 5) = 22
Indices:	X^3	"to the power of"	3^4 = 3 x 3 x 3 x 3 = 81
Multiplication:	×	"times" or "lots of"	2 x 2 = 4 4 x 7 = 28
Division:	÷	"divided by" or "over"	10 ÷ 2 = 5 9 ÷ 2 = 4.5
Addition:	+	"the sum of" or "plus"	7 + 4 + 6 = 17
Subtraction:	-	"difference" or "minus"	23 - 5 = 18 3 - 2 = 1

2. Decimal numbers and rounding:

Ten Thousands	Thousands	Hundreds	Tens	Ones	Decimal Point	Tenths	Hundreths	Thousandths	Ten Thousandths
10000	1000	100	10	1	.	0.1	0.01	0.001	0.0001
10000	1000	100	10	1	.	$\frac{1}{10}$	$\frac{1}{100}$	$\frac{1}{1000}$	$\frac{1}{10000}$
$\times 10^4$	$\times 10^3$	$\times 10^2$	$\times 10^1$	$\times 10^0$		$\times 10^{-1}$	$\times 10^{-2}$	$\times 10^{-3}$	$\times 10^{-4}$

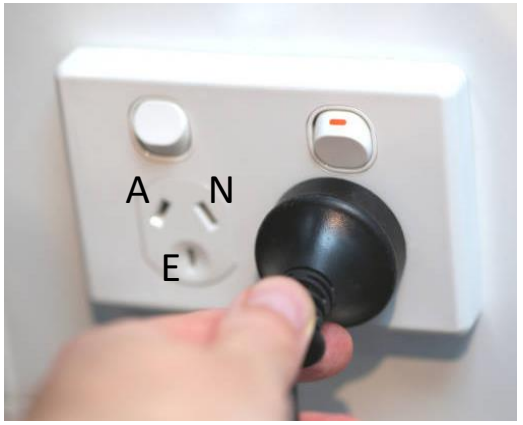
3. Engineering Notations and Measurement Unit Multiples and Sub-Multiples

Prefixes	Value	Standard form	Symbol
Tera	1 000 000 000 000	10^{12}	T
Giga	1 000 000 000	10^9	G
Mega	1 000 000	10^6	M
Kilo	1 000	10^3	k
deci	0.1	10^{-1}	d
centi	0.01	10^{-2}	c
milli	0.001	10^{-3}	m
micro	0.000 001	10^{-6}	µ
nano	0.000 000 001	10^{-9}	n
pico	0.000 000 000 001	10^{-12}	p

Technical Basics Part 1 - Electrical Concepts

4. DC means Direct Current, where all the electron flow is in one direction.
5. The **mains** voltage in Australia is **230** Volts (RMS). The frequency is **50** Hertz.
6. The **Active** conductor carries the voltage. The potential of both the **Neutral** and **Earth** conductors is **zero Volts**.
7. In electrical cords, the **Active** is **BROWN**. The **Neutral** is **BLUE**. The **Earth** is **GREEN** with a **YELLOW** stripe.
8. The Earth connection is used so that the fuse will blow when there is a short between the Active and the chassis of the equipment. It is designed to protect people from electrocution.
9. A fuse is designed to protect equipment from damage due to over-current. Over-current can permanently damage devices in the equipment. Over-current will also cause heat that can lead to fire.

   Switches isolate equipment from the supply. Never open the case of equipment while it switched on.



10. Electrical quantities and units:

QUANTITIY	SYMBOL	DESCRIPTION	UNITS
Voltage	V or E	Pressure, potential difference or EMF	Volts (V)
Resistance	R	Opposition to current flow	Ohms (Ω)
Current	I	The rate of flow of electrons	Amperes (A)
Power	P	The rate at which work is done (Heat)	Watts (W)

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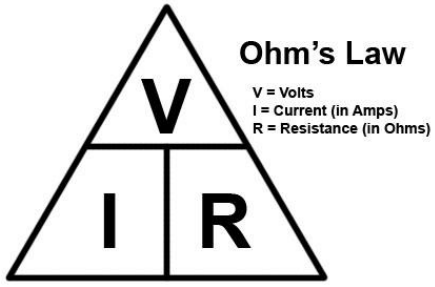
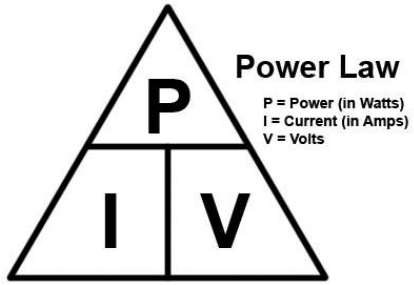
11. EMF is “Electromotive Force” it describes the Potential of a Voltage supply. Potential difference is another term for Voltage, but this refers to the difference in voltage between any two points in a circuit.



