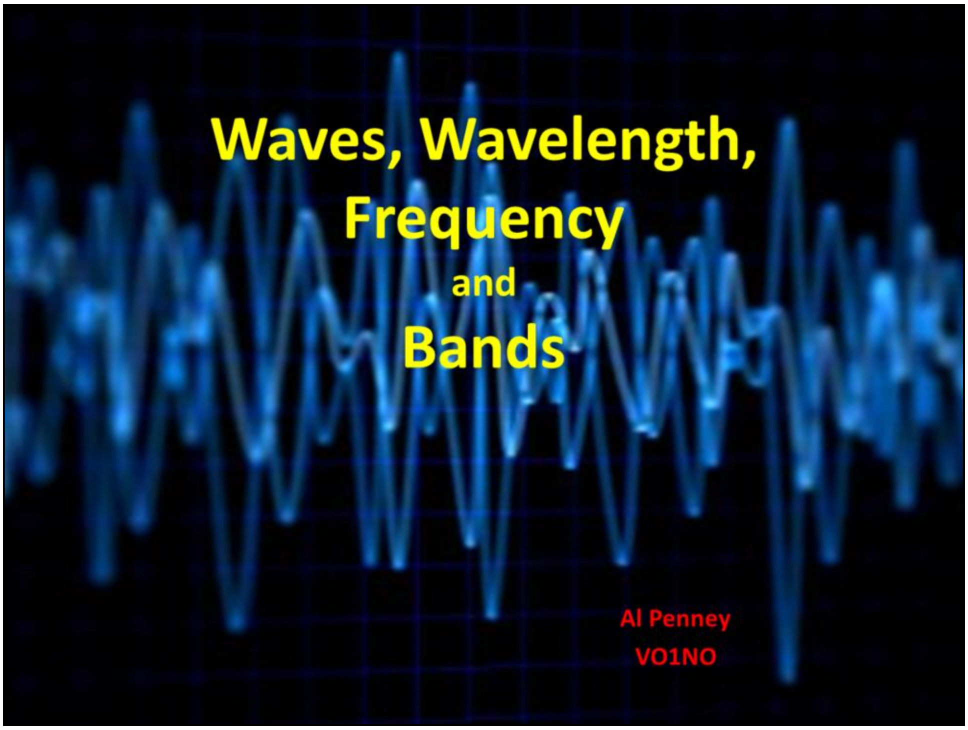
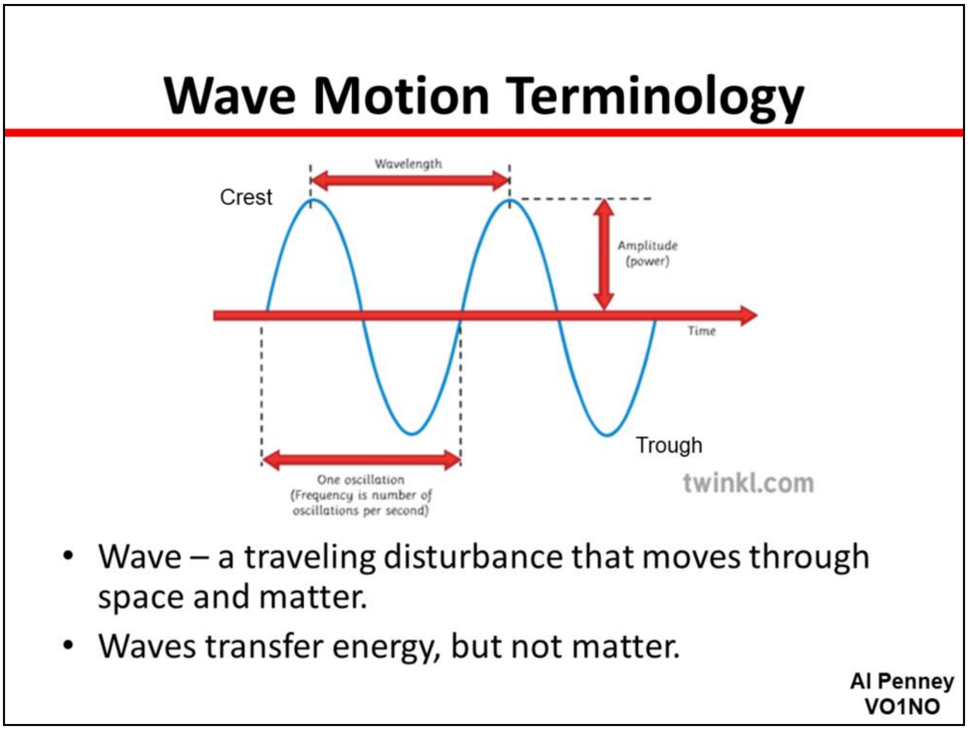

Waves, Wavelength,
Frequency
and
Bands
Al Penney
VO1NO

Objective

On completion, you should be able to:

- Define Frequency, Wavelength, Band;
- Perform simple calculations involving frequency and wavelength; and
- Be familiar with the bands that make up the Electromagnetic Spectrum.

Al Penney
VO1NO



Wave - A wave is a traveling disturbance that moves through space and matter. Waves transfer energy from one place to another, but not matter.

Amplitude - The measure of the displacement of the wave from its rest position. The higher the amplitude of a wave, the higher its energy.

Crest - The crest is the highest point of a wave. The opposite of the crest is the trough.

Frequency - The frequency of a wave is the number of times per second that a wave cycles. The frequency is the inverse of the period.

Wavelength - The wavelength of a wave is the distance between two corresponding points on back-to-back cycles of a wave. For example, between two crests of a wave.

Trough - The trough is the lowest part of the wave. The opposite of the trough is the crest.

Frequency

- Defined as the number of **identical** parts of a wave that pass a given point in a fixed period of time.
- For Electromagnetic (EM) waves, we use the second as the period of time.

Al Penney
VO1NO

Wave frequency is the number of waves that pass a fixed point in a given amount of time. The SI unit for wave frequency is the **hertz (Hz**), where 1 **hertz** equals 1 wave passing a fixed point in 1 second.

Frequency

- Unit of measurement is the **Hertz**.
- Abbreviation is Hz.
- One Hertz = **1 cycle per second**.

