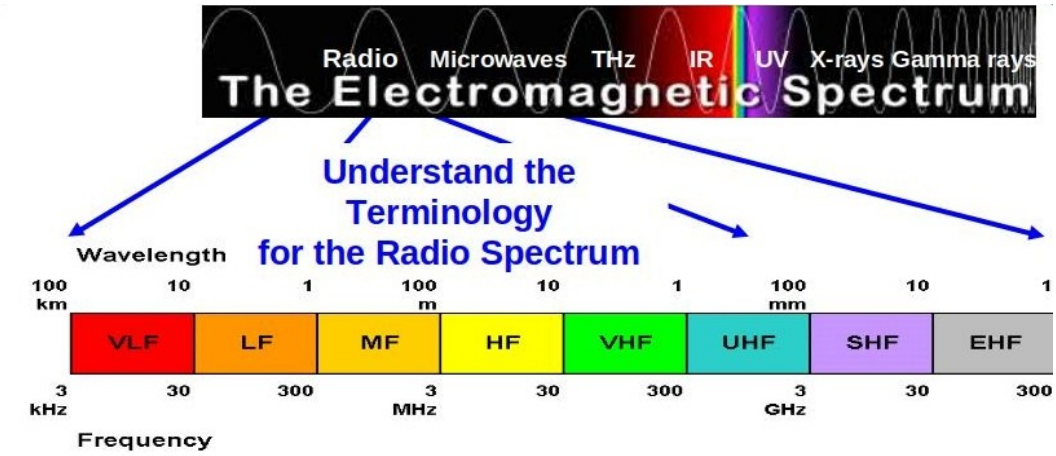
Amateur Radio Foundation Course Key Facts

Introduction:

- The exam last for 60 minutes, there are 26 questions, minimum pass mark is 19 questions right. As of October 2024 all exams have to be taken online.
- You will need a pen and may use a calculator (not a smart phone).
- You Must produce Photo ID

Nature of amateur radio:

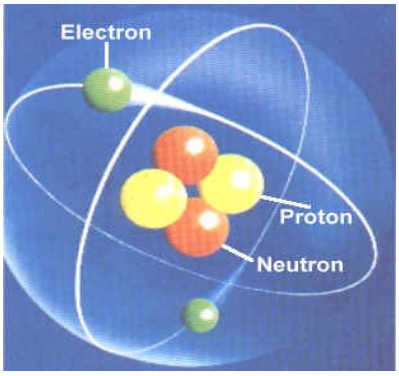
- An amateur licence is for self-training in radio communications and is of a non-commercial nature.
- The Foundation Licence is the entry level to Amateur Radio in the UK
- There are 3 levels of Amateur Radio Licence :- **Foundation, Intermediate and Full**
- Values of Amateur Radio : Technical Innovation, Emergency Communications, Development of Skills, International Friendship and Recreational Activity
- **Amateur Radio Aspects:**
  - **BANDS** HF, VHF, UHF (and Microwave)
  - **SPECIAL** Repeaters, Internet Links, Packet/UIView, DX Cluster, RAYNET (and Satellites/ISS)
  - **MODES** Voice, Morse, Data/Packet, Slow Scan TV,
  - **MODULATION** CW, AM, SSB, FM, FSK,
  - **OTHER** RSGB/Radcom, Clubs/Events, QSL Cards, Contests, Awards



- Remember ranges for Radio Frequencies (RF):-
  - HF: 3-30MHz
  - VHF: 30-300MHz
  - UHF: >300MHz
- UK AC Mains Frequency = 50Hz
- General Audio (AF) for Normal Hearing: 100Hz-15kHz
- Audio Frequencies for Communications: 300Hz-3kHz

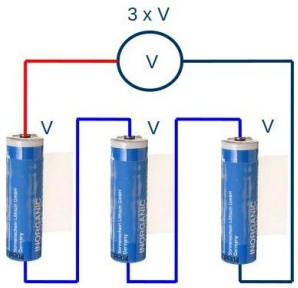
Technical Basics:

- The word electronics comes from the word electron.
- A stable elementary particle with indivisible charge of negative electricity
- Part of an atom and acting as carrier of electricity in solids.

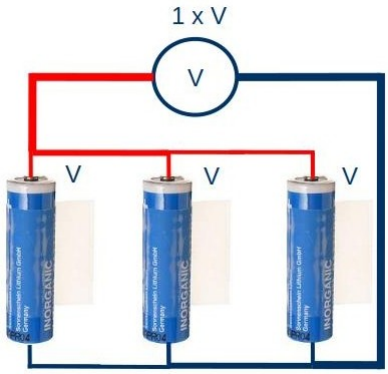


- Electrons can flow easily in some materials that are called **conductors** and not flow easily in others which are called **insulators**.
- A conductor could be a piece of copper wire while an insulator could be plastic.
- Insulators are often found around the out side of a wire so that your fingers are "insulated" from the wire carrying electrons.
- Batteries are made of an number of Cells connected in series or parallel
- Recall that a battery provides voltage (potential difference) at its terminals and that a circuit is needed to allow current to flow.
- There is a **POTENTIAL DIFFERENCE** between the negative and positive terminals of a battery.
- The greater the number of electrons trying to make the journey between positive and negative terminals of the battery the larger the potential.
- The **Potential Difference is measured in Volts**. Thus it is also said that a battery supplies a voltage.

- When Cells are connected in series (i.e. stacked on top of another as in a torch) you add the voltage of all the cells.
- The maximum current remains the same.

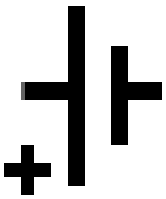


- When Cells or Batteries are connected in parallel the voltage remains the same.
- The current is the sum of all the Cells or Batteries.



- **NEVER connect a wire from the positive terminal to the negative terminal of any cell or battery else a fire could result.**
- The above connection is called a "short circuit".

- The circuit symbol for a Cell/Battery
- The long line is always the positive on a battery



- ***If you connect the positive terminal of the battery to the negative terminal of the equipment and the other lead negative to positive DISASTER is most likely to occur.***
- ***In some cases, fire could occur.***

- **Direct Current** D.C.
- **Alternating Current** A.C.

- Direct Current (DC) is the constant flow of electrons from a power source, through a load (your circuit) and back to the power source.
- The current only flows in one direction

Direction of current flow?

Actual Current Flow:

- Electrons flow from the negative terminal through the load and back to the positive terminal

Conventional Flow:

- In the early days of science, it was believed that current flow was from positive to negative.

- Alternating current flows first one way and then back again.

- **The number of times the direction changes is called the frequency. Mains changes direction 50 times per second or 50Hz.**

Why use Alternating Current?

- It is easy to step up or down voltage via a transformer.
- Easy to generate at a power station.

- Identify Units of measurement and multiple/sub-multiple prefixes.
- Identify the units of and abbreviations for, Voltage (potential difference), Current, Power and Resistance.
- Note: Prefixes milli, kilo and Mega may be used.

Unit	Measured in	Abbreviation	Symbol
Voltage or PD	Volts	V	V
Current	Amps	I	A
Resistance	Ohms	R or W	R or W
Power	Watt	P	W
Frequency	Hertz	f	Hz
Wavelength	Metres	l	m

Note-1: Resistance is the opposition to current flow
Note-2: Voltage is sometimes referred to as Potential Difference

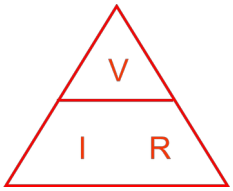
micro = (divide by 1,000,000) Symbol = µ or u
milli = (divide by 1,000) Symbol = m
kilo = (time 1,000) Symbol = k
Mega = (times 1,000,000) Symbol = M

Examples:

- 4,700Ω 4.7KΩ or 4k7Ω
- 2000mA = 2A or 2Amps
- 14,100,000Hz = 14.1MHz
- 600,000Hz = 600kHz or 0.6MHz

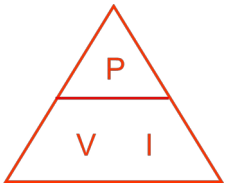
- Recall that resistance is the opposition to current flow.

- To explain the relationship between Volts, Current and Resistance
- Think of this room, the door and someone shouting fire.
- The room is like a container
- We are like the electrons, and the person who shouted fire is applying the PD
- The door is the resistance.



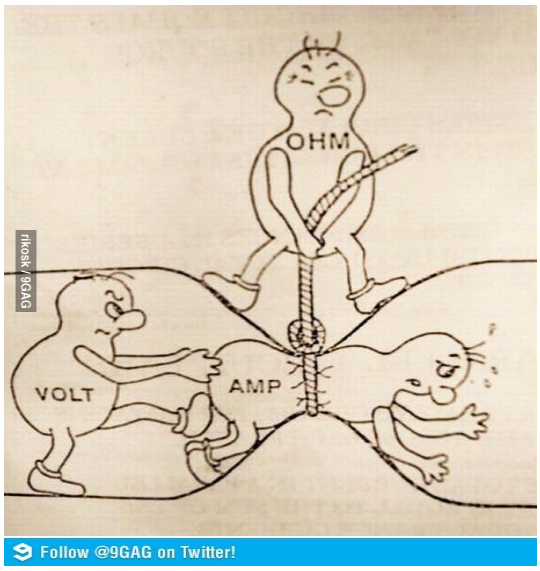
- Recall the relationship between Voltage (potential difference), Current and Resistance. (V=IxR, I=V/R, R=V/I)
- If you know the value of two items you can find the unknown.

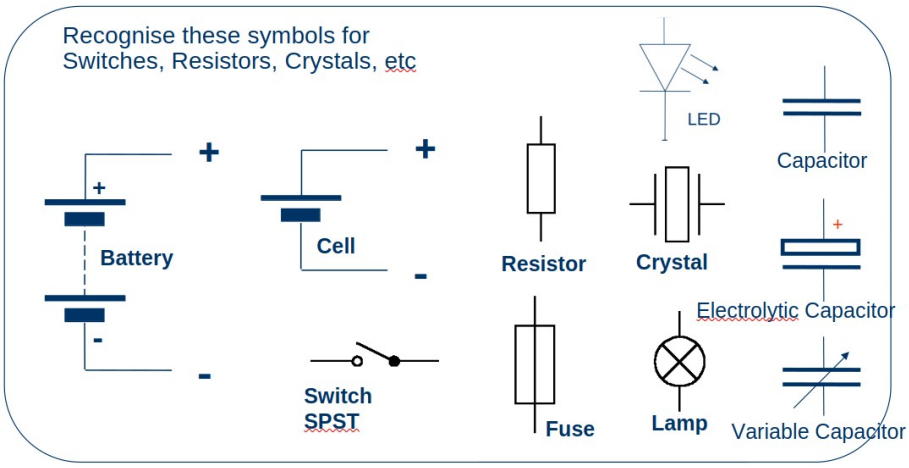
V = Voltage
I = Current
R = Resistance

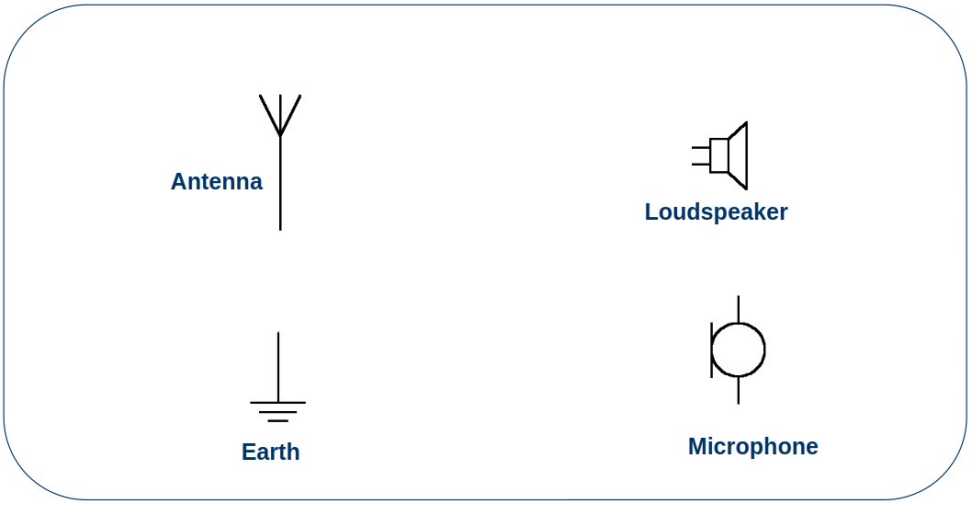


- Recall the relationship between Voltage (potential difference), Current and Power. (P=VxI, I=P/V, V=P/I)

P = Power in Watts
V = Volts
I = Current in Apps





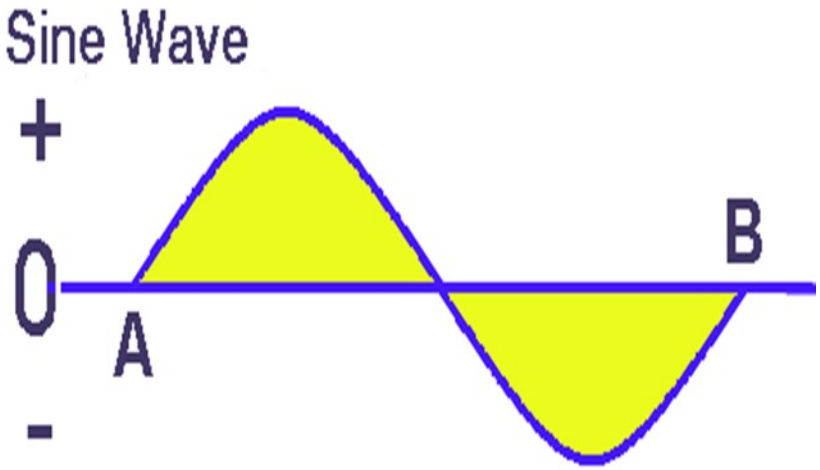


- **Frequency is the number of times something happens per unit of time.**
- In audio and radio, we refer Frequency as the number of changes per second.
- This is measured in Hertz.