12. Ohms Law and Power calculations:

- Identify the Triangle with all the quantities given in the question.
- Cover up the symbol for the unknown value, writing that symbol on the LHS of an equals sign.
- Use the arrangement of the other symbols to construct the rest of the formula
- Substitute the known values for the symbols in your formula.
- Pick up your calculator and perform the calculation.



13. Excessive voltage or current can damage components and equipment and can cause injury or death.

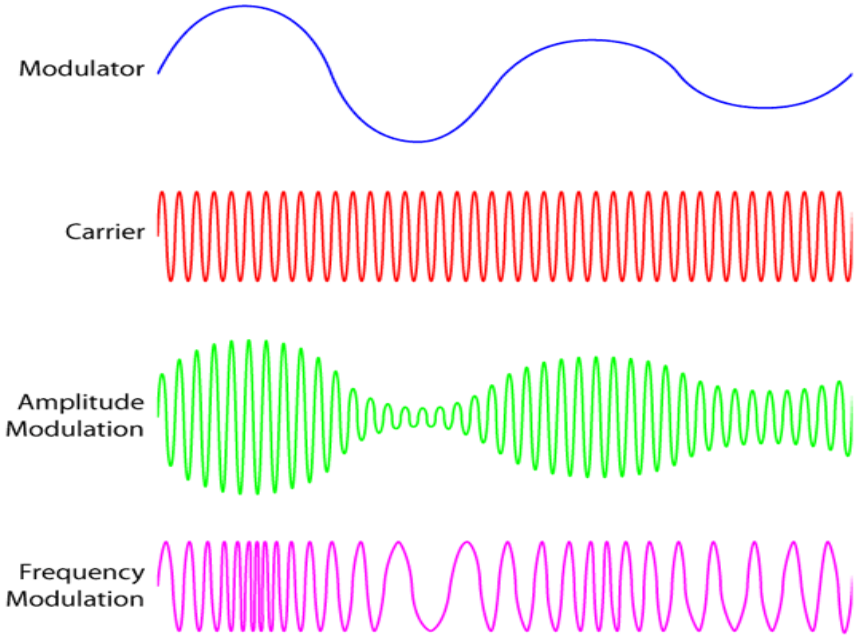
14. Reversing the polarity of the voltage supply can damage components and equipment. The RED wire means Positive. The BLACK wire means Negative.

Technical Basics Part 2 - Types of Signals & Modulation

1. A transmitted signal is made up of sinewaves.

2. AM means Amplitude Modulation, where the radio frequency (RF) carrier wave amplitude is moderated by the information wave (voice or data signal).

3. FM is Frequency Modulation. In this type of transmission, the carrier frequency changes very slightly in sympathy with the information signal.



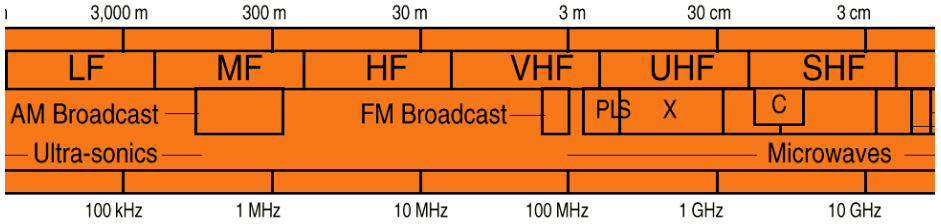
4. Frequency is measured in Hertz (Cycles per second)

5. Audio Frequencies:

   Humans can hear frequencies from as low as 20 Hz and as high as 20 kHz. Our ears are not sensitive to electromagnetic waves. We hear acoustic compression waves in the air.

6. The part of human hearing used for radiotelephony is the minimum necessary to ensure that a voice is understandable. It is 150 Hz to 3.5 kHz.