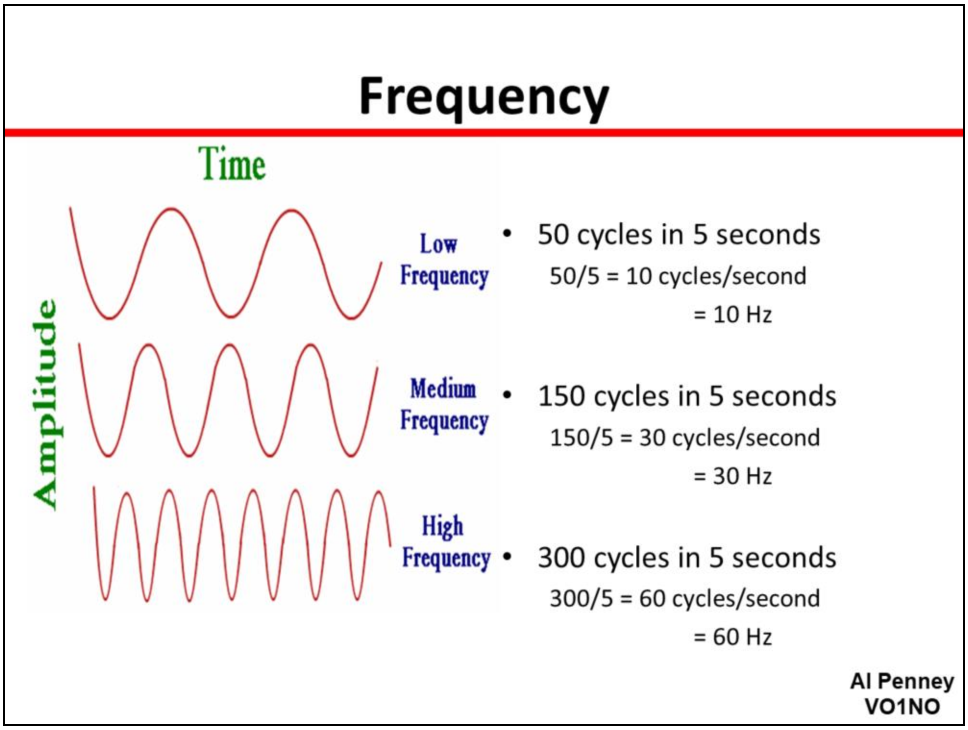
- Example: 500 waves pass a point in 2 seconds. What is the frequency?
  - 500 cycles/2 seconds = 250 Hz

Al Penney
VO1NO

FREQUENCY

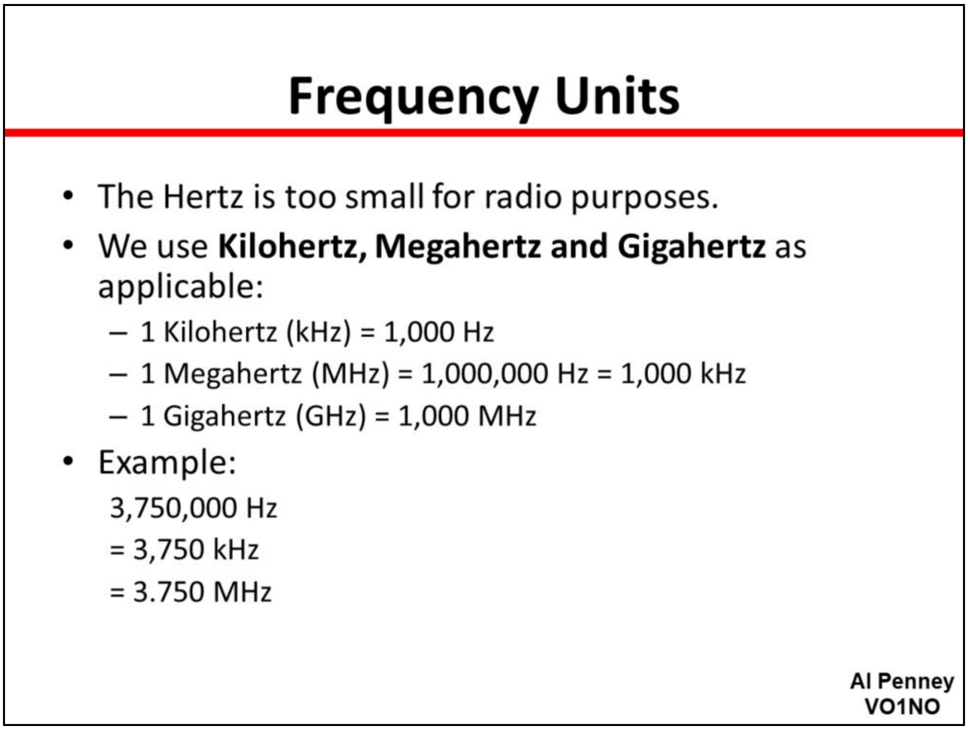
The number of crests that pass a given point within one second is described as the frequency of the wave. One wave—or cycle—per second is called a Hertz (Hz), after Heinrich Hertz who established the existence of radio waves. A wave with two cycles that pass a point in one second has a frequency of 2 Hz.

Heinrich Rudolf Hertz (22 February 1857 – 1 January 1894) was a German physicist who first conclusively proved the existence of the electromagnetic waves predicted by James Clerk Maxwell's equations of electromagnetism. The unit of frequency, cycle per second, was named the "hertz" in his honor



FREQUENCY

The number of crests that pass a given point within one second is described as the frequency of the wave. One wave—or cycle—per second is called a Hertz (Hz), after Heinrich Hertz who established the existence of radio waves. A wave with two cycles that pass a point in one second has a frequency of 2 Hz.



The **hertz** (symbol: **Hz**) is the derived unit of frequency in the International System of Units (SI) and is defined as one cycle per second. It is named after Heinrich Rudolf Hertz, the first person to provide conclusive proof of the existence of electromagnetic waves. Hertz are commonly expressed in multiples: kilohertz (10^3 Hz, kHz), megahertz (10^6 Hz, MHz), gigahertz (10^9 Hz, GHz).

The kilohertz is a relatively small unit of frequency; more common units are the MHz, equal to 1,000,000 Hz or 1,000 kHz, and the GHz, equal to 1,000,000,000 Hz or 1,000,000 kHz.

Frequency Conversions

- To change Kilohertz (kHz) to Megahertz (MHz), **divide by 1000**:

  3755 kHz = 3755/1000 MHz = 3.755 MHz

- To change Megahertz (MHz) to Kilohertz (kHz), **multiply by 1000**:

  14.295 MHz = 14.295 x 1000 kHz = 14,295 kHz

Al Penney
VO1NO

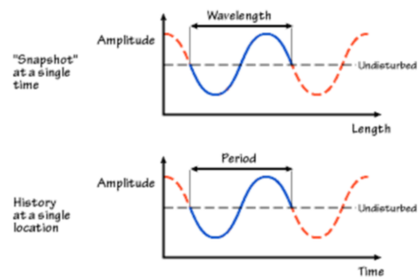
Period

- The period of a wave is the time it takes to complete one full cycle.
- It is measured in seconds.
- Abbreviated T
- T = 1/f
- Example: f = 100 Hz

  T = 1/f

  T = 1/100 Hz

  T = 0.01 seconds



Al Penney
VO1NO

The **period** is the duration of time of one cycle in a repeating event, so the **period** is the reciprocal of the **frequency**.