- **Audio Frequencies are between 20Hz and 20KHz**
- **UK Mains Frequency = 50Hz**
- **Audio Range for Communications = 300Hz to 3kHz**

- Around 150kHz to 1.8Mhz Broadcast (Long and Medium Wave)
- **3MHz to 30MHz is called the HF band**
- **30MHz to 300MHz is called the VHF band**
- **300MHz to over 1000MHz is called UHF band**

- The sine wave is the most basic of wave forms and is one that you have to be able to recognise.

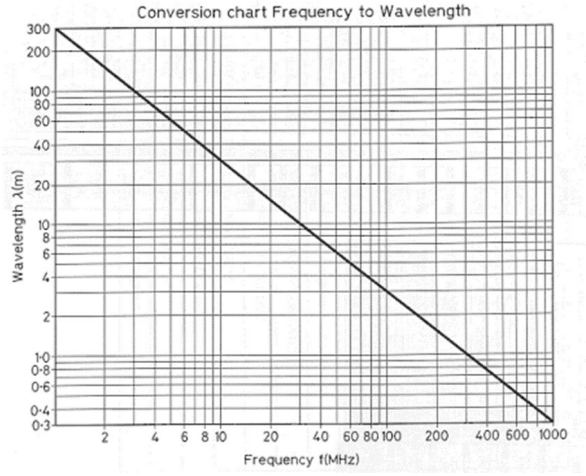


- Understand that frequency bands are allocated for particular use, e.g. broadcasting, aeronautical, maritime and amateur.

- Note that ALL the frequencies given in the table are in MHz - ***in the exam be careful to check that you are marking the box with MHz and not kHz.***

- Understand the relationship between frequency and wavelength. Use a graph to convert from one to the other.

Note: calculations are not required.



Bulbs in Series and Parallel (New)

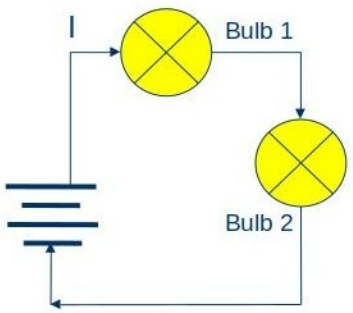
- The circuits for fitting bulbs in Series or Parallel is shown below.

Series

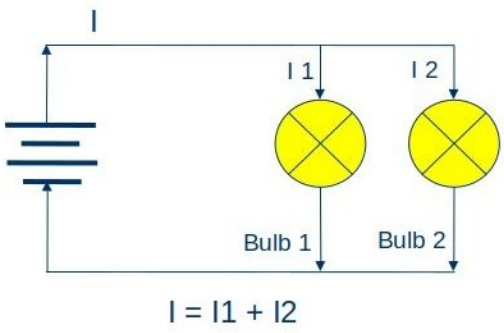
- In the Series Circuit, if the bulbs are the same value, half the voltage will be applied across each bulb.
- The current flow from the battery through the bulbs and back to the battery is the same at any point in the circuit.

Parallel

- In the Series Circuit, the voltage applied across each bulb will be the same.
- The current flow from the battery through the bulbs and back to the battery is the sum of the current flowing through each bulb in the circuit.



Series

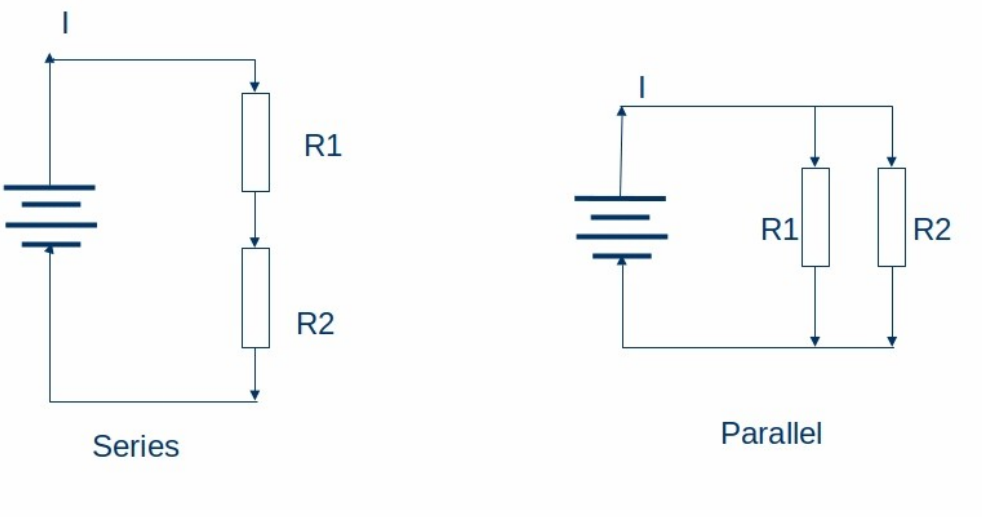


I = I1 + I2

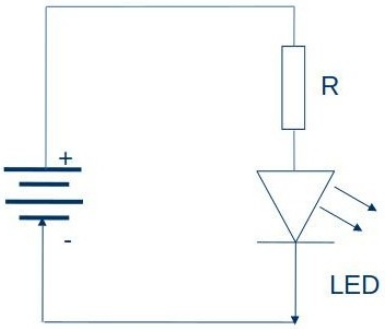
Parallel

Resistors in Series and Parallel (New)

- The circuits for fitting Resistors in Series or Parallel is shown below.
- The information for Series and Parallel Resistor circuits is the same in this case, just replace Bulb with Resistor.



LED Circuit (New)



- The Resistor R is to limit the current through the LED and drop the voltage applied to the LED.
- The LED will only light if it is connected with the correct polarity.

Operating Procedures

- Operating practices and procedures
  - Listen before calling and then ask if the frequency is in use.
  - Know how to make a CQ call.
  - Move off the calling channel (when on VHF/UHF) once contact is established.
  - Know the phonetic alphabet.

- The transmission of music and the use of offensive or threatening language whilst on the air are unacceptable in amateur radio.
- Know how to respond to music or inappropriate language overheard or received from other stations.
  - Firstly do not respond to these abuses or if you think you are talking to a pirate (Someone with out an Amateur Radio Licence) then end the conversation and ignore them going forward
- Understand the common practice of keeping a log if requested by Ofcom and the items recorded.

Operating through a repeater.

- Repeaters are mainly intended to extend the range of mobile stations.
- Know how to use a repeater and understand the need for an access or CTCSS tone and frequency offset.

Band plans

- Understand why band-plans are used.
- Identify items on a published band-plan (e.g. calling frequencies and recommended modes).
- Band plans are advisory
- Group modes into common frequencies
- Low bandwidth modes are found at lower frequencies
- Large bandwidth modes at higher frequencies
- Maximise the use of the spectrum.

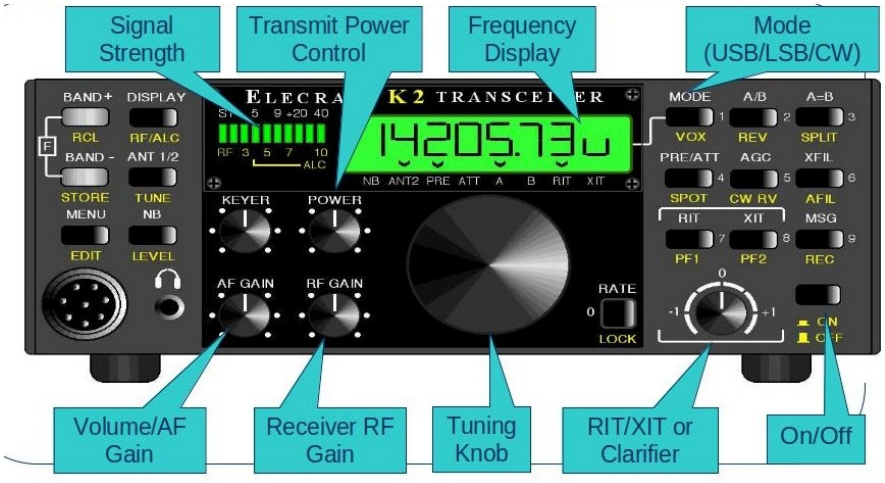
Connecting microphones and other audio sources to the transmitter.

- Connecting anything other than the supplied microphone (e.g. packet radio TNCs) to the transmitter requires correct operation of the PTT line and correct audio signal levels.
- By sending too much audio to the radio can cause **EMC Problems**, wrong of faulty wiring of a microphone may put your transmitter into **permanent transmit.**

Operating a Radio

- The Controls for HF radios and V/UHF FM radios differ from HF radios
- All HF radios have the same basic controls
- All V/UHF radios have similar basic controls
- Different manufacturers may call them different things.

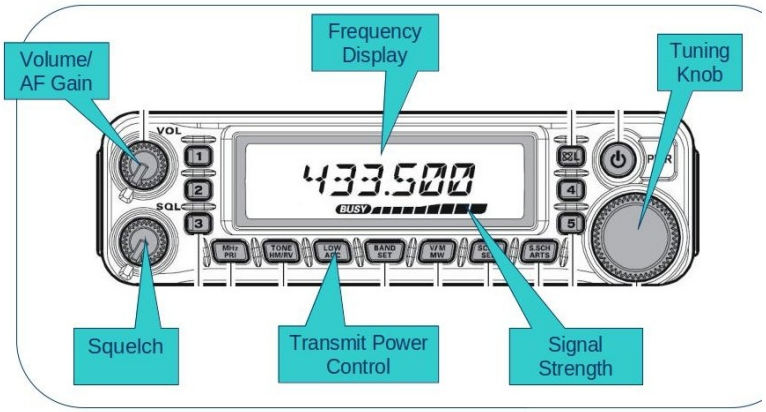
HF Radios



Other HF Controls

- Microphone Gain
- Audio filter selection
- RF filter selection
- Memory/ VFO selection
- Automatic Gain Control

VHF/UHF Radios



Other VHF/UHF Controls

- Repeater Shift
- Tone Burst
- CTCSS Tone
- Memory/VFO selection

Operating

- The radio is set up
- You have the microphone in your hand
- You are ready to transmit
- What do you do first?
- LISTEN!
- Check whether the frequency is in use, there may be a conversation in progress that you cannot hear both sides of.
- A general call for a contact is called a “CQ call”
- A CQ Call follows the general format:
- “CQ CQ CQ. This is G 7 S A C, Golf Seven Sierra Alpha Charlie, G 7 S A C, calling CQ and standing by.”
- And may get a response like:
- “G7SAC this is 2 E 0 C T H, Two Echo Zero Charlie Tango Hotel”
- and off you go……

Things to Remember

- CB Jargon is not used – we have our own!
- Some band/modes have a calling frequency, once a contact is established you move to a ‘working’ channel.
- The licence prohibits certain material being transmitted (copyrighted music, ciphers, bad language etc.)

Signal Reports

- Signal reports consist of two or three elements of Readability

Signal Strength
Tone (for Morse and some data modes)
Readability (1-5)
R1 - Unreadable
R2 – Barely readable, occasional words distinguishable
R3 – Readable with considerable difficulty
R4 – Readable with practically no difficulty
R5 – Perfectly readable

Signal Strength (1-9)
S1 – Faint, signals barely perceptible
S2 – Very weak signals
S3 – Weak signals
S4 – Fair signals
S5 - Fairly good signals
S6 – Good signals
S7 – Moderately strong signals
S8 – Strong signals
S9 – Extremely strong signals

Tone (1-9) – used for Morse (CW) only
T1 – Extremely rough hissing note
T2 – Very rough ac note, no trace of musicality
T3 – Rough, low-pitched ac note, slightly musical
T4 – Rather rough ac note, moderately musical
T5 – Musically modulated note
T6 – Modulated note, slight trace of whistle
T7 – Near dc note, smooth ripple
T8 – Good dc note, just a trace of ripple
T9 – Purest dc note

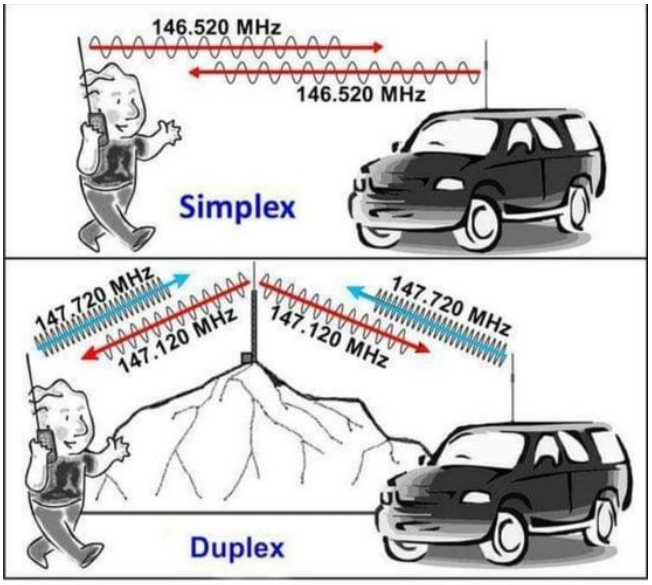
Q-Codes

- Q-Codes are an internationally recognised series abbreviations
- Q-Codes are divided into Aviation, Maritime and Telecommunications
- Some have been adopted by radio amateurs.