7. Radio Frequencies are described in terms of frequency or wavelength:



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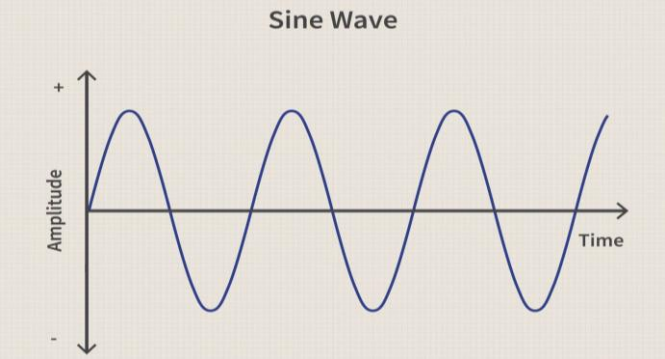
8. Low Frequency, Medium Frequency, High Frequency, Very High Frequency etc. represent Decades (x10) steps in the radio spectrum 3MHz to 30 MHz or 30 MHz to 300 MHz, for example.

9. Sinewaves can be drawn with a horizontal axis shown in time, or degrees.

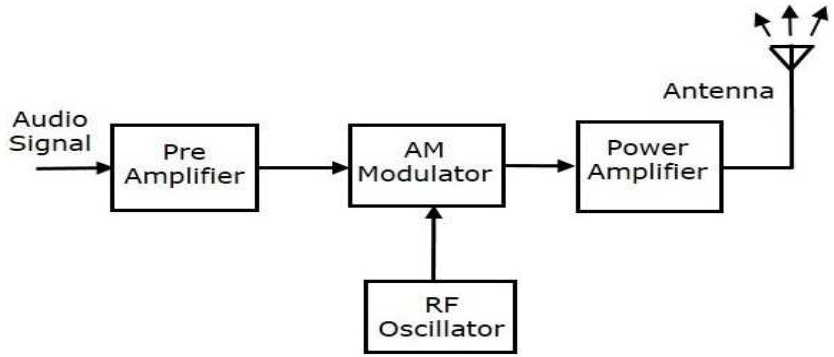


The relationship between time, frequency and wavelength revolves around the speed of propagation of radio waves: The Speed of Light. 300 x 10^6 m/s.

$$\lambda = \frac{300}{f} \quad \text{and} \quad f = \frac{300}{\lambda}$$

Technical Basics Part 2 - Transmitter Diagrams

The block diagram for a transmitter looks different for each different transmission mode. We will look at AM and FM.



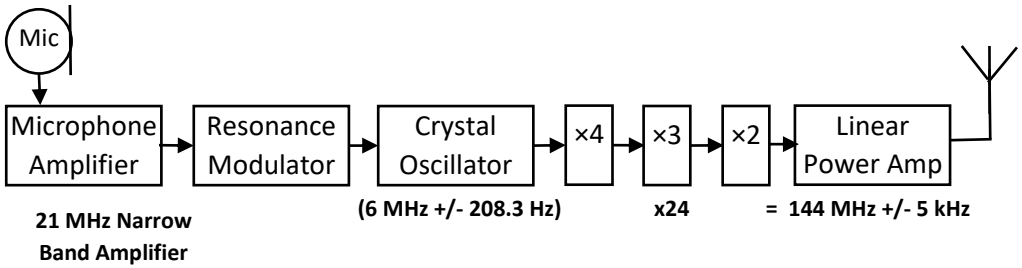
AM Transmitter

A **Microphone** produces a millivolt signal in sympathy with vocal frequencies. It sends the signal to the Pre-Amplifier.

The **Pre-Amplifier** is an Audio Pre-Amp that lifts the Information signal to about 0.5V peak so that it can be used to modulate the carrier wave from the RF Oscillator

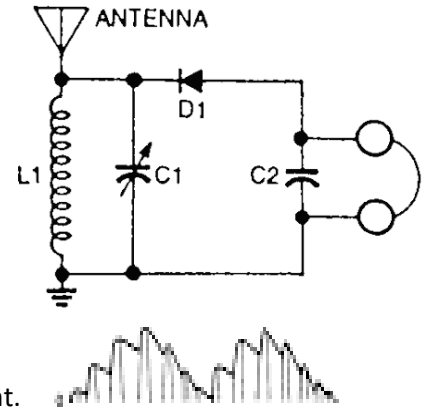
The **RF Oscillator** produces a sinewave at a Radio Frequency. The **AM Modulator** is used to vary the amplitude of the RF signal in sympathy with the audio signal (also called the Information Signal). The **Power Amplifier** is a **linear amplifier** that uses power from a battery or power supply, to boost the signal, providing output power for transmission.

Block diagram for an FM transmitter



Receivers – Block Diagrams

Simple AM receiver (Crystal Set)



- L1 and C1 form a tuned circuit, resonant at a frequency within the AM broadcast band. C1 is variable. It allows the tuned frequency to be changed to match the frequency of an AM Broadcast station.
- D1 (Germanium) is the demodulator.
- C2 acts as a low pass filter to smooth out the rectified RF, leaving the AF component.