Wavelength

- The **distance** a wave travels during one cycle is the **Wavelength**.
- For radio waves, the **meter** is the most common unit of length.
- For microwave frequencies, the centimeter is sometimes used.
- The symbol for wavelength is the **Greek letter lambda λ**.

Al Penney
VO1NO

In physics, the **wavelength** is the **spatial period** of a periodic wave—the distance over which the wave's shape repeats. It is the distance between consecutive corresponding points of the same phase on the wave, such as two adjacent crests, troughs, or zero crossings, and is a characteristic of both traveling waves and standing waves, as well as other spatial wave patterns.

Visible light:

Violet: 0.4 - 0.446 µm

Blue: 0.446 - 0.500 µm

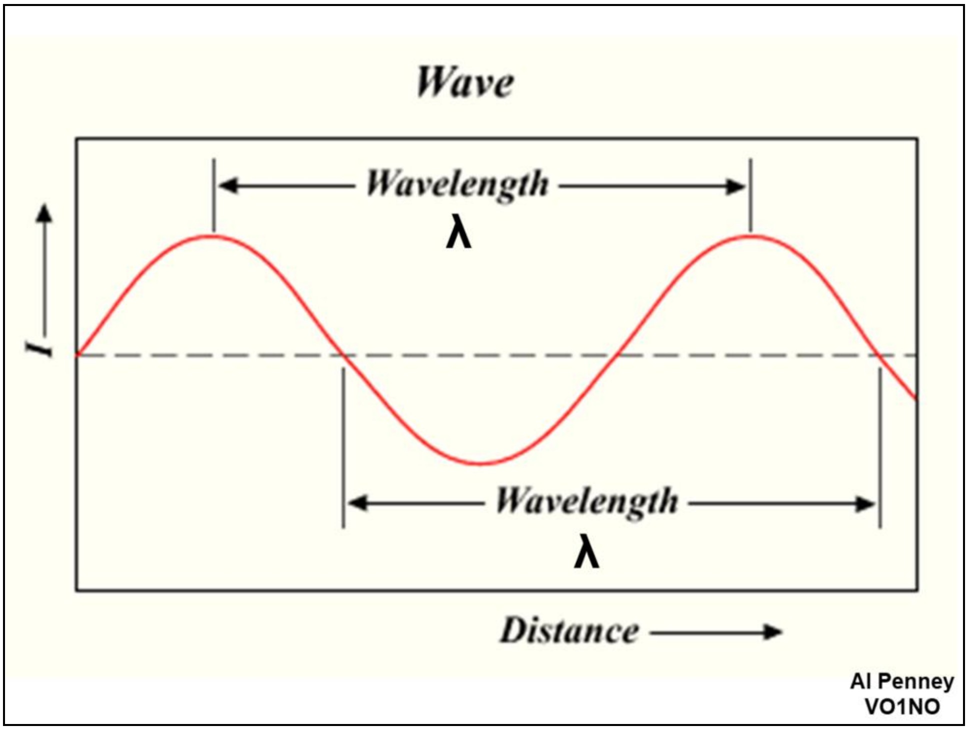
Green: 0.500 - 0.578 µm

Yellow: 0.578 - 0.592 µm

Orange: 0.592 - 0.620 µm

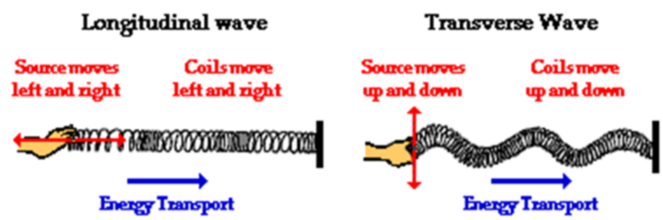
Red: 0.620 - 0.7 µm

The nearest smaller common SI unit is the nanometre, equivalent to one one-thousandth of a micrometre, or one billionth of a metre (0.000000001 m). The nanometre is often used to express dimensions on an atomic scale: the diameter of a helium atom, for example, is about 0.06 nm, and that of a ribosome is about 20 nm. The nanometre is also commonly used to specify the wavelength of electromagnetic radiation near the visible part of the spectrum: visible light ranges from around 400 to 700 nm.[4] The ångström, which is equal to 0.1 nm, was formerly used for these purposes.


Wave
Wavelength
λ
I
Wavelength
λ
Distance
Al Penney
VO1NO

Waves

- Transverse
  - Vibration is at right angles to direction of propagation, e.g.: guitar string
- Longitudinal
  - Vibration is parallel to direction of propagation, e.g.: sound waves



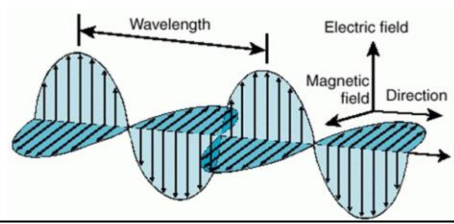
Al Penney
VO1NO

Transverse wave, motion in which all points on a wave oscillate along paths at right angles to the direction of the wave's advance. Surface ripples on water, seismic *S* (secondary) waves, and electromagnetic (*e.g.*, radio and light) waves are examples of transverse waves.

Longitudinal wave, wave consisting of a periodic disturbance or vibration that takes place in the same direction as the advance of the wave. A coiled spring that is compressed at one end and then released experiences a wave of compression that travels its length, followed by a stretching; a point on any coil of the spring will move with the wave and return along the same path, passing through the neutral position and then reversing its motion again. Sound moving through air also compresses and rarefies the gas in the direction of travel of the sound wave as they vibrate back and forth.

Electromagnetic (EM) Waves

- Transverse waves
- Consist of Electric and Magnetic components:
  - In phase with each other; and
  - At right angles to each other.
- Orientation of Electric field determines Polarization.