Common Q-Codes

- QRM – Interference from other stations
- QRN – Interference from atmospheric noise or from nearby electrical apparatus
- QRO – High power
- QRP – Low Power
- QRT – Close(d) down
- QRX - Standby
- QSB – Fading
- QSL – Verification card/ Confirm contact
- QSO – Radio contact
- QSY – Change frequency
- QTH - Location

Repeaters



<u>DO NOT USE</u> the frequencies shown in the above illustration as they are not UK frequencies

- Repeaters operate on a split frequency or referred to as a repeater shift
- Transmit on one frequency
- Receive on the other frequency
- Require CTCSS or 1750Hz tone burst to access the repeater
- Further details can be found in the RSGB yearbook, or repeater websites

TNC

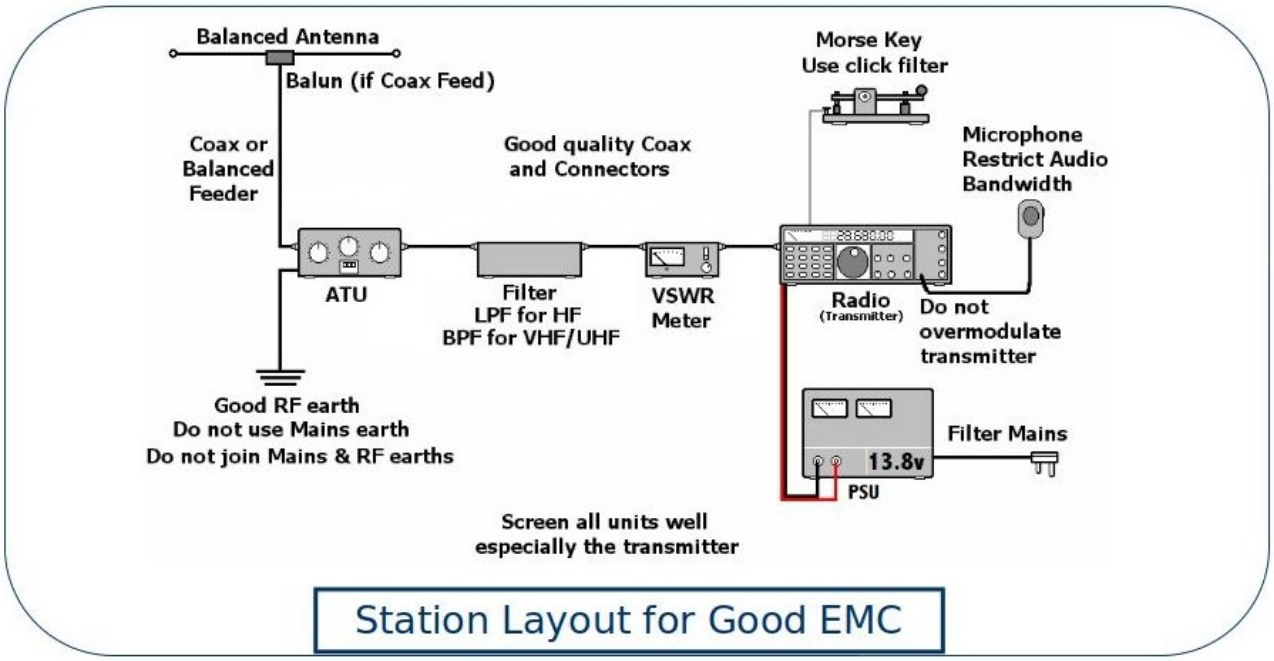
- TNC or Terminal Node Controller
- Think of it as a radio Modem
- Now days usually referred to a data interface
- Provides decoding of CW, RTTY, PSK and Packet (radio email) signals
- It is important that the PTT and Microphone gain is setup correctly for the radio.

Digital interfaces (New)

- There are digital voice (DV) and digital data (DD) modes available and different systems may not be compatible.
- Appropriate radio equipment is needed for each of these digital systems.
- DV radios may embed the callsign and this will need to be considered if using borrowed equipment.
- Users of Digital Voice (DV) should check that the channel is not in use by other modes.
- Users of FM should check that the channel is not in use by other modes.
- Such checks are not 100% reliable.

Electromagnetic Compatibility

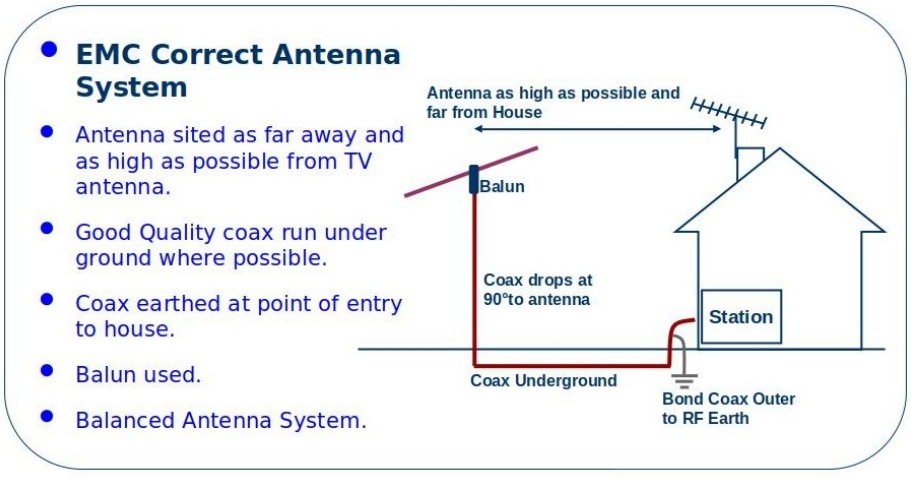
- EMC - Electro-Magnetic Compatibility
- Consumer Appliances and Radios working together in Perfect Harmony!
- EMC has two aspects:-
  - Avoidance of generating interference.
  - Immunity of your own kit from being interfered with.
- The more power you run – the greater the likelihood of causing interference
- The type of mode in use has a great affect on the interference

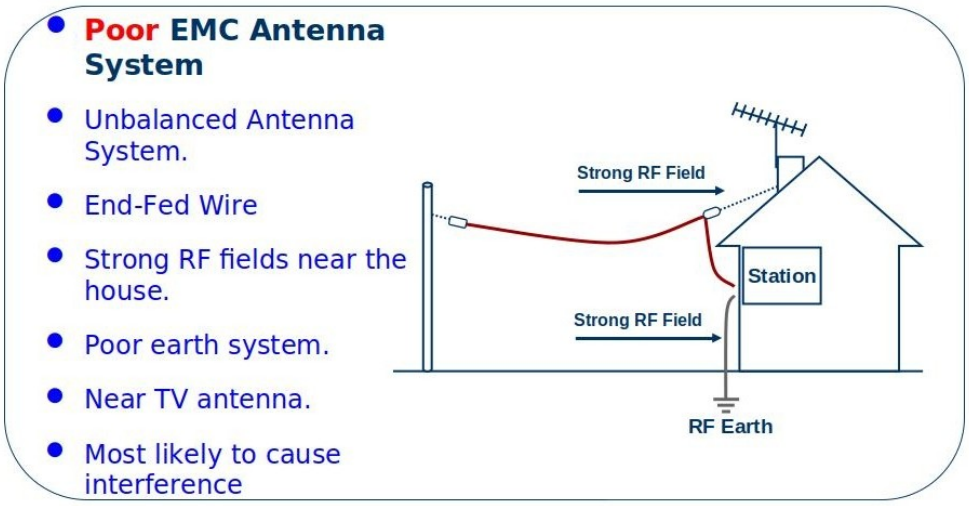


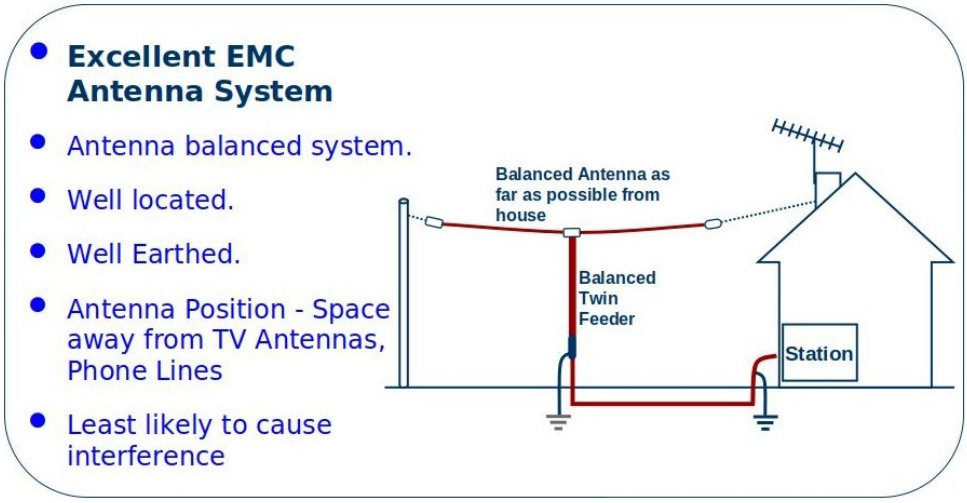
RF Earth Connection

- Use a good RF earth connection in an HF transmitting station
- Provides a path to ground to minimise RF currents entering the mains earth system
- Minimises the possibility of interference to other electronic equipment
- Should consist of the shortest possible length of thick copper braid to an earth stake in the ground

Choice of Antenna Type Dipole / Balanced System







Effects of different transmission modes

- FM Transmission
  - Least likely to cause interference
- AM or SSB
  - Most likely to cause interference
- CW – Morse code
  - Can cause interference

EMC Precautions

- Suppress problems at their source !
- Use Lowpass/Band Pass Filters to suppress Harmonics for TVI at the transmitter end.
- Use Dedicated RF Earths - NOT Safety Mains Earths
- RF Traps / Baluns on antenna feeders
  - Improves the Source
- Inline Filters, Ferrite Rings may be needed
  - Helps the Victims - TV, HiFi, PC, Home Theatre etc
- Fit filters as close as possible to affected equipment.

Social issues

EMC has the potential for causing Neighbour Disputes

- Commonly Television Interference - TVI
- Sometimes on HiFi, Telephone Lines
- Even a few Watts is enough to overpower a TV preamp
- Keep log book up to date – it will help you
- Get them to keep a log book – it may not be you!
- Advice is available from the RSGB EMC Committee
- Local Ofcom officers will also help in dealing with cases of interference.

Mobile Issues

- Most modern cars have microprocessor control.
- Can activate vehicle theft alarms.
- Can block remote central locking.
- Keep all RF cables away from main vehicle wiring.
- Take power for rigs directly from the battery via a fuse.