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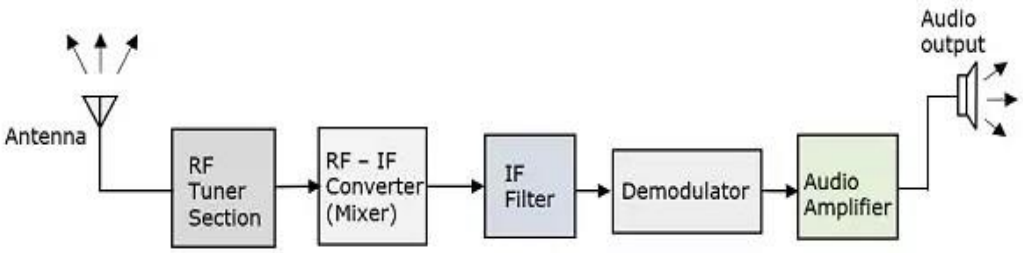


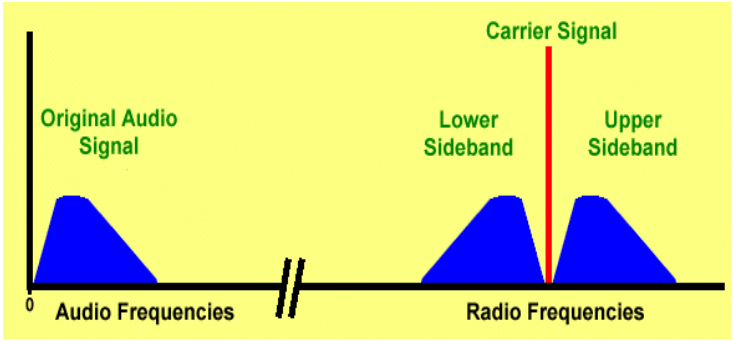
Super Heterodyne Radio Receiver

Superheterodyne refers to a receiver that converts the received RF signal to an **Intermediate Frequency (IF)** and then to the **Audio Frequency** that will be amplified and sent to the speaker. Converting the frequencies in **two stages** helps the receiver to maintain a good sensitivity and selectivity across the range of frequencies for which it was designed.

Proper adjustment of a transmitter's controls is essential to ensure that no harmful interference is caused to other radiocommunications services.

Single Sideband is a form of transmission in which the upper or lower half of the AM signal has been filtered out. An AM transmission's bandwidth is described below. It is because when two frequencies are mixed, the products of that mixer include both the sum and the difference between the two frequencies.

When the Upper or Lower Sideband is filtered out, you are left with only one "image" of the information. SSB is much more efficient than AM.



Transmission Lines and Antennas

1. **Velocity Factor** of a **Transmission Line** is the ratio of Velocity of the transmission of the signal in the line to the Velocity of Light in free space.

2. The first three cable types pictured are **Balanced.**
   These are called **Ladder, Window** or **Ribbon** Cable.
   300 Ω, **75 Ω** and **450 Ω** impedance cables are common for RF applications.

3. The last three, the Coax examples, are **Unbalanced.** 50 Ohm Coax is used. The size of the cable, Thickness of the **dielectric** and the type of **insulating material**, will determine the impedance as well as the Velocity Factor.

4. **Allowing for Velocity Factor**, the ideal length of the cable to match 50 Ω impedance at a given frequency, is **0.5, 1, 1.5 or 2 wavelengths**. Multiply the calculated wavelength by the cable's Velocity Factor to get the physical cable length. The velocity factor of most coaxial cable is about 0.66.

5. Note that transmission line loss increases with frequency. This may determine what type of cable you choose for a given application. The usable frequency range, based on those losses, is an important specification and varies with the manufacturer.

6. Often used at Microwave Frequencies, **waveguides** are hollow metal tubes of specific dimensions to guide electromagnetic waves of a given frequency. They can be used to focus signals into a narrow beam. They can also act as filters and impedance transformers.

7. **Baluns** are ferrite cored, **RF Transformers**, used to **change impedance** of signals between a **bal**anced antenna and **un**balanced transmission line to a transceiver. Without a balun, going from balanced to unbalanced can cause radiation in the feedline.