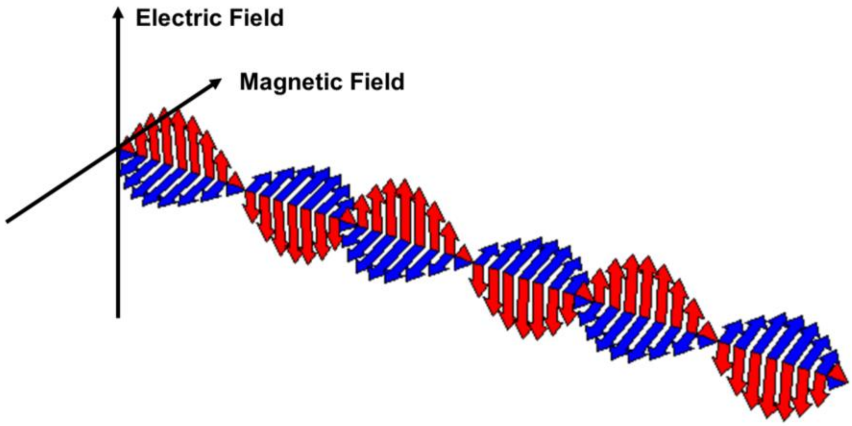


Al Penney
VO1NO

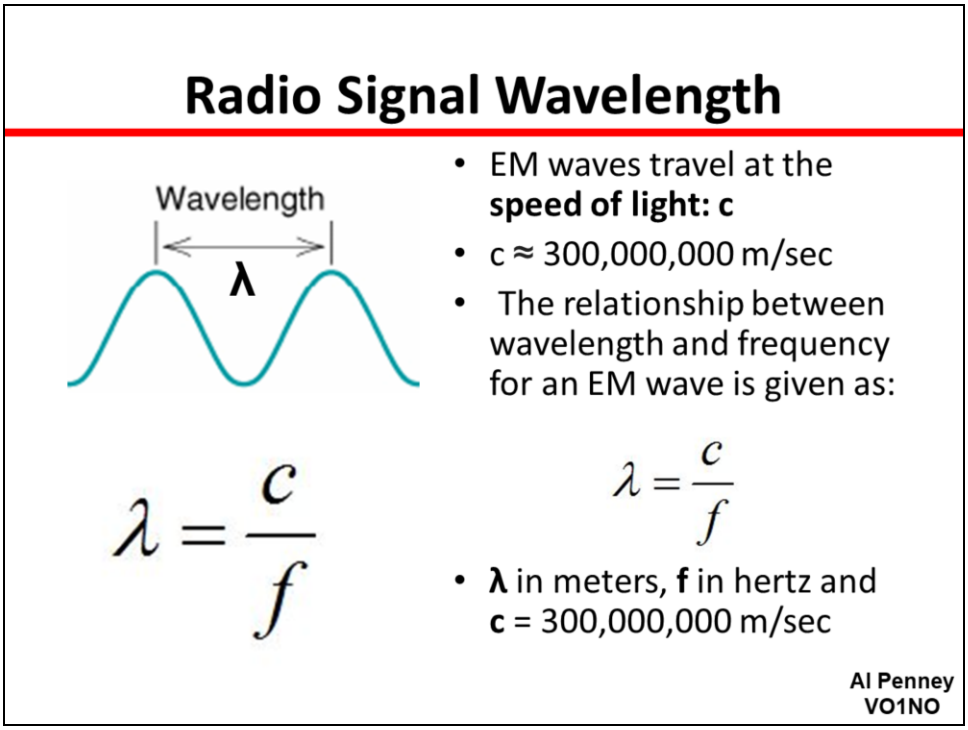
Electromagnetic (EM) radiation is a form of energy that is all around us and takes many forms, such as radio waves, microwaves, X-rays and gamma rays. Sunlight is also a form of EM energy, but visible light is only a small portion of the EM spectrum, which contains a broad range of electromagnetic wavelengths.

EM radiation is created when an atomic particle, such as an electron, is accelerated by an electric field, causing it to move. The movement produces oscillating electric and magnetic fields, which travel at right angles to each other in a bundle of light energy called a photon. Photons travel in harmonic waves at the fastest speed possible in the universe: 186,282 miles per second (299,792,458 meters per second) in a vacuum, also known as the speed of light. The waves have certain characteristics, given as frequency, wavelength or energy.

Electromagnetic Waves



Al Penney
VO1NO



Note that this is in free space, not a conductor (such as an antenna or transmission line).

Precise speed in a vacuum is 299,792,458 meters per second, but we can round it off to 300,000,000 meters per second.

Frequency Equations

- Because the Hertz is too small a unit to use for most practical radio work, we can use the following equations:

  $\lambda = 300 / f$ and

  $f = 300 / \lambda$

  where **λ is in meters**, and **f in Megahertz**

Al Penney
VO1NO

Calculating Wavelength

- What is the wavelength of an EM wave with a frequency of 7,200 kHz?

Al Penney
VO1NO

Calculating Wavelength

- What is the wavelength of an EM wave with a frequency of 7,200 kHz?

  Convert 7,200 kHz to MHz

Al Penney
VO1NO

Calculating Wavelength

- What is the wavelength of an EM wave with a frequency of 7,200 kHz?

  Convert 7,200 kHz to MHz

  7,200/1000 = 7.2 MHz

  $\lambda =$

Al Penney
VO1NO

Calculating Wavelength

- What is the wavelength of an EM wave with a frequency of 7,200 kHz?

  Convert 7,200 kHz to MHz

  7,200/1000 = 7.2 MHz

  $\lambda = 300 / f$

  $=$

Al Penney
VO1NO

Calculating Wavelength

- What is the wavelength of an EM wave with a frequency of 7,200 kHz?

  Convert 7,200 kHz to MHz

  7,200/1000 = 7.2 MHz

  $\lambda = 300 / f$

  $= 300/7.2$

  $= 41.66$ meters

Al Penney
VO1NO

Calculating Frequency

- What is the frequency of an EM wave with a wavelength of 5.9 meters?

  f =

Al Penney
VO1NO

Calculating Frequency

- What is the frequency of an EM wave with a wavelength of 5.9 meters?

  $f = 300 / \lambda$

  $=$

Al Penney
VO1NO

Calculating Frequency

- What is the frequency of an EM wave with a wavelength of 5.9 meters?

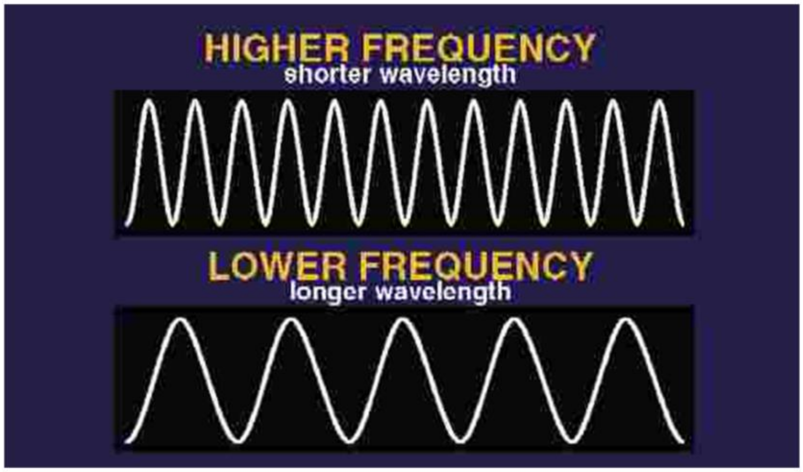
  f = 300 / λ

  = 300 / 5.9 meters

  = 50.847 MHz

Al Penney
VO1NO

Wavelength versus Frequency



Al Penney
VO1NO

Harmonics

- Integer multiples of a given frequency.
- Example:

  3.550 MHz is the **Fundamental** frequency.

  Two x 3.550 MHz = 7.100 MHz (**2^{nd} Harmonic**)

  Three x 3.550 MHz = 10.650 MHz (**3^{rd} Harmonic**)

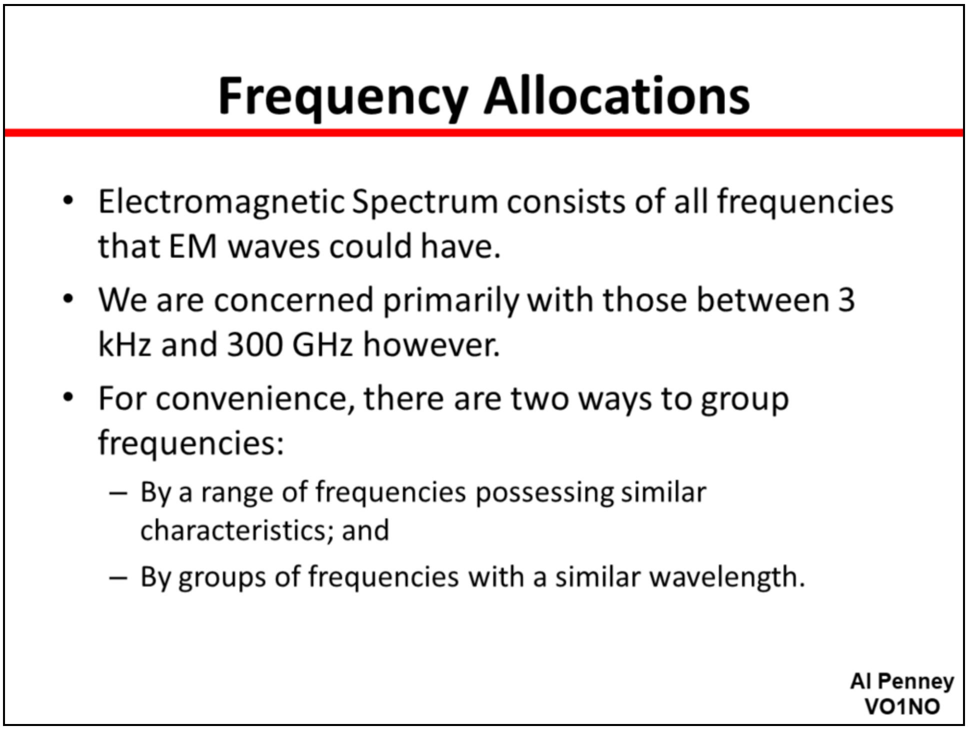
  Four x 3.550 MHz = 14.200 MHz (**4^{th} Harmonic**)

- Note: The slang term for a Ham's children is harmonics!

Al Penney
VO1NO

A **harmonic** is just any integer multiple of a single frequency — this single frequency is usually referred to as the **fundamental frequency** or sometimes the **first harmonic.** So your fundamental frequency (f_0) harmonics would be:

- *1^{st} harmonic = $1 \times f_0$ = fundamental frequency*
- *2^{nd} harmonic = $2 \times f_0$*
- *n^{th} harmonic = $n \times f_0$*



The **electromagnetic spectrum** is the range of frequencies (the spectrum) of electromagnetic radiation and their respective wavelengths and photon energies.

The electromagnetic spectrum covers electromagnetic waves with frequencies ranging from below one hertz to above 10^{25} hertz, corresponding to wavelengths from thousands of kilometers down to a fraction of the size of an atomic nucleus. This frequency range is divided into separate bands, and the electromagnetic waves within each frequency band are called by different names; beginning at the low frequency (long wavelength) end of the spectrum these are: radio waves, microwaves, infrared, visible light, ultraviolet, X-rays, and gamma rays at the high-frequency (short wavelength) end. The electromagnetic waves in each of these bands have different characteristics, such as how they are produced, how they interact with matter, and their practical applications. The limit for long wavelengths is the size of the universe itself, while it is thought that the short wavelength limit is in the vicinity of the Planck length. Gamma rays, X-rays, and high ultraviolet are classified as *ionizing radiation* as their photons have enough energy to ionize atoms, causing chemical reactions.

The **radio spectrum** is the part of the electromagnetic spectrum with frequencies from 30 Hz to 300 GHz. Electromagnetic waves in this frequency range, called radio waves, are widely used in modern technology, particularly in telecommunication. To prevent interference between different users, the generation and transmission of radio waves is strictly regulated by national laws, coordinated by an international body, the International Telecommunication Union (ITU).

Radio Frequency Spectrum: Ranges

Designation	Abbreviation	Frequencies	Wavelengths
Very Low Frequency	VLF	3 kHz - 30 kHz	100 km - 10 km
Low Frequency	LF	30 kHz - 300 kHz	10 km - 1 km
Medium Frequency	MF	300 kHz - 3 MHz	1 km - 100 m
High Frequency	HF	3 MHz - 30 MHz	100 m - 10 m
Very High Frequency	VHF	30 MHz - 300 MHz	10 m - 1 m
Ultra High Frequency	UHF	300 MHz - 3 GHz	1 m - 100 mm
Super High Frequency	SHF	3 GHz - 30 GHz	100 mm - 10 mm
Extremely High Frequency	EHF	30 GHz - 300 GHz	10 mm - 1 mm

www.rfpage.com Al Penney VO1NO

Extremely low frequency (**ELF**) is the ITU designation for electromagnetic radiation (radio waves) with frequencies from 3 to 30 Hz, and corresponding wavelengths of 100,000 to 10,000 kilometers, respectively. In atmospheric science, an alternative definition is usually given, from 3 Hz to 3 kHz. In the related magnetosphere science, the lower frequency electromagnetic oscillations (pulsations occurring below ~3 Hz) are considered to lie in the ULF range, which is thus also defined differently from the ITU radio bands.

ELF radio waves are generated by lightning and natural disturbances in Earth's magnetic field, so they are a subject of research by atmospheric scientists. Because of the difficulty of building antennas that can radiate such long waves, ELF frequencies have been used in only a very few man-made communication systems. ELF waves can penetrate seawater, which makes them useful in communication with submarines

Since ELF radio waves can penetrate seawater deeply, to the operating depths of submarines, a few nations have built naval ELF transmitters to communicate with their submarines while submerged. China has recently constructed the world's largest ELF facility roughly the size of New York City in order to communicate with its submarine forces without requiring them to surface.[26] The United States Navy in 1982 built the first ELF submarine communications facility, two coupled ELF transmitters at Clam Lake, Wisconsin and Republic, Michigan. They were shut down in 2004. The Russian Navy operates an ELF transmitter called ZEVS (Zeus) at Murmansk on the Kola Peninsula. The Indian Navy has an ELF communication facility at the INS Kattabomman naval base to communicate with its Arihant class and Akula class submarines

Super low frequency (**SLF**) is the ITU designation for electromagnetic waves (radio waves) in the frequency range between 30 hertz and 300 hertz. They have corresponding wavelengths of 10,000 to 1,000 kilometers. This frequency range includes the frequencies of AC power grids (50 hertz and 60 hertz). Another conflicting designation which includes this frequency range is Extremely Low Frequency (ELF), which in some contexts refers to all frequencies up to 300 hertz.