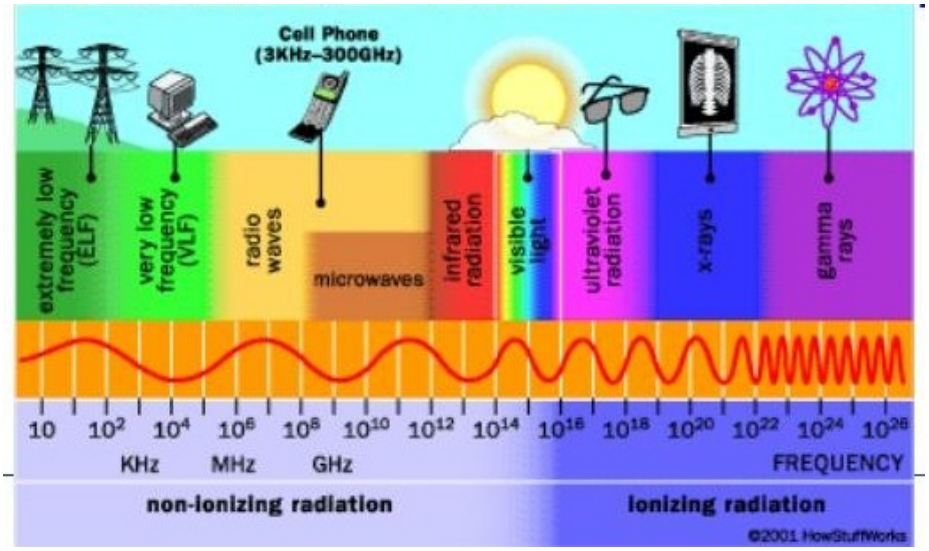
Mobile installations (New)

- **Any tests following mobile radio equipment installation should be done static with all vehicle electronic systems operating before any on-road tests are carried out.**

Transmitters and Receivers

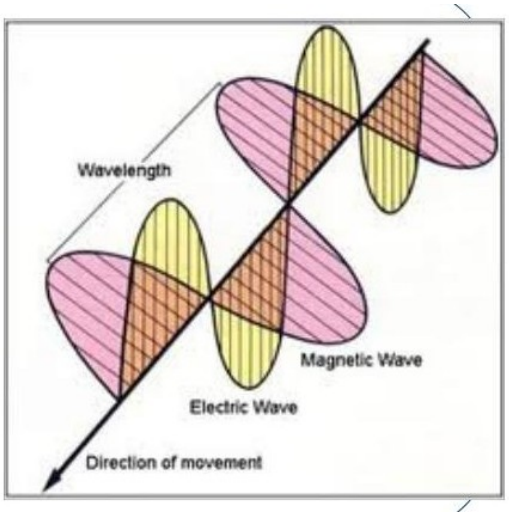
Electromagnetic waves

- Electromagnetic waves are an oscillating electrical and magnetic field travelling at the speed of light.
- The frequency is the number of times per second that the field changes polarity. 1 Hz = 1 cycle per second.



Wavelength and Frequency

Radio waves travel at 300,000,000 metres per Second.
The wavelength is the distance that the radio wave has travelled in ONE cycle.



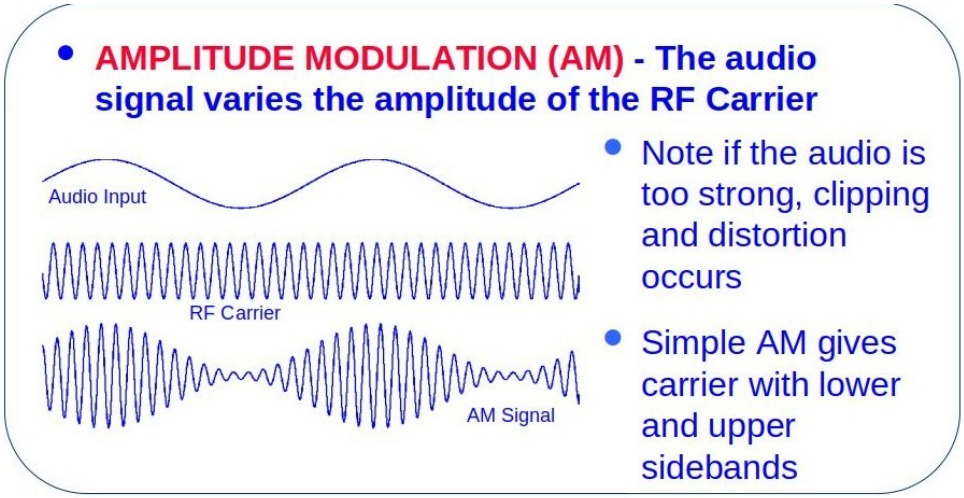
Tuned circuits

- Radios depend on the concept of tuned circuits.
- Tuned circuits are built from combinations of inductors and capacitors which have a self-resonant frequency.
- Tuned circuits are able to selectively pass or block selected frequencies.
- They are the basis of tuners, filters, oscillators, ATUs etc.

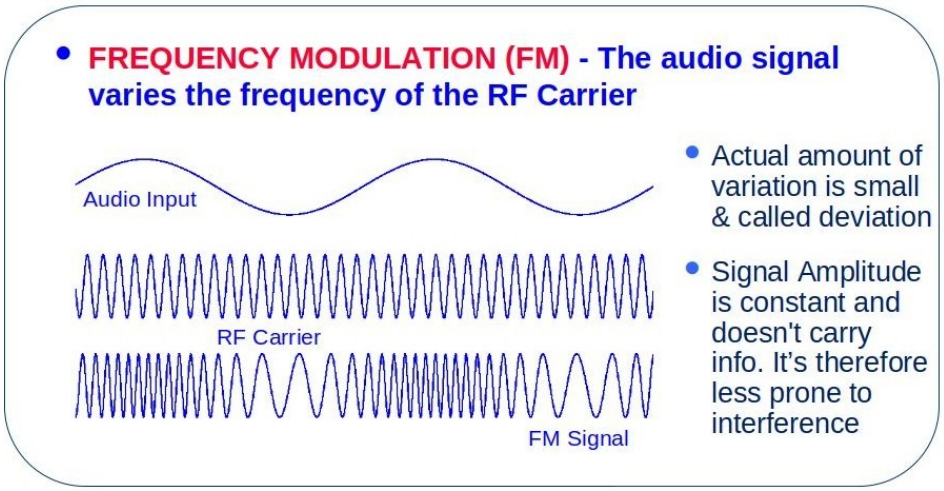
Modulation

- Radio waves themselves carry no information. Like a torch beam it is simply either on or off.
- This pure radio wave is called the Carrier wave.
- The carrier wave has a regular sine wave pattern.
- Modulation refers to the way that the pure sine wave is modified to carry speech or data information.

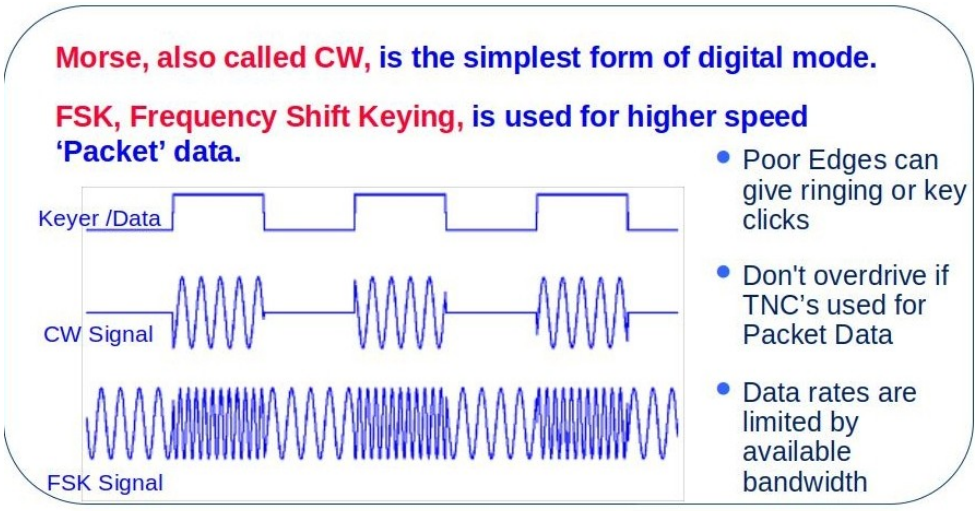
AM Modulation



FM Modulation

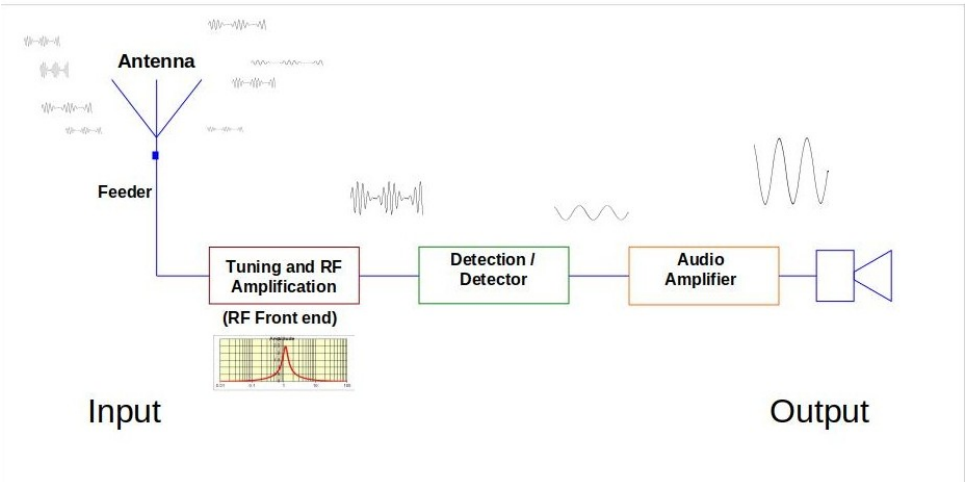


CW & FSK Modulation



Receiver concepts (New)

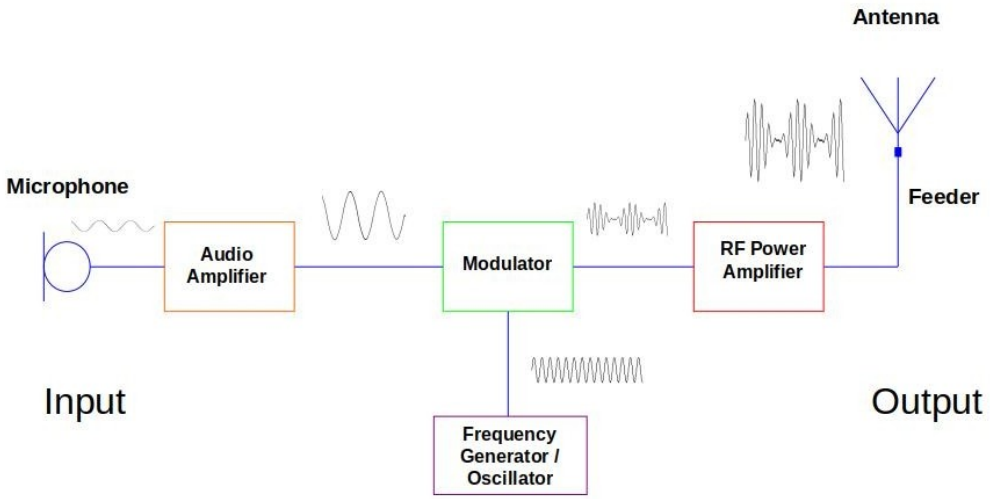
- The function of a radio receiver is to recover information sent from one place to another using electromagnetic radiation/wireless technology.
- The process of recovering information from a modulated radio frequency signal is known as demodulation.



Transmitter concepts (New)

- The function of a radio transmitter is to send information from one place to another using electromagnetic radiation/wireless technology.
- The process of adding information to a radio frequency carrier is known as modulation.

Simple transmitter



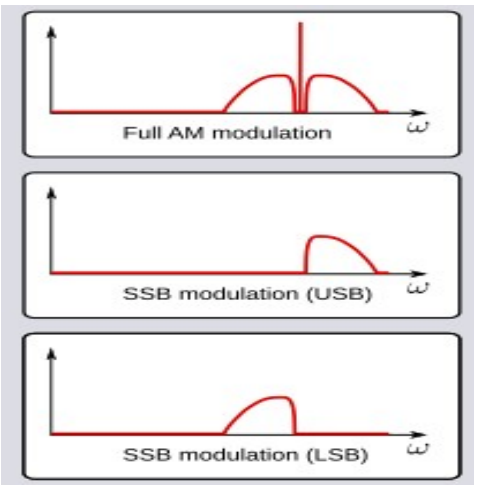
- RF Front end is critical to performance. Inductors and capacitors create selectively tuned circuits.
- RF Amplifier stage dominates the noise performance
- Detection circuits for decoding AM, FM, SSB etc. are different

Operating precautions

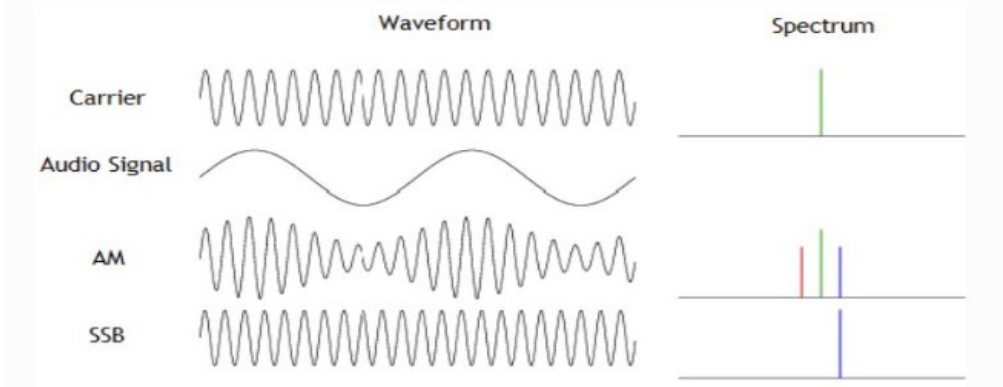
- Ensure Transmitter frequencies/modes are setup correctly so emissions are always in band, and conform to bandplans.
- RF power amplifier outputs must be connected to a correctly matched antenna to work properly. Use of the wrong antenna can result in damage to the transmitter.
- Excessive AM modulation or FM deviation will cause distorted outputs, and interference on adjacent channels
- Ensure that Microphone Gain (where fitted) is correctly adjusted

Single Sideband (New)

- When you modulate a signal on to a carrier you produce two sidebands, (Upper and Lower Sidebands).
- This is far easier to see on AM modulation than FM Modulation. The sidebands carry our wanted information at Radio Frequencies.
- The diagram shows sidebands produced by voice.