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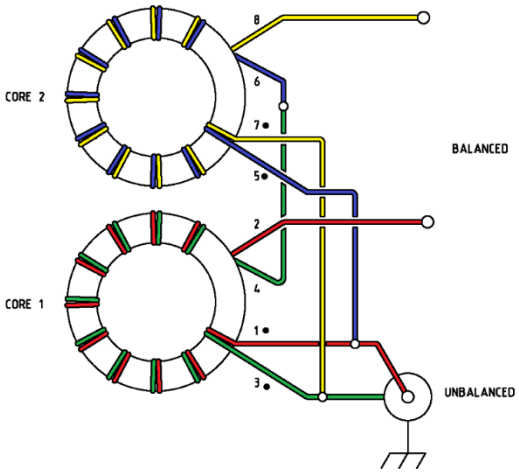
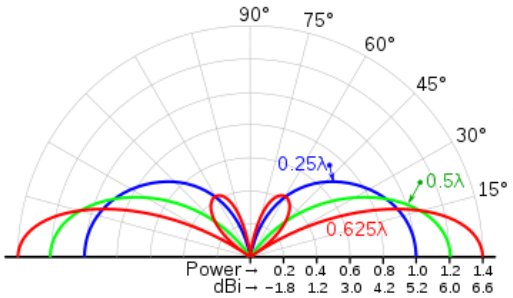
Below are a wiring diagram of a Guanella 4:1 Balun

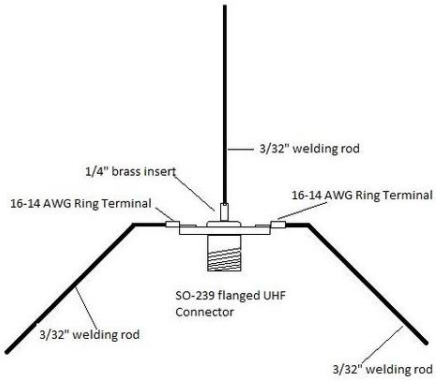


8. An **Un-un** is used similarly but for unbalanced antennae. $\mathbf{Z_P:Z_S}$ is equal to $\mathbf{N_P^2:N_S^2}$. This is why **Impedance Ratios** of 1:1, 1:4 and 1:9 are common.
9. **End Factor** is a result of capacitance based on **wire thickness** and the use of **end insulators**. It is typically **0.95** so, **End-Factor Corrected**, your antenna's physical length will be another **5% shorter**.

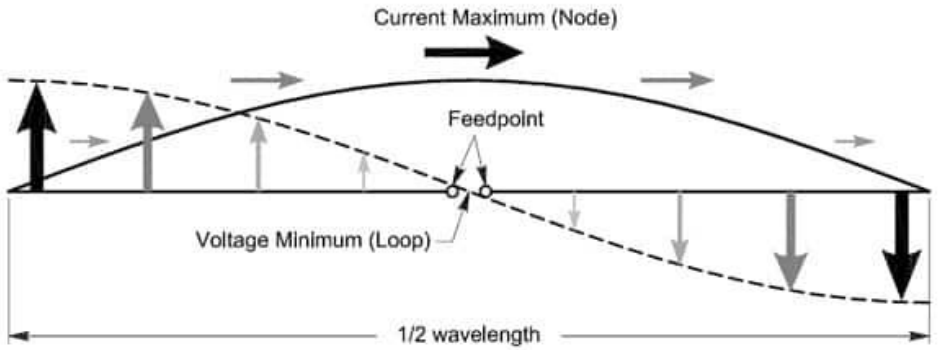
Antenna Performance

1. Each type of antenna, installed in a particular manner, will have a specific Vertical Angle of Maximum Radiation.
2. In the **diagram below**, we see plots of **vertical ground plane antennae** of various lengths. You can see that a 5/8 λ antenna has a low propagation angle which is great for DX.

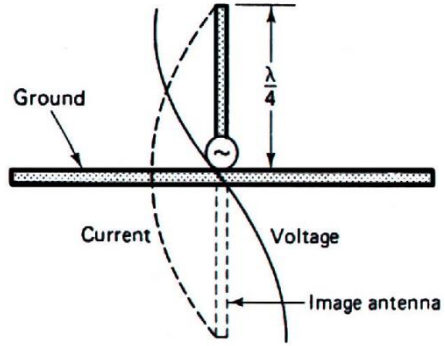




3. **Dipole Antenna Current and Voltage Distribution**



4. **1/4 Wave Vertical Antenna Current and Voltage Distribution** has another imaginary 1/4 wave antenna element reflected in the ground.