Because of the extreme difficulty of building transmitters that can generate such long waves, frequencies in this range have been used in very few artificial communication systems. However, SLF waves can penetrate seawater to a depth of hundreds of meters. Therefore, in recent decades the U.S., Russian and Indian military have built huge radio transmitters using SLF frequencies to communicate with their submarines.

Ultra low frequency (**ULF**) is the ITU designation for the frequency range of electromagnetic waves between 300 hertz and 3 kilohertz, corresponding to wavelengths between 1000 to 100 km. Some monitoring stations have reported that earthquakes are sometimes preceded by a spike in ULF activity.

Very low frequency or **VLF** is the ITU designation for radio frequencies (RF) in the range of 3–30 kHz, corresponding to wavelengths from 100 to 10 km, respectively. The band is also known as the **myriameter band** or **myriameter wave** as the wavelengths range from one to ten myriameters (an obsolete metric unit equal to 10 kilometers). Due to its limited bandwidth, audio (voice) transmission is highly impractical in this band, and therefore only low data rate coded signals are used. The VLF band is used for a few radio navigation services, government time radio stations (broadcasting time signals to set radio clocks) and for secure military communication. Since VLF waves can penetrate at least 40 meters (120 ft) into saltwater, they are used for military communication with submarines.

OMEGA was the first global-range radio navigation system, operated by the United States in cooperation with six partner nations. It was a hyperbolic navigation system, enabling ships and aircraft to determine their position by receiving very low frequency (VLF) radio signals in the range 10 to 14 kHz, transmitted by a global network of eight fixed terrestrial radio beacons, using a navigation receiver unit. It became operational around 1971 and was shut down in 1997 in favour of the Global Positioning System.

Low frequency (**LF**) is the ITU designation for radio frequencies (RF) in the range of 30–300 kHz. Since its wavelengths range from 10–1 km, respectively, it is also known as the **kilometre band** or **kilometre wave**.

LF radio waves exhibit low signal attenuation, making them suitable for long-distance communications. In Europe and areas of Northern Africa and Asia, part of the LF spectrum is used for AM broadcasting as the "longwave" band. In the western hemisphere, its main use is for aircraft beacon, navigation (LORAN), information, and weather systems. A number of time signal broadcasts also use this band.

Amateur Radio 2200M band 135.7 – 137.8 kHz

In Europe, Africa, and large parts of Asia (International Telecommunication Union Region 1), where a range of frequencies between 148.5 and 283.5 kHz is used for AM broadcasting.

Medium frequency (**MF**) is the ITU designation for radio frequencies (RF) in the range of 300 kilohertz (kHz) to 3 megahertz (MHz). Part of this band is the medium wave (MW) AM broadcast band. The MF band is also known as the **hectometer band** as the wavelengths range from ten to one hectometer (1000 to 100 m). Frequencies immediately below MF are denoted low frequency (LF), while the first band of higher frequencies is known as high frequency (HF). MF is mostly used for AM radio broadcasting, navigational radio beacons, maritime ship-to-shore communication, and transoceanic air traffic control.

Amateur Radio 630M band 472 – 479 kHz and 160M 1800 – 2000 kHz

High frequency (**HF**) is the ITU designation for the range of radio frequency electromagnetic waves (radio waves) between 3 and 30 megahertz (MHz). It is also known as the **decameter band** or **decameter**

wave as its wavelengths range from one to ten decameters (ten to one hundred metres). Frequencies immediately below HF are denoted medium frequency (MF), while the next band of higher frequencies is known as the very high frequency (VHF) band. The HF band is a major part of the shortwave band of frequencies, so communication at these frequencies is often called shortwave radio. Because radio waves in this band can be reflected back to Earth by the ionosphere layer in the atmosphere – a method known as "skip" or "skywave" propagation – these frequencies are suitable for long-distance communication across intercontinental distances and for mountainous terrains which prevent line-of-sight communications. The band is used by international shortwave broadcasting stations (2.31–25.82 MHz), aviation communication, government time stations, weather stations, amateur radio and citizens band services, among other uses.

Amateur Radio 80, 60, 40, 30, 20, 17, 15, 12, and 10 meter bands

Very high frequency (**VHF**) is the ITU designation for the range of radio frequency electromagnetic waves (radio waves) from 30 to 300 megahertz (MHz), with corresponding wavelengths of ten meters to one meter. Frequencies immediately below VHF are denoted high frequency (HF), and the next higher frequencies are known as ultra high frequency (UHF).

Common uses for radio waves in the VHF band are digital audio broadcasting (DAB) and FM radio broadcasting, television broadcasting, two-way land mobile radio systems (emergency, business, private use and military), long range data communication up to several tens of kilometers with radio modems, amateur radio, and marine communication. Air traffic control communications and air navigation systems (e.g. VOR & ILS) work at distances of 100 kilometres (62 mi) or more to aircraft at cruising altitude.

In the Americas and many other parts of the world, VHF Band I was used for the transmission of analog television. As part of the worldwide transition to digital terrestrial television most countries require broadcasters to air television in the VHF range using digital rather than analog format.

Amateur Radio 6, 2 and 1.25M bands (222 MHz band)

Ultra high frequency (**UHF**) is the ITU designation for radio frequencies in the range between 300 megahertz (MHz) and 3 gigahertz (GHz), also known as the **decimetre band** as the wavelengths range from one meter to one tenth of a meter (one decimeter). Radio waves with frequencies above the UHF band fall into the super-high frequency (SHF) or microwave frequency range. Lower frequency signals fall into the VHF (very high frequency) or lower bands. UHF radio waves propagate mainly by line of sight; they are blocked by hills and large buildings although the transmission through building walls is strong enough for indoor reception. They are used for television broadcasting, cell phones, satellite communication including GPS, personal radio services including Wi-Fi and Bluetooth, walkie-talkies, cordless phones, and numerous other applications.