The diagram below shows the the sidebands for the modulation of a single audio frequency.



- Single Sideband is far more efficient than an AM signal.
- For example if you are transmitting a 10 watts AM Modulated signal, The carrier is 50% of your power with 25% of your power in each sideband.
- If we get rid of the carrier and the side band we don't want all our power is transmitted in the one sideband.

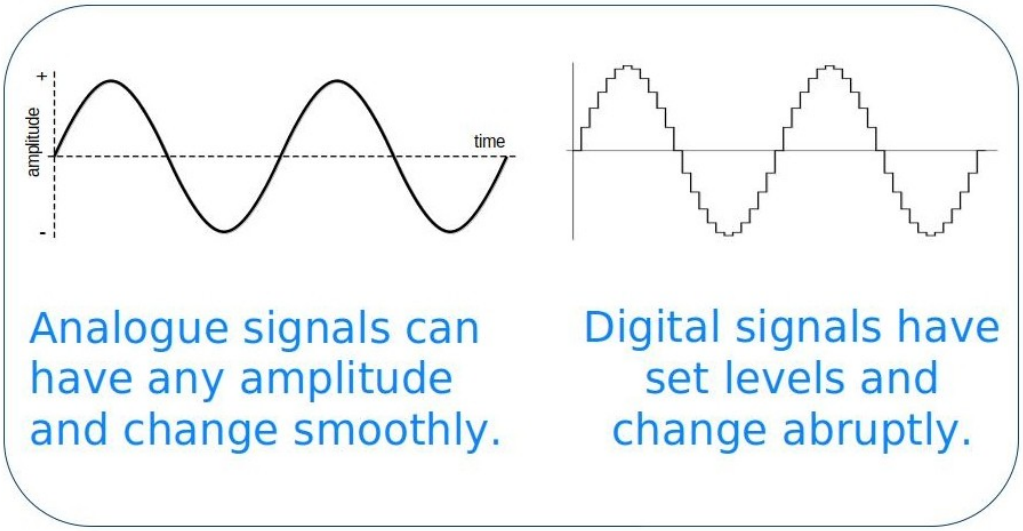
SDR Transmitters & receivers (New)

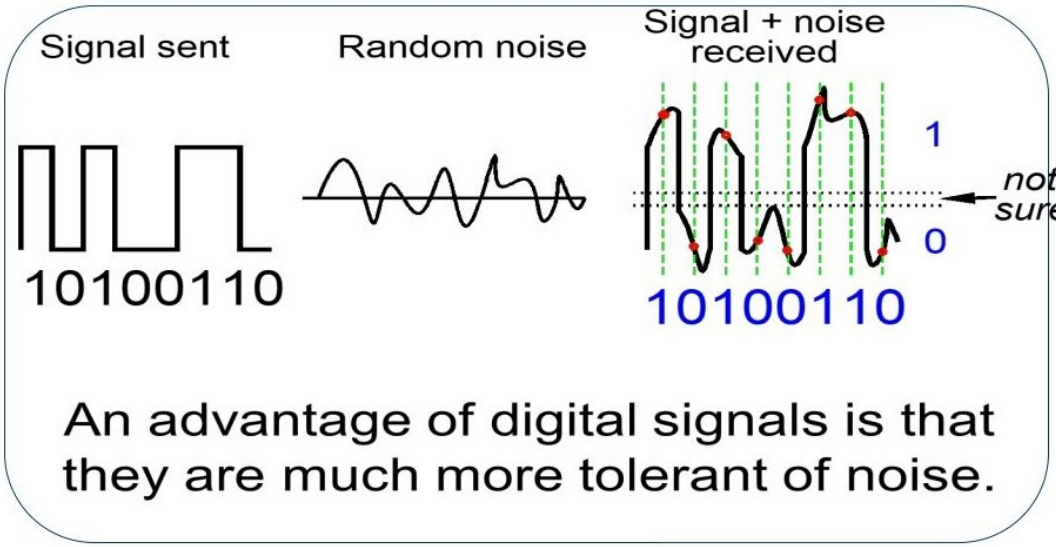
- The SDR receiver takes in all electrical signals from the antenna and digitises this input for processing in software.
- A mathematical operation enables all the signals to be sifted into separate frequency components.
- The required signal is selected using a filter defined in software.
- Demodulation is carried out in software.
- Software Defined Radio (SDR) receivers convert incoming speech signals to digital format and then perform filtering and modulation on an RF signal using software.
- SDR transmitters generate modulated radio signals using software.

SDR Radio

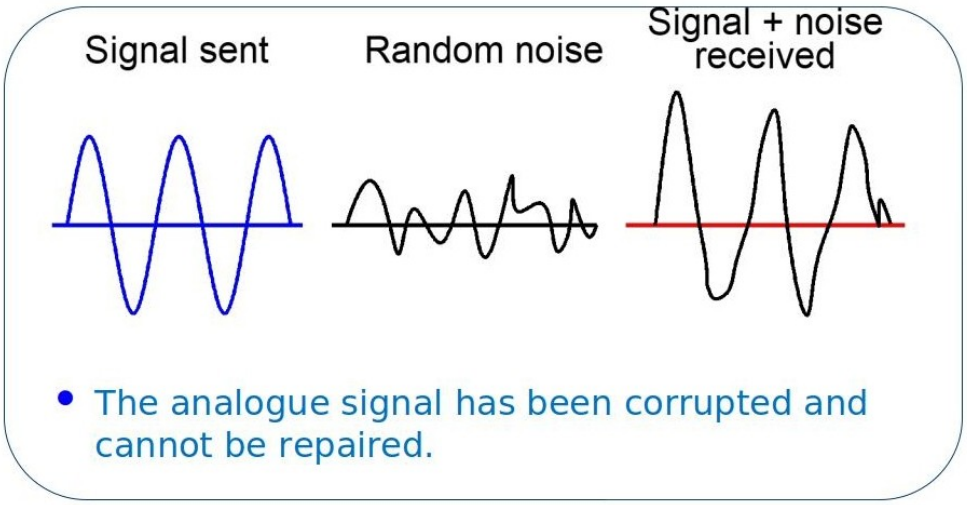
Digital signals (New)

- Analogue signals are constantly changing in amplitude, frequency or both.
- Digital signals are a stream of finite values at a specific sampling interval.
- Digital signals can be processed by a computing device with suitable software.
- Analogue to Digital Convertor (ADC) is a device used to sample an analogue signal and produce a digital representation of it.
- The meaning of the term **ADC (Analogue to Digital Convertor)**.
- A computing device is required to process digital signals.
- A Digital to Analogue Convertor (DAC) is a device used to represent a digital signal in analogue format.
- The meaning of the term **DAC (Digital to Analogue Convertor)**.

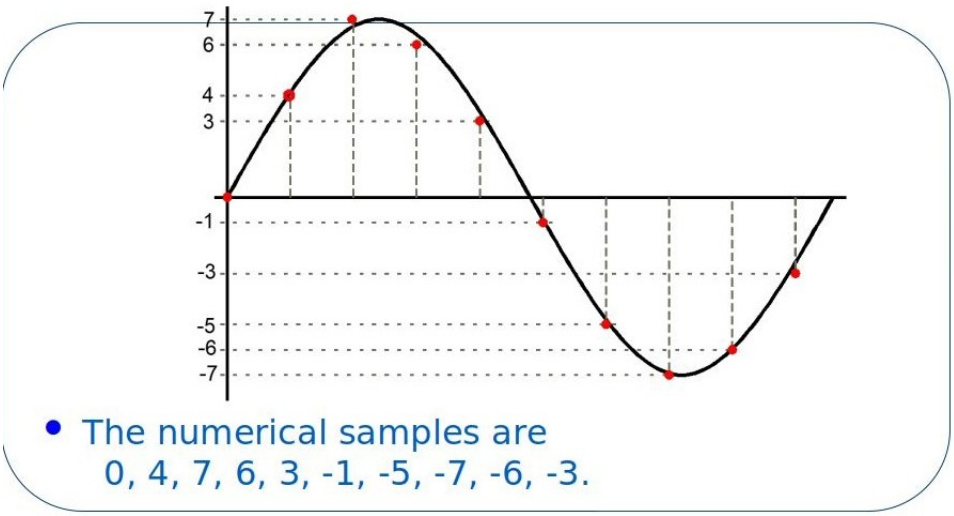




Same noise on analogue signal (New)

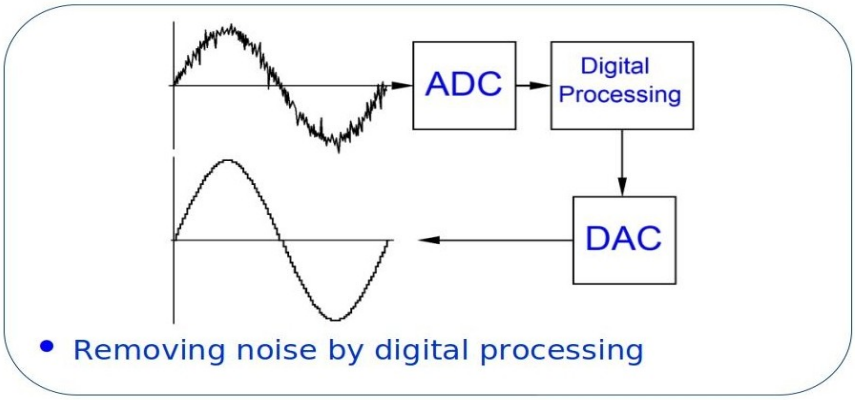


Analogue to digital conversion (New)



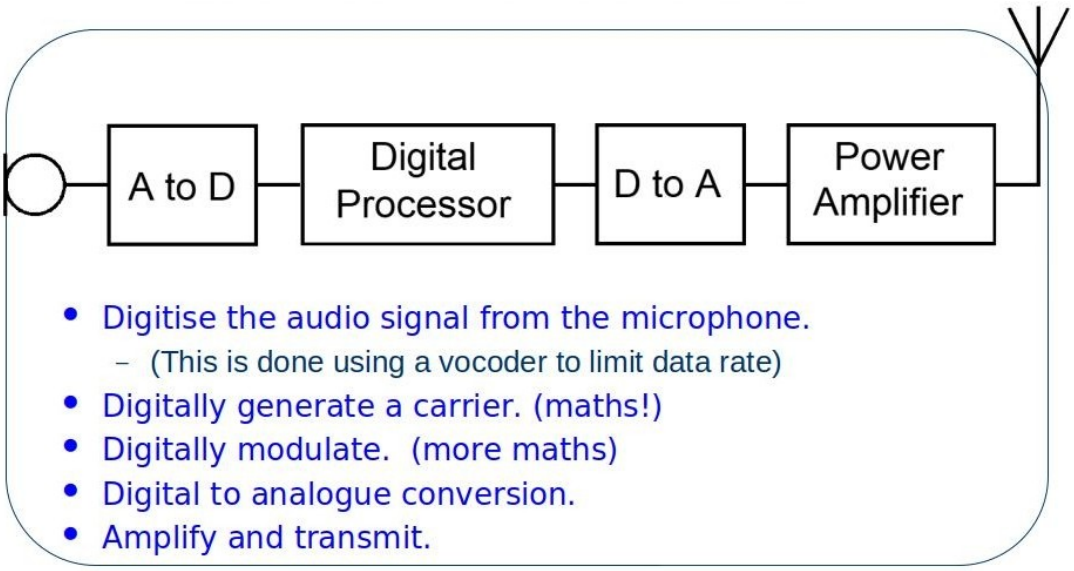
What do we mean by digital processing? (New)

- Almost anything an analogue radio can do and quite a bit more can be done in Digital.
  - Digital filters
  - Demodulation
  - Removing annoying whistles
  - Reducing background noise
  - Displaying signals and frequency bands.