Grounded Marconi Antenna

Antenna Parameters

Impedance, Resonant Frequency and Bandwidth, Feedpoint Voltage and Current, Vertical or Horizontal Polarity and Radiation Patterns, Physical Length and Electrical Length, Gain and Directionality.

5. **Impedance Table**

Antenna Type	Typical Impedance
Open 1/2 λ Dipole	72Ω at h = 1/4 λ - decreasing to 50 Ω at reduced h
Folded 1/2 λ Dipole	300Ω (Impedance matching Balun required)
Inverted V Dipole	A dipping angle of 40° means Z = 50 Ω.
1/4 λ ground plane	36 Ω (Dipping the radials to 40° means Z = 50 Ω
End Fed 1/2 λ	Approx. 2500 Ω. (Requires a 49:1 Un-un)
Loop antenna	Square: 120 Ω Triangular: 105 Ω
Small magnetic loop	Impedance matched by placement of sensor coil

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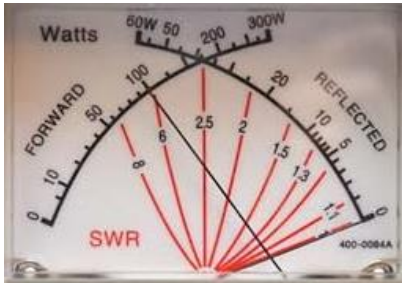
(The author of this document does not actually endorse cheating!)

6. An **Antenna Trap** is a **Parallel Tuned LC Circuit** that has a very high impedance at the tuned frequency. Installed Part way along an antenna element, it will shorten the element at that specific frequency, allowing the antenna to be tuned to multiple bands.

SWR (Standing Wave Ratio)



1. **Standing Waves** are caused by interference between **Forward** and **Reflected**

   waves on a transmission line. **SWR** is the relationship between the two.

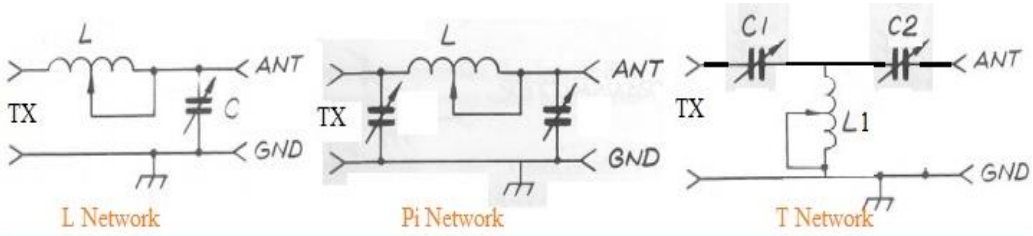
2. **SWR (Standing Wave Ratio)** can be determined by comparing forward and reflected currents or voltages.

1. **Return Loss** is the ratio of the forward signal power to the return signal power. This ratio is normally **expressed in dB**.

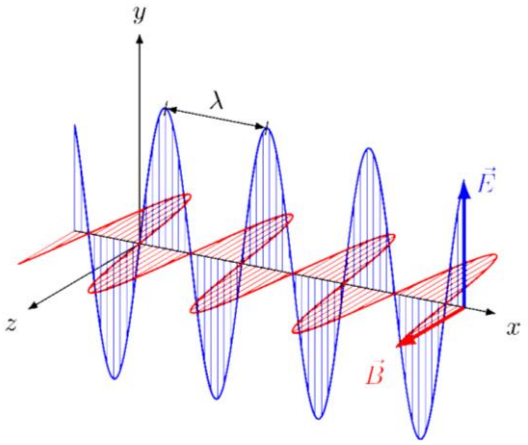
   The signal travels along the transmission line and through the antenna. Some of the forward power is reflected back through the transmission line so **Total Return Loss** at the transmitter equals the Return Loss of the Antenna plus (2 x) the **Transmission Line Loss**.

2. Standing Waves increase **Transmission Line Loss**. An SWR of **1.5:1 or less** is acceptable.

3. The **Antenna Matching Unit (AMU)** or **Transmatch** can "tune out" the **reactive** parts of antenna system and **match impedances** to an acceptable level. **Note** that if the AMU is at the transmitter and not at the feedpoint of the antenna, it cannot reduce the SWR or the actual losses in the transmission line. The ideal position of a Transmatch is at the feedpoint.