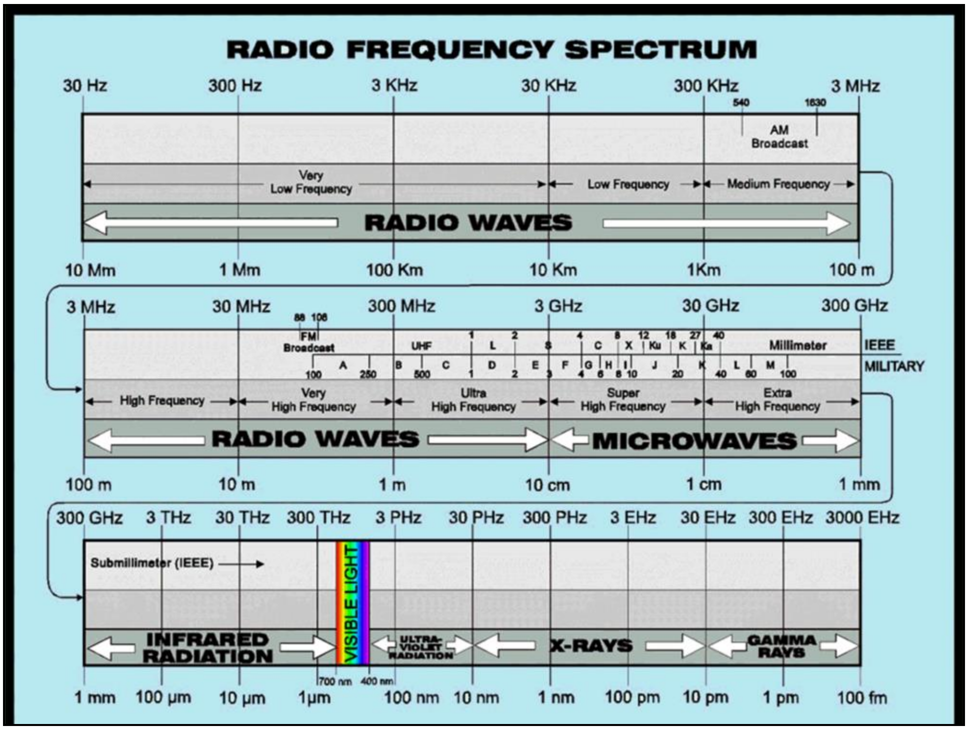
Consumer ovens work around a nominal 2.45 gigahertz (GHz)—a wavelength of 12.2 centimetres (4.80 in) in the 2.4 GHz to 2.5 GHz ISM band—while large industrial/commercial ovens often use 915 megahertz (MHz)—32.8 centimetres (12.9 in

Amateur radio 70 cm, 902MHz, 1296MHz and 2.4 GHz bands

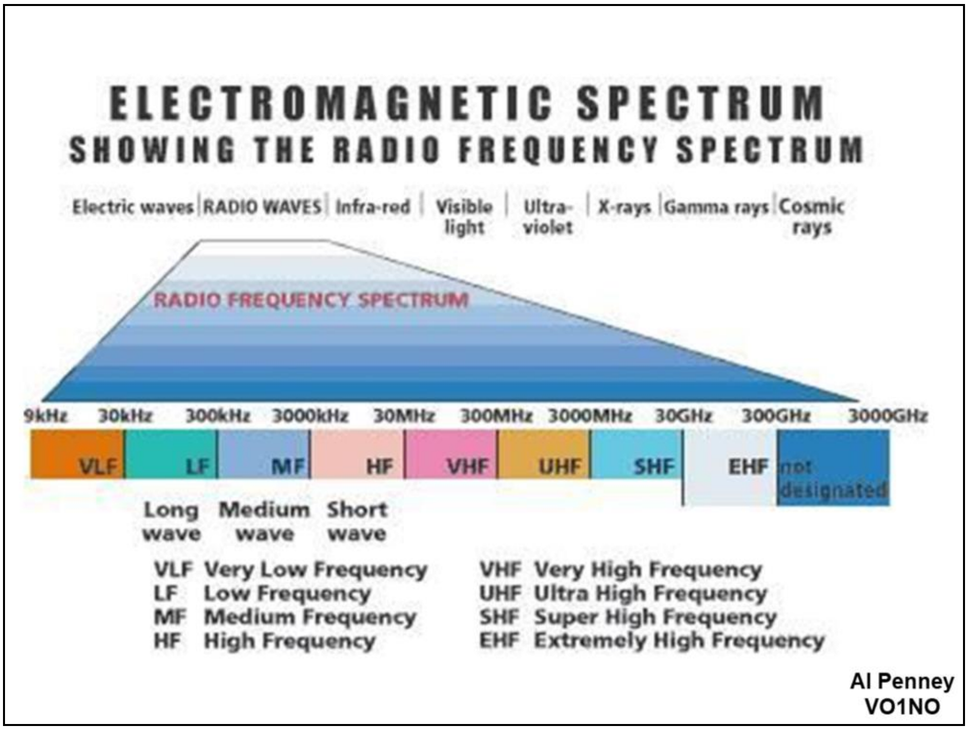
Super high frequency (**SHF**) is the ITU designation for radio frequencies (RF) in the range between 3 and 30 gigahertz (GHz). This band of frequencies is also known as the **centimetre band** or **centimetre wave** as the wavelengths range from one to ten centimetres. These frequencies fall within the microwave band, so radio waves with these frequencies are called microwaves. The small wavelength of microwaves allows them to be directed in narrow beams by aperture antennas such as parabolic dishes and horn antennas, so they are used for point-to-point communication and data links and for radar. This frequency range is used for most radar transmitters, wireless LANs, satellite communication, microwave radio relay links, and numerous short range terrestrial data links. They are also used for heating in industrial microwave heating, medical diathermy, microwave hyperthermy to treat cancer, and to cook food in microwave ovens.

Extremely high frequency (**EHF**) is the International Telecommunication Union (ITU) designation for the band of radio frequencies in the electromagnetic spectrum from 30 to 300 gigahertz (GHz). It lies between the super high frequency band, and the far infrared band, the lower part of which is the terahertz band. Radio waves in this band have wavelengths from ten to one millimetre, so it is also called the **millimetre band** and radiation in this band is called **millimetre waves**, sometimes abbreviated **MMW** or mmW or mmWave. Millimetre-length electromagnetic waves were first investigated by Bengali Indian physicist Jagadish Chandra Bose during 1894–1896, when he reached up to 60 GHz in his experiments.

Compared to lower bands, radio waves in this band have high atmospheric attenuation: they are absorbed by the gases in the atmosphere. Therefore, they have a short range and can only be used for terrestrial communication over about a kilometer. Absorption increases with frequency until at the top end of the band the waves are attenuated to zero within a few meters. Absorption by humidity in the atmosphere is significant except in desert environments, and attenuation by rain (rain fade) is a serious problem even over short distances. However the short propagation range allows smaller frequency reuse distances than lower frequencies. The short wavelength allows modest size antennas to have a small beam width, further increasing frequency reuse potential. Millimeter waves are used for military fire-control radar, airport security scanners, short range wireless networks, weapon system LRAD, and scientific research.