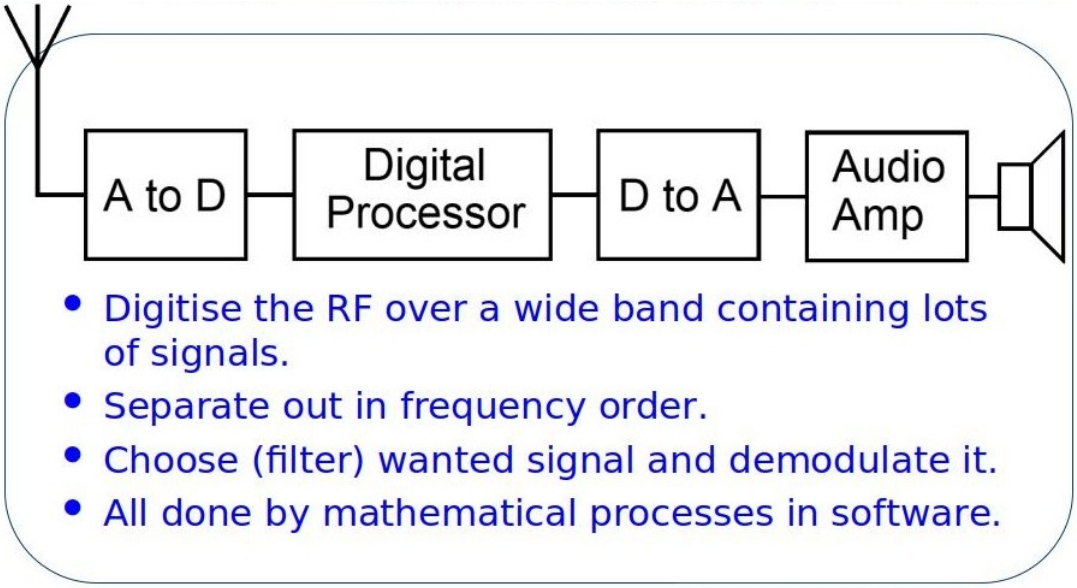


Software Defined Radio

SDR Transmitter (New)

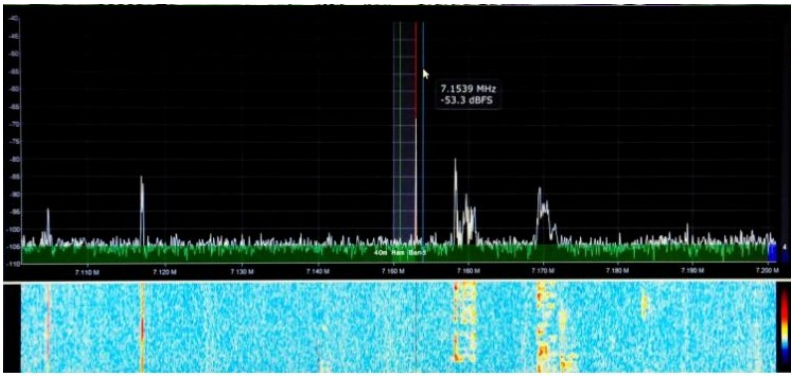


SDR Receiver (New)



SDR spectrum of amateur band (New)

Sample the RF very fast, calculate the different frequencies from the samples, display as signal strength vertical axis, frequencies on horizontal axis.



Safety

Sources of danger: mains, power supplies and high current batteries.

Be aware

- High voltages carry a risk of electrocution
- High currents carry a risk of overheating and fire
- Understand why mains powered equipment should have a safety earth.
- That special care is needed with earthing arrangements if your house has PME.
- That details of PME earthing can be obtained from the local electricity supply company and are covered in a separate RSGB leaflet.
- Understand that a correct fuse must be fitted to all electrical equipment.
- The fuse is connected to the live wire of mains powered equipment
- The fuse is connected according to the manufacturers' instructions in low powered equipment.

- Know only to work inside equipment that is disconnected from the mains.
- Know the correct way to wire a 3-pin mains plug.

- Understand the need for a clearly marked switch to turn off all station equipment in case of emergency

Sources of Danger

- High voltages carry a risk of electrocution - as little as 80 volts can be dangerous.
- UK mains is 230V -6%, +10%
- i.e. 216.2V- 253.0 V

Batteries & High Current Supplies can cause burns if shorted (+ & - terminals connected together)

- Remember P = V x I
- A 1.2V nicad cell can produce 20A for a short time
- A 12V car/leisure battery can briefly produce 100A
- A typical 12V power supply can produce 20-25A continuously

- Battery charging must be in accordance with manufacturer instructions and that lithium batteries in particular can cause fire and explosion if not properly treated.
- Different battery technologies require different charging techniques and must use the correct type of charger.

Protecting Yourself

- Ensure your station has a clearly marked OFF switch
- Make sure equipment is disconnected from the mains before opening
  - **If in doubt – don't open it**
- Remove jewellery (Watches, rings, bracelets) when connecting high capacity batteries or power supplies.
- **Never, never, never put cells/ batteries in your pocket**

Why do we Earth equipment?

- Only items which have 'Double Insulation' need not be earthed.

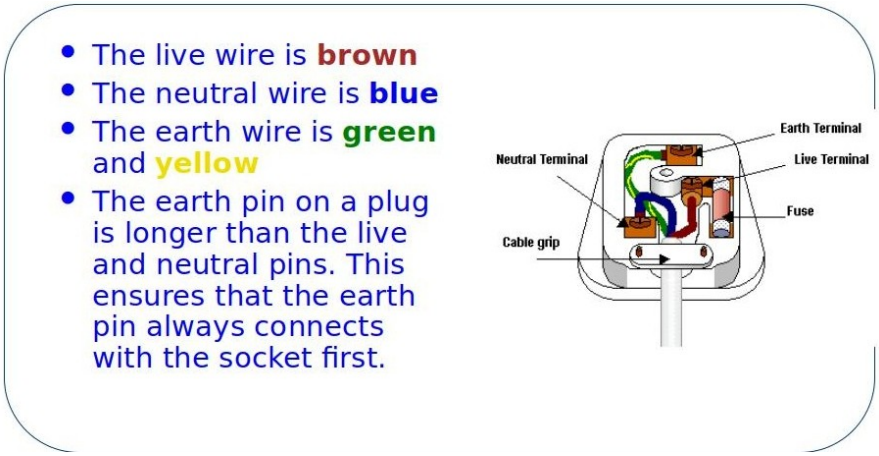
Double insulation symbol

- PME – Protective Multiple Earthing requires special attention. RF earthing for radios and antennas may lead to a hazardous situation.
- Seek information from your electricity provider supplier if you have PME.
- Leaflet on PME available on RSGB web site.

Why do we Fuse equipment?

- The fuse is there to protect the equipment against high current flow.
- A fuse is simply a very thin wire. As current flows through the wire it heats up. If too large a current flows it melts, breaking the circuit.
- Fuses are used to protect equipment. If too large a current flows through an appliance it may damage it.
- **Fuses are unlikely to act quickly enough to prevent human electrocution – their main purpose is to prevent fires due to large currents.**
- Fuses are rated as to how much current they can carry. In plugs fuses are usually 3A (red), 5A (black), or 13A (brown).
- The correct fuse for an appliance is one that is just above the normal working current for that equipment.

Wiring a mains plug



A way of remembering which colour wire goes to which connector, Think of Blue, the first two letters are BL (Bottom Left) and Brown the first two letters are BR (Bottom Right). The Green and Yellow connects to remaining connector

Wiring a mains plug

Do not use the mains plug if:

- The body is damaged, cracked or chipped
- The internals are exposed
- The cable is loose or damaged
- The cable if not securely clamped
- Any of the terminals are damaged or bent
- The lead is frayed or has “whiskers”

Actions to be taken and avoided in the event of an accident.

- In the event of an accident involving electricity, the first action is to switch off the power.
- The casualty must not be touched unless the power has been switched off.

From a US military publication:

- **Do not try to pull or grab the victim**
- **If possible, turn off the electrical power**

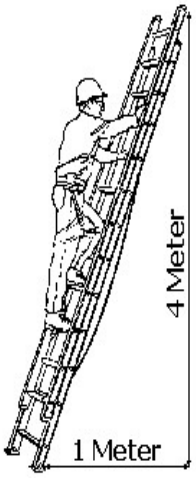
- **Send for help as soon as possible**
  - If you cannot turn off the electrical power, push, pull or lift the person to safety using a **dry wooden pole** or a **dry rope** or some other insulating material but only if you are confident and it is safe to do so.
  - After the injured person is free of contact from the source of electric shock, move the person a short distance away and immediately start first aid.

Station layout and tidiness

- Wires trailing across the floor are a trip hazard and there may be a risk of frayed insulation.
- Elevated wires and antennas must be suitably located and secured.
- Antennas and feeders should not be sited close to overhead power cables.
- Antenna erection is potentially hazardous and that it is advisable to have someone to help you. Understand the need for at least one adult to be present.
- Antenna elements should not be touched whilst transmitting (Electric shock / RF Burns) and should be mounted to avoid accidental contact.
- This does not apply to low powered devices such as hand-held equipment.
- High antennas may need special protection against lightning.

Ladders – Safety

- Take care when erecting ladders etc.
- The correct angle can be expressed as a 1:4 ratio
- Ladder should be suitably secured at the top or held at the bottom by an adult.
- Over-reaching can cause a fall or cause the ladder to slip, rotate.
- Use a tool belt to carry tools this will help prevent falling objects. Wear hard hats when working at height or when others are working at height.



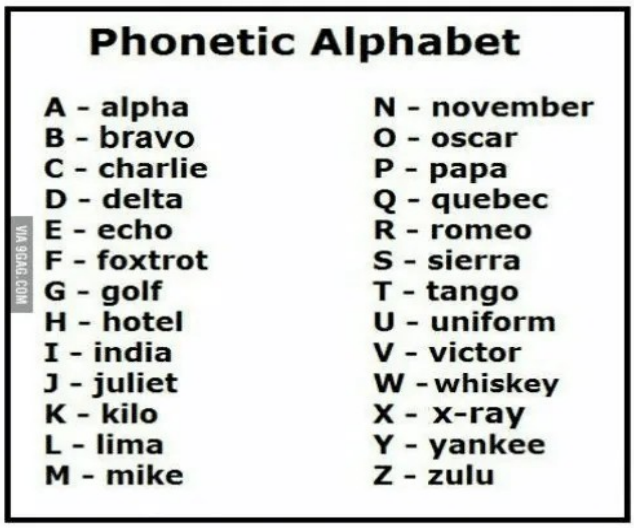
General Safety

- Danger of trailing wires across floor - trips, drags equipment off table, frays cable.
- Ladders - Take care when erecting antennas etc
- Lightning - Disconnect your Antennas !
- Keep clear of overhead power lines, and snagging or coupling in to telephone lines
- Feeders/antennas must be soundly fixed in case of being accidentally being pulled, high winds, icing, bird strikes

Tool Safety

- Eye protection should be worn when using drills, files, soldering irons etc.
- This will prevent solder flux spitting up into your face.
- Only solder in a well ventilated area, if possible with a fan blowing the fumes away from you.
- Soldering fumes can cause breathing problems, particularly for asthmatics.

Phonetic Alphabet



Safe use of headphones

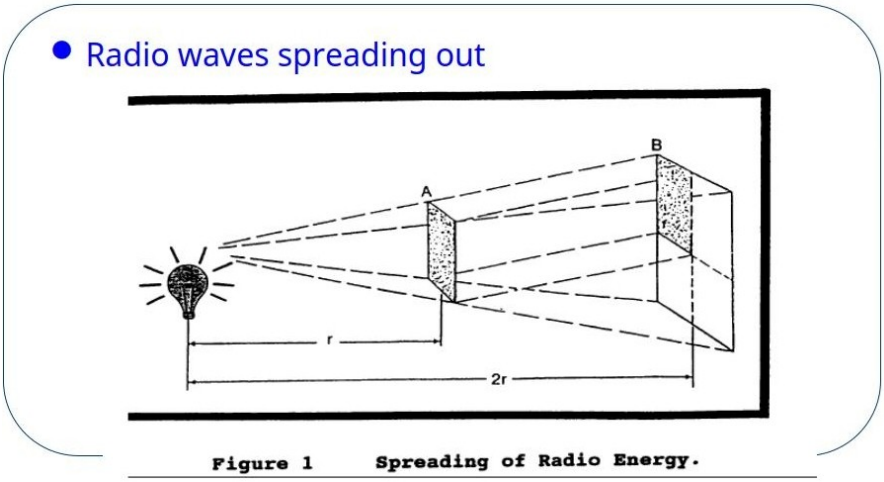
Excessive volume when wearing headphones can cause damage to hearing.

- Noise, Cracks and Pops from the radio can be significantly louder than the signal you are listening to.
- Ensure the volume is set at a relatively low level.
- Avoid prolonged use.
- Only use when seated.
- Risk of electric shock from frayed leads and faulty equipment.