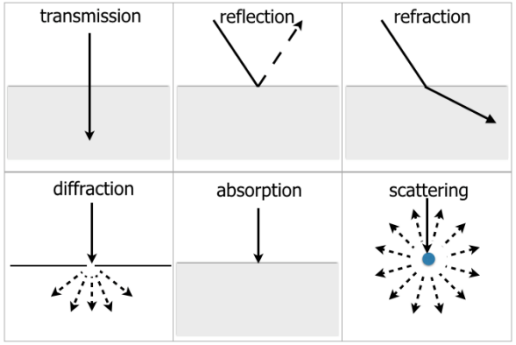
Propagation



1. Radio waves are electromagnetic waves. They are just like light. The electrical and magnetic fields of an electromagnetic wave are perpendicular.

2. Like light, the intensity, or signal strength, of a radio transmission gets weaker with distance. This concept is described as the inverse squared law of radiation.

3. The communications range of the VHF and UHF bands depends on antenna height, a clear path, transmitter power, and receiver sensitivity.



4. Above 30MHz it is important for transmit and receive antennas to be of the same orientation. Below 30MHz orientation (polarity) is less significant.

5. Remember that, like light, radio waves can be reflected, refracted and diffracted.

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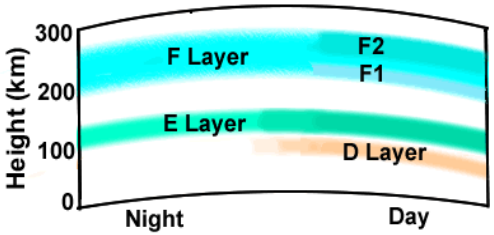
(The author of this document does not actually endorse cheating!)

6. In free space electromagnetic waves travel in a straight line and spread out according to the inverse squared law [Look it up]. Field Strength in Volts/Metre decreases.

7. The Ionosphere comprises layers of gasses, high in the atmosphere that are ionized by ultraviolet radiation and charged solar particles.



8. The Ionosphere changes at night, where F1 and F2 come together to form a more dense ionised layer (“F”). This means that long distance (DX) communication is more available to us at night.

9. Sporadic E occurs occasionally in the VHF band. It produces single hops of up to 2000km. Because of its greater height, F2 layer refraction supports single hops for HF of 4000kms. The F layers combine at night. Multiple hops allow world wide propagation.

10. **Critical Frequency** is the highest frequency transmitted vertically that will reflect back to the transmitter. The maximum frequency that will be refracted **over a given path** is the **Maximum Usable Frequency (MUF)**.

11. Solar activity such as sun spots will impact propagation conditions. The D layer also absorbs HF radiation during the day. As a result, the various HF Bands “open up” to ionospheric propagation at **different times of the day and year**.

Interference

1. Other radiocommunication equipment and services, including broadcast radio receivers and televisions, can suffer interference from local sources, including Amateur Radio Operators due to faulty operation.

2. Local interference (Noise) can also impact Amateurs. Such noise sources include:
    a. Inverters
    b. Welders
    c. Electrical and Electronic equipment that is not compliant
    d. Other Radiocommunications equipment

3. Amateur Radio equipment can be the source of interference if:
    a. Your transmitter antenna is in proximity to a broadcast reception antenna
    b. Yor transmitter’s filters are faulty and producing spurious emissions
    c. Your mic gain is too high, and you are transmitting poor audio quality
    d. The power amplifier in your transmitter is faulty and producing harmonic distortion

4. A technical solution will often resolve the issue, but in dealing with neighbours and others, it is important to be **diplomatic**.

5. Electromagnetic Compliance (EMC) is the ability of electronic or radio equipment to operate properly, without interference, in the presence of electromagnetic radiation. This type of radiofrequency immunity depends on strategies such as shielding and Earthing.

6. Interference Pathways can be by direct radiation or by signals induced in building wiring, speaker wires or data cables.

7. Interference resulting from EMC problems may depend on the power, frequency, type of emission, and the distance involved.

8. Some transmission modes are more likely than others, to cause objectionable (harmful) interference than others.

9. The installation of suitable filters in power cables and TV antenna cables, as close to the equipment as possible, can improve electromagnetic compliance.

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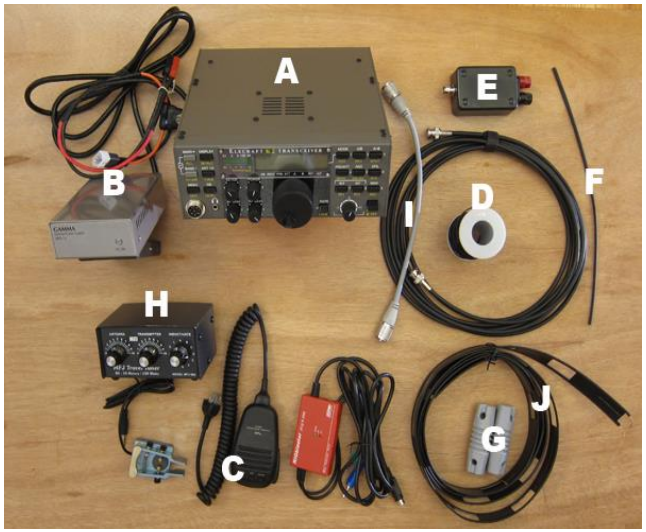
10. You should be able to construct a simple RF Choke, by winding coaxial or power cable through a ferrite toroid.

11. Installing a separate RF Earth connection in an Amateur Station is important. It provides a path to ground that minimises RF currents entering the Mains earthing system and other building wiring.

12. Remember that an Amateur station cannot be operated if it produces 'Harmful' interference to radiocommunication services.

Operating Practices and Procedures

1. You will need to know how to connect all of the equipment found in a simple radio shack:



- Transceiver
- Power supply
- Antenna Tuning Unit
- Antenna & Feedline
- VSWR Meter
- Microphone

2. Someone with a Foundation qualification can transmit on any of six frequency bands (80m, 40m, 15m, 10m, 2m and 70cm).
3. The Band information is in the Amateur Class License document.
4. Know how to use a radio and conduct a QSO. (See Practical Videos)
5. The WIA Amateur Band Plans play an important part in managing interference and getting the most out of our hobby.
6. Understand how to operate through a repeater, including Offset, CTCSS Tone, repeater etiquette etc. (See Practical Videos)
7. Be practiced at using the Phonetic alphabet and Q-Codes.
8. Understand the VSWR Meter and how to adjust VSWR.

Safety

1. Dangerous voltages can cause electrical and RF burns, electric shock, and death by electrocutions.
2. High currents can cause contact burns and destruction of property and equipment because of cable insulation burning.
3. Electrical and Communications equipment must be approved by a relevant authority/qualified person and will be appropriately labelled.
4. You should check local supply authority requirements regarding installation and testing of equipment and cables.
5. Most Mains-operated equipment should have a mains Earth connection.
6. Equipment fitted with fuses, that protect equipment from over-current, fires etc., should always be fitted with the correctly rated fuse.
7. Precautions should be taken when fitting or replacing fuses!
8. The layout and maintenance of your Radio Shack and, in particular, any associated cables, is important to avoid frayed or damaged cables, trip hazards and heat due to coiled extension leads.

9. You should know the location of a mains switch that will isolate power to your equipment.

Amateur Radio Foundation Exam Preparation Cheat Sheet No. 11

(The author of this document does not actually endorse cheating!)

10. In the event of an accident involving electricity, firstly, safely switch off the power. A casualty of electric shock MUST NOT be touched until the power is isolated.

11. Then, call Emergency Services and administer CPR if required.
12. Batteries contain chemicals and can emit fumes that can harm people or animals. Avoid flames and sparks as batteries can explode.
13. Keep people and animals away from antennas because of high voltages and currents as well as RF radiation. The risks depend on the frequency of operation, proximity, Effective Radiated Power (ERP), antenna type and orientation.
14. Always use appropriate Personal Protection Equipment (P.P.E.)
15. Avoid working at heights when erecting an antenna. Have a suitably qualified person do the work for you.
16. Site antennas and secure them such that neither the antennas or the fittings, are ever close to mains poles or powerlines.
17. It is a good practice to install lightning protection on antennas and feedline. Disconnect antennas from radio equipment prior to thunderstorms. NEVER operate your shack during a thunderstorm!
18. Be aware that excessive volume when using headphones can damage your hearing.
19. Recognise the following:
    - Schematic Symbols:

Ground	Lamp
Cell	Antenna
Battery	Mic
Switch	Speaker
Fuse	Resistor

- Balanced antennas:
  - Dipole (73 Ω)
  - Folded Dipole (300 Ω)
  - Loop Antenna (100 Ω)
- Unbalanced antennas:
  - End Fed (1000 to 5000 Ω)
  - Vertical Ground-plane (72 Ω)
  - Inverted “V” Antenna (50 Ω)
  - Off-centre Fed (200 to 300 Ω)
- UHF Connectors:
  - SO239
  - PL259

- BNC Connectors
- SMA Connectors
- N-Type Connectors
- Coil
- RF Choke (Toroid or Ferrite Rod)
- Balun (Impedance Matching RF Transformer)