Propagation

Propagation basics

- Propagation is about how radio waves travel from transmitter to receiver
- Radio waves are part of the electromagnetic spectrum
- The waves get weaker the further they travel as the signals spread out
- They also get weaker due to obstructions
- Like other types of electromagnetic energy, radio waves normally travel in straight lines but are affected by reflection, refraction and diffraction



Propagation : Obstructions

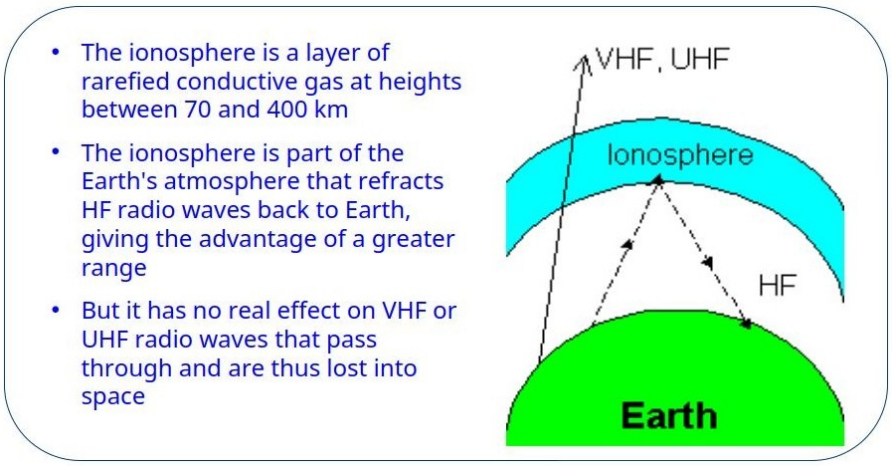
- Affects all electromagnetic energy
- Frequency dependent
- Buildings: masonry attenuates – but glass is more transparent to radio
- Hills: shadows in valleys
- Curvature of the Earth
- Tunnels

Propagation : VHF/ UHF

- Basically line of sight (LOS)
- Range is less at higher frequencies: UHF not as good as VHF
- Range Slightly more than LOS due to refraction
- Walkie Talkie range is only a few km
- Best from a hilltop
- Space communication is LOS

Propagation : HF

- Hops can be up to 4000 km
- Frequency dependent and time day
- Sometimes multiple hops

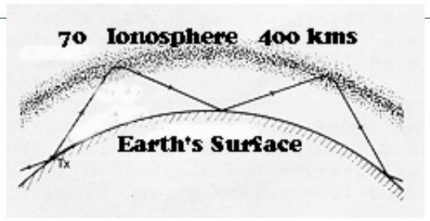


Ionospheric Variation

How well it refracts

- Frequency dependent
- Depends on strength of ionisation:
  - Daily variation
  - Seasonal variation
  - Sunspot cycle
- When good, bands are said to be open

Ionospheric Basics



Long distance communication is possible on HF when the radio wave bounces off the ionosphere. Worldwide coverage requires several bounces. In between we have skip zone.

Frequency dependence

- VHF and UHF are normally used for local communications, whereas HF is suitable for long distance communication.
- Higher frequencies, that is VHF and UHF, are not refracted by the ionosphere but pass straight through it. VHF and UHF signals go straight through the ionosphere and are lost in space [unless communicating with a satellite or spacecraft]. Therefore, VHF and UHF radio waves are normally used over short distances i.e. line of sight.

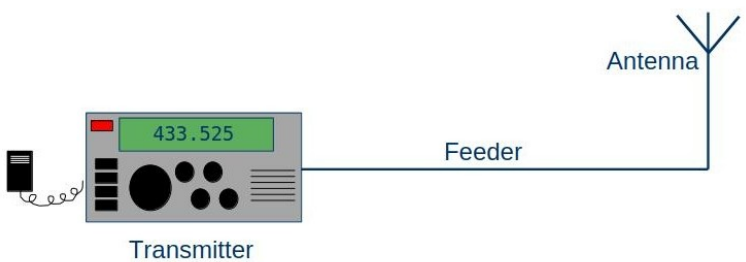
Give propagation a chance

- We aim is to transmit and receive a good signal - "working DX"
- Higher, outdoor antennas are always better than more power
- In practice, always try to get your aerial above roof height to clear obstructions
- On VHF/UHF, if loss is high, a clear path is much more effective in getting a good signal than a 10 or 100 times increase in transmit power
- For example, satellites can be accessed with very low power at a great distance.
- Typical ranges are a few km with a handheld, and tens of km from a mast-mounted antenna.
- A well-sited antenna is also better for receiving and reducing EMC

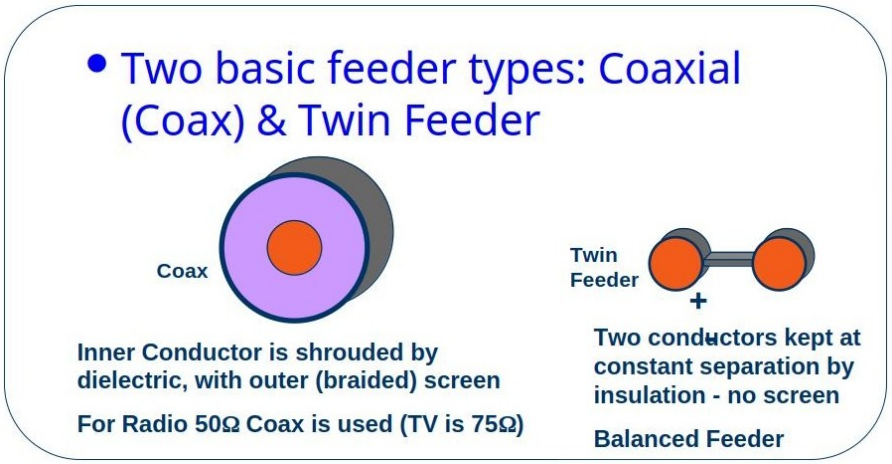
Feeders and Antennas

Feeder

- The wire that connects a transmitter to an antenna (or aerial) is called the feeder.



Feeder types



Balanced/Unbalanced

- **Coax is unbalanced** - Inner has voltage, Outer is earthed
- Coax is widely used because its outer acts as a screen
- **Twin feeder is balanced** - conductors have equal and opposite voltages/currents/fields
- In order to connect an unbalanced feeder to a balanced antenna (eg coax feeding a dipole) a transformer known as a balun is needed.
- **BALUN: BAL**anced - **UN**balanced
- Without a balun RF currents flow on the outside braid, and the screening properties of the coax are lost

Feeder loss

- The longer the feeder, the more “loss” it will incur. – i.e. more of the signal will be converted to heat before it reaches the antenna.
- Higher quality feeder has less loss.
- The higher the frequency, the higher the loss. For higher frequencies good quality feeder is essential.
- Loss is measured in db’s. -3db = loss of half of the power, so of the 10W going into the feeder, only 5W will be delivered to the aerial, the other 5W will be lost as heat.
- Affects both transmit and receive performance.

Feeder impedance

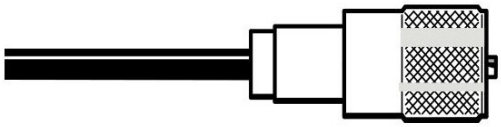
- Impedance is a characteristic of all feeders, and is covered in more detail at the Intermediate and Advanced levels.
- For the Foundation exam, you need to know that for Amateur radio, you should use feeder with 50Ω (50 ohm) impedance.

Coaxial Connectors

- A wide variety of connectors exist
- Common RF Connectors include BNC PL259, N-type, SMA etc
- Ensure both the inner conductor and outer braid are assembled correctly.
- Centre pin connects to centre core of coax.
- Outer body connects to outer braid of coax, which is connected to the body of the radio.
- Badly fitted connectors are a major cause of **High SWR** (which can damage your transmitter) or cause/ receive interference.
- Foundation Licence requires good understanding of PL259, N Type, BNC, and SMA connectors.

PL259 Connector

- Common HF/VHF connector with reasonable power handling.

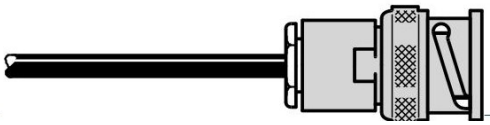


“N” type Connector

- Has reasonable power handling and often used for UHF frequencies.

BNC Connector

- BNC Connectors have a Bayonet locking action and are commonly used for lower power interconnections
- Take care not to mix incompatible 50 and 75 Ohm versions which have different inner pin sizes
- Smaller than the PL259 and N Type connector

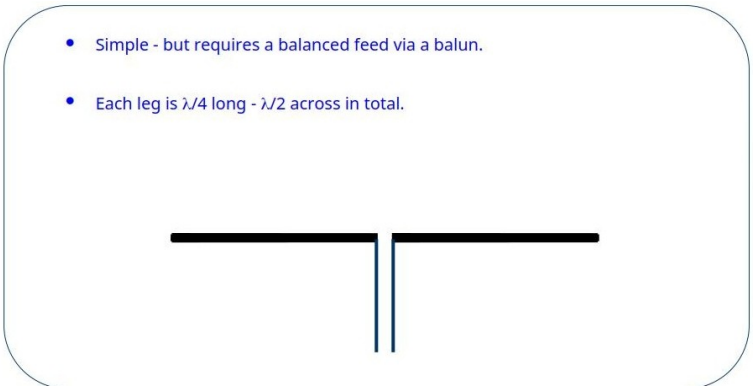


SMA Connector

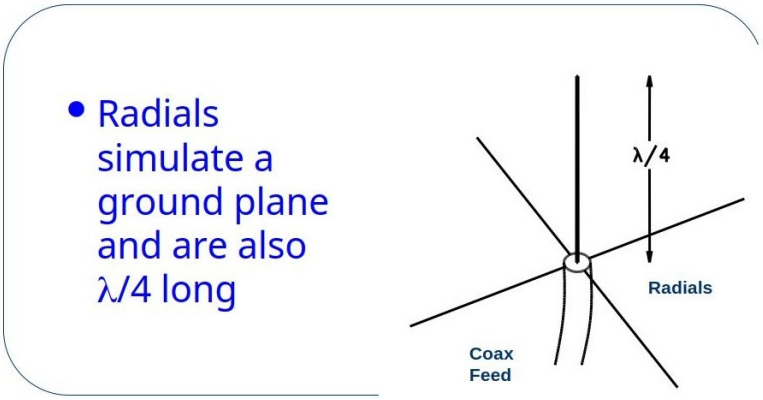
Antennas

- Antennas transform AC signals into propagating radio waves
- Gain is the directing of power in the wanted direction
- **You need to know the following types:-**
  - **Dipole**
  - **Quarterwave ground plane**
  - **Five-eighths ground plane**
  - **Yagi**
  - **End-fed wire**
- Antenna size is determined by the operating wavelength, .
- Example: a 2m λ/4 is a third of the size of a 6m λ/ 4.

Dipole

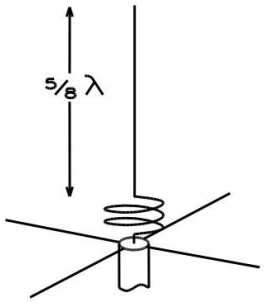


Quarter Wave: λ/4



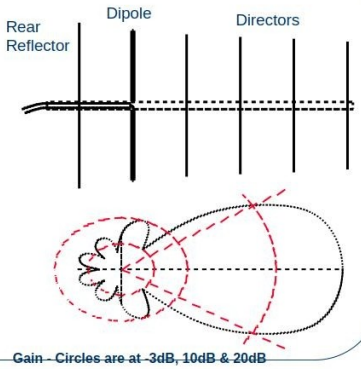
Five-Eighths: 5/8λ

- 5/8λ - Common antenna for mobile use
- Better impedance match and gain than basic quarterwave
- Radials emulate groundplane like the quarterwave



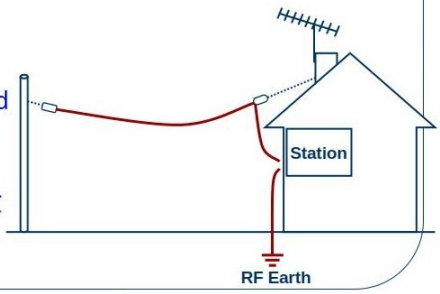
Yagi

- Dipole acts as pick up
- Front Directors 'focus' to give Gain
- Rear Reflector gives back/front isolation
- Yagis may be horizontal or vertical



End Fed Antennas

- Common at HF where wavelengths are long
- Needs an ATU to match it for HF multiple bands
- Is unbalanced
- Has strong RF voltages and currents near the house. These are likely to couple into TV and other equipment and cause EMC problems



Gain/ERP

- **ERP = Effective Radiated Power**
- ERP is the power radiated in the direction of the maximum radiation
- ERP is the product of the power supplied to the antenna, multiplied by the gain of the antenna.
- ERP = Power x Gain (in linear units, or dB's)

Antenna Gain and ERP

- Some antenna such as a Yagi antennas have signal gain in one direction. This is because the RF beam is focused in one direction just like a torch.
- This Gain is expressed in Decibels (dB), relative to a halfwave dipole
- A gain of 3dB would result in double the power feed in to the antenna. Or power radiated from an antenna in the direction of the beam.

Loss or Gain (New)

The following shows gain and Loss in an antenna system

Antenna Gain	Multiplies the power by a factor
3dB	*2
6dB	*4
9dB	*8
10dB	*10
Losses	**Divides the power by a factor**
-3dB	/2
-6dB	/4
-9dB	/8
-10dB	/10

Effective Radiated Power (ERP) (New)

- ERP is a measurement of how much power is being radiated from an antennas
- It is calculated by multiplying the power feed to the antenna in watts by the gain of the antenna.

Antenna Gain	Gain (times)	Power into antenna	ERP from the antenna
3dB	x2	25 watts	50 watts
6dB	x4	25 watts	100 watts
9dB	x8	25 watts	200 watts
10dB	x10	25 watts	250 watts

- I have told you about ERP. There is another way to express the gain of an antennas.
- EIRP = Effective Isotropic Radiated Power.
- ERP is calculated by using the gain relative to a half-wave dipole

SWR or VSWR (New)

- SWR = Standing Wave Ratio and VSWR is Voltage Standing Wave Ratio
- It is the ratio of the transmitted power and reflected power from a miss match antenna system
- High SWR is **BAD** and indicates a fault in the antenna system
- Try to keep your SWR below 2:1 (the lower the better)

Antenna Match - SWR

- Antennas must be suited for the frequency of the transmitted signal. This is a challenge for multiband operation.
- SWR - Standing Wave Ratio is a measure of the mismatch of the antenna system to the nominal impedance of the radio.
- A high SWR will result in Output Power being reflected back to the Transceiver - Inefficient and Potentially Damaging.
- At HF most antennas are not matched for the wide range of frequency bands, unless a matching unit is used.
- SWR Meters are valuable for checking correct antenna design, installation and operation - and indicating faults
- Dummy Loads permit radio tests without radiating a signal

Polarisation

- Polarisation is the plane of the antenna's radiating electric field.
- Common polarisations are Horizontal and Vertical.
- Transmitter and receiving antenna polarisations need to match for optimum signal strength.
- Verticals (λ/4, 5/8λ) use vertical polarisation.
- Yagis and Dipoles may be either horizontal or vertical depending on their mounting.
- In complex situations polarisation can rotate.

Licensing

Amateur Radio benefits

- Technical innovation - there are always new ideas and technologies being developed.
- Emergency communications - although as a Foundation Licence holder you cannot actually take a full active part in emergency communications.
- Development of skills - the hobby might well give you an idea to follow some form of electronics as a career.
- International friendship - as a Foundation Licence holder you gain access to amateurs world wide via the HF bands (3.5 to 30 MHz), and you may well strike up a friendship that could lead to an exchange visit to amateurs abroad.
- Amateur Radio is also a recreational activity and will hopefully give you a hobby for life.
- Remember that the Foundation Licence is the entry level to Amateur Radio in the UK and the course is based upon the concept and ideas, and that you are entirely new to electronics..

Operating Limitations

- Only operate whilst in the United Kingdom
  - The Foundation Licence only gives you the permission to operate whilst in the United Kingdom as it is not recognised outside of the UK, unless with prior agreement.
- You can operate from vessels at sea in UK territorial waters, as well from any type of aircraft.
- You MUST get the permission of the captain or person in charge, check the bandplans and power levels

Licence Conditions

- You cannot transmit from other countries, their territorial waters or their airspace.
- Other administrations do not routinely recognise our Foundation Licence

Regional Secondary Locators

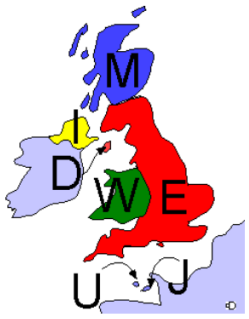
- As of February 2024 these are no longer mandatary for use except for Intermediate licensees.
- You can use them if you want and even add an E to an English call sign if you want.

Licence Level	Format	Example
Foundation	“M3”, “M6”, “M7” + 3 letters	M3XHS, M6HUD, M7KTV
Intermediate	“2” + letters	2E0,2E1,2W0,2W1, 2M0,2M1 etc
Full	Any other callsign starting “M” or “G”	G0,G1,G2.G3,G4,G 5.G6,G7,G8,M0,M1 ,M5 are all full licences

UK call sign format

- The Amateur Licence areas in the United Kingdom is split up into regions :-
  - England, Scotland, Wales, Northern Island, Isle of Man, Jersey, Guernsey
- To indicate a region other than England there are secondary identifiers used with the "England" call sign.
- So your call sign can change depending on where you are.

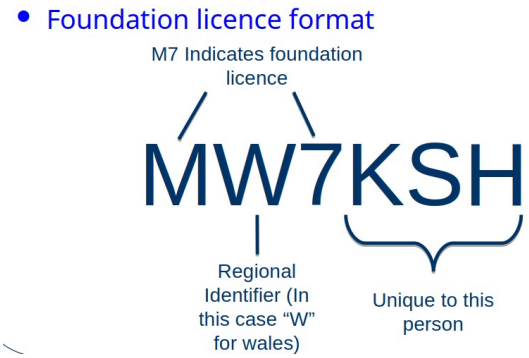
- Secondary identifiers also known as Regional identifiers
- You need to know how Secondary Identifiers, sometimes called REGIONAL IDENTIFIERS are used with the M7 Foundation Licence callsign
- Scotland M, Wales W, Northern Island I, Isle of Man D, Jersey J, Guernsey U.

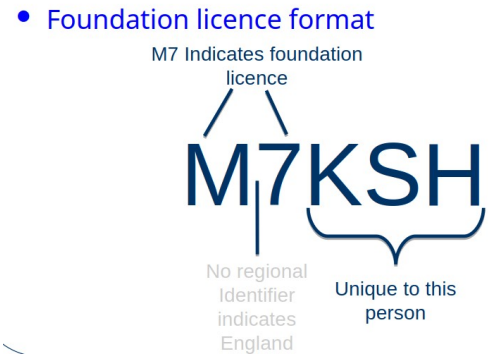


Regional identifiers examples

- An M7+3 letter call (eg M7PKY) signifies a Foundation Licence holder in ENGLAND
- For the other regions the secondary identifier is added immediately after the initial "M" and before the “7" as shown below.

- MM7+3 letter call (e.g. MM7PKY) would indicate the licence holder has his main station address in SCOTLAND
- MW7+3 letter call (e.g. MW7PKY) would indicate the licence holder has his main station address in WALES
- MI7+3 letter call would indicate the licence holder has his main station address in NORTHERN IRELAND
- MD7+3 letter call would indicate the licence holder has his main station address in Isle of Man
- MU7+3 letter call would indicate the licence holder has his main station address in GUERNSEY
- MJ7+3 letter call would indicate the licence holder has his main station address in JERSEY





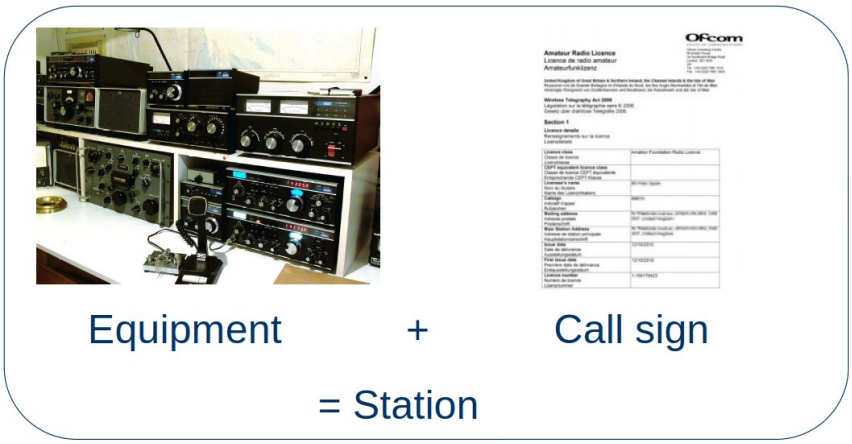
Call Sign Suffixes

- As of February 2024 these are no longer required and if used they can be any anything providing they are not offensive or obscure correct identification.
- i.e. callsign / my back yard

The Four most common Suffixes

Suffix	Meaning	Example
/M	Mobile: Car, pedestrian, bike Inland Waterway	M7AAA/M
/A	Alternative Postal Address i.e. friends house, hotel, holiday flat	M7AAA/A
/P	Temporary: in a field or some where with no post code	M7AAA/P
/MM	Maritime Mobile (at sea in a vessel)	M7AAA/MM

What is an Amateur Radio station?



Who can operate your station?

- Your station is all the equipment when being used with YOUR call-sign. Without your call-sign it is not a station but just equipment.
- **Only Licensed amateurs may operate your station.**
- Holders of a UK amateur radio licence who visit you can use your station (with your callsign) **but must work under your supervision, and are subject to your Licence conditions.**
- If they use YOUR equipment and THEIR call-sign (/A), it becomes THEIR station and subject to their license conditions. (And they can supervise you!)
- In certain circumstances Official ‘User services’ (Police, Ambulance etc) may also use your station.
- In certain circumstances, i.e. an disaster or emergency, Official ‘User services’ (Police, Ambulance, Fire etc) may also use your station. (Category 1)
- Category 2 responders include British Red Cross,St Johns Ambulance, St Andrew’s Ambulance Association, Royal Voluntary Service, Salvation Army and any Government Department.

Supervision

- As of February 2024 all radio amateurs can let members of the public operate their station provided they are supervised at all times and adhere to YOUR licencing conditions.
- You must ensure the member of the public is aware of your licencing terms and conditions while operating
- You remain within your licencing conditions

When you must transmit your callsign

- Your license says….
  - You must transmit your callsign
  - During initial calls ("CQ" calls)
  - When you change frequency
  - At the start of a conversation and **as frequently as practicable during a transmission.**
  - When you change mode. – e.g. from Voice to Morse.
  - Change of “supervisor”
- The licensee shall ensure that:
  - The callsign is given in voice or other format consistent with the mode of operation.
    - i.e. Morse Code, Data, Voice.

Locations

- MAIN STATION ADDRESS
  - When you connect up a transceiver, antenna and power supply, it is called setting up a station.
  - This is normally your home address.
  - The Main Station Address is the address printed on your licence document.

Who may you talk to on the radio?

- You may ONLY talk with other Licensed amateurs or their stations.
- Any one who does not have an amateur radio licence and gains access to the amateur bands are considered as pirates. What can't I do?
- Should you come across one, don't be the policeman of the bands - just ignore and stop the conversation.

What can you talk about?

- The items that you talk about can be any item of mutual interest. You will often hear stations telling each other about their equipment especially their rigs and antennas.
- Sensitive topics such as politics and religion should be avoided.
- It is wise not to tell a person where you live or your age.
- Should you be called by a station in response to your CQ call and that other station fails to give a call sign when asked, then break off the contact and assume that they were unlicensed (a pirate).

What can't I do?

- Secret codes are not allowed
  - You are not permitted to make up a "secret" code" that only you and other friend know about.
- There are "Q" Codes which are in general use by amateurs. These are not considered as secret code but you do not need to know about them for the Foundation Licence Exam.
- You may NOT broadcast!
  - Broadcasting is sending a message to many recipients at the same time none of which you don't expect a reply from. It's a one way process.
- In amateur radio, the only time you can talk into the microphone and not necessarily get a reply is to make a CQ call.
- You may not just pick up the microphone and tell anyone or everyone it is your birthday or whatever it is you want to say.
- You may NOT transmit music or broadcast material.
  - If you are operating using a microphone then the only thing that should be heard at the receiving station is your voice.
  - Make sure that all sources of broadcast material and music are off or very quiet before making voice transmissions.

Ofcom

- Ofcom are the UK regulator that govern the use of Radio, amongst other things.
- Issue amateur radio licences.
- Have enforcement powers for those that break the rules.
- **Give IMMEDIATE NOTICE OF MOVING**
    - You must give immediate notice to Ofcom either in writing or by means of Ofcom's on-line licensing system of any change to the your name, Main Station Address (or mailing address) from that recorded in your Licence. Otherwise the authorities do not know where to send information etc.
- **Ofcom has the right to inspect**
- Ofcom has the right to call at your house to check your station and license document at any reasonable time.
- If Ofcom believe that you are breaking your license conditions they may inspect your station and license at ANY time without warning.
- **Ofcom have the right to restrict operation**
    - If Ofcom believe that you are causing interference or otherwise in breach of your license terms your station could be closed down or you could have your operation of the station restricted.
    - This means that you might be stopped from transmitting temporarily
        - or be able to transmit only at certain times
        - or with reduced power
        - or only on certain bands.

Licence Revalidation

- Your license is valid for life, however you must log in to the Ofcom website and revalidate your license at least once every 5 years.
- Revalidation confirms that you are still living at the same address and that you do not wish your licence to be retired.
- Failure to do this can result in your licence being REVOKED and you will have to pay a fee to get it back.
- Reactivating revoked call signs is entirely at the discretion of Ofcom.
- Once your license is revoked you may no longer transmit.

Reference Data

- You should have downloaded the four page reference data and become familiar with this document.
- You can take this document into the exam, or will be given an new one at the time of your exam.
- Page 2 there is a large table of your frequency allocations as well as other operation information.
- This can be downloaded from www.sxham.uk/ex307
- **Things which may catch you out:**
    - Check the frequency, i.e. 430-432MHz power level limit in ERP
    - 431-432Mhz cannot be used with in 100km of London's Charing Cross
    - Frequencies above 2400MHz are low power
    - 135.7 – 137.8kHz are low power and with ERP restrictions

EMC Rules

- Your licence requires that your equipment must not expose the public to EMF (Electromagnetic Fields) over agreed limits.
- EIRP = Radiated Power Relative to a Theoretical Antenna
- This applies to a transmitted power over **10 watts EIRP which is calculated to 6.1 Watts ERP.**
- "The Public" includes neighbours, visitors, family members, and people in the field.
- Amateurs are required to complete an assessment and keep records to show Ofcom should the request them.
- If the assessment potential shows risks, appropriate steps must be taken to keep within the limits
- It no action is required, the reason must be stated. Power level etc.
- An EMF Calculator has been created by the RSGB and can be downloaded from their website.