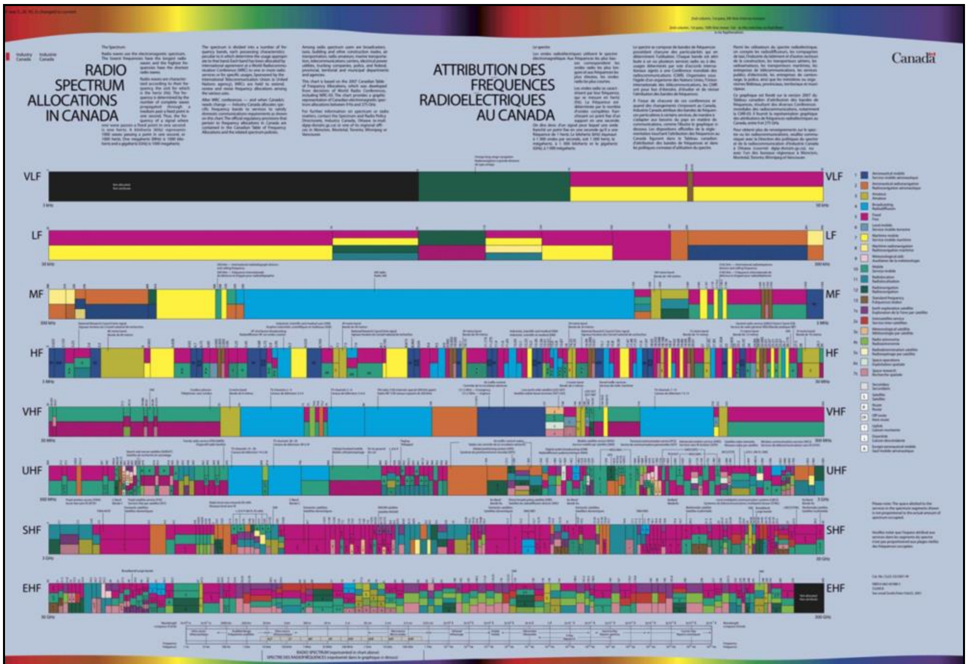
RADIO FREQUENCY SPECTRUM
30 Hz
300 Hz
3 KHz
30 KHz
300 KHz
3 MHz
540
1630
AM Broadcast
Very Low Frequency
Low Frequency
Medium Frequency
RADIO WAVES
10 Mm
1 Mm
100 Km
10 Km
1Km
100 m
3 MHz
30 MHz
300 MHz
3 GHz
30 GHz
300 GHz
88 108
FM Broadcast
UHF
Millimeter
IEEE
MILITARY
High Frequency
Very High Frequency
Ultra High Frequency
Super High Frequency
Extra High Frequency
RADIO WAVES
MICROWAVES
100 m
10 m
1 m
10 cm
1 cm
1 mm
300 GHz
3 THz
30 THz
300 THz
3 PHz
30 PHz
300 PHz
3 EHz
30 EHz
300 EHz
3000 EHz
Submillimeter (IEEE)
VISIBLE LIGHT
INFRARED RADIATION
ULTRA-VIOLET RADIATION
X-RAYS
GAMMA RAYS
700 nm
400 nm
1 mm
100 µm
10 µm
1µm
100 nm
10 nm
1 nm
100 pm
10 pm
1 pm
100 fm



Radio waves are a type of electromagnetic radiation with wavelengths in the electromagnetic spectrum longer than infrared light. Radio waves have frequencies as high as 300 gigahertz (GHz) to as low as 30 hertz (Hz). At 300 GHz, the corresponding wavelength is 1 mm, and at 30 Hz is 10,000 km. Like all other electromagnetic waves, radio waves travel at the speed of light in vacuum. They are generated by electric charges undergoing acceleration, such as time varying electric currents. Naturally occurring radio waves are emitted by lightning and astronomical objects.

Radio waves are generated artificially by transmitters and received by radio receivers, using antennas. Radio waves are very widely used in modern technology for fixed and mobile radio communication, broadcasting, radar and radio navigation systems, communications satellites, wireless computer networks and many other applications. Different frequencies of radio waves have different propagation characteristics in the Earth's atmosphere; long waves can diffract around obstacles like mountains and follow the contour of the earth (ground waves), shorter waves can reflect off the ionosphere and return to earth beyond the horizon (skywaves), while much shorter wavelengths bend or diffract very little and travel on a line of sight, so their propagation distances are limited to the visual horizon.

To prevent interference between different users, the artificial generation and use of radio waves is strictly regulated by law, coordinated by an international body called the International Telecommunications Union (ITU), which defines radio waves as "electromagnetic waves of frequencies arbitrarily lower than 3 000 GHz, propagated in space without artificial guide". The radio spectrum is divided into a number of radio bands on the basis of frequency, allocated to different uses.



Al Penney
VO1NO

Bands

- A group of frequencies that lie between two clearly defined limits.
- Identified by a numerical value that is close to the wavelength of one of the frequencies near the center of the group.
- Example: 80 meter band is 3.5 to 4.0 MHz

  f =

Al Penney
VO1NO

Bands

- A group of frequencies that lie between two clearly defined limits.
- Identified by a numerical value that is close to the wavelength of one of the frequencies near the center of the group.
- Example: 80 meter band is 3.5 to 4.0 MHz

  $f = 300 / \lambda =$

Al Penney
VO1NO

Bands

- A group of frequencies that lie between two clearly defined limits.
- Identified by a numerical value that is close to the wavelength of one of the frequencies near the center of the group.
- Example: 80 meter band is 3.5 to 4.0 MHz

  $f = 300 / \lambda = 300/80 =$

Al Penney
VO1NO

Bands

- A group of frequencies that lie between two clearly defined limits.
- Identified by a numerical value that is close to the wavelength of one of the frequencies near the center of the group.
- Example: 80 meter band is 3.5 to 4.0 MHz

  $f = 300 / \lambda = 300/80 = 3.75$ MHz

Al Penney
VO1NO

Canadian Amateur Bands

Item	Column I: Frequency band	Column II: Maximum bandwidth	Column III: Operating provision	Column IV: Operator qualifications
1	135.7-137.8 kHz	100 Hz	5.67A	B and 5, B/H, B and A
2	472-479 kHz	1 kHz	5.80A	B and 5, B/H, B and A
3	1.800-2.000 MHz	6 kHz	-	B and 5, B/H, B and A
4	3.500-4.000 MHz	6 kHz	-	B and 5, B/H, B and A
5	5.332 MHz	2.8 kHz	C21	B and 5, B/H, B and A
6	5.348 MHz	2.8 kHz	C21	B and 5, B/H, B and A
7	5.3515-5.3665 MHz	2.8 kHz	C21	B and 5, B/H, B and A
8	5.373 MHz	2.8 kHz	C21	B and 5, B/H, B and A
9	5.405 MHz	2.8 kHz	C21	B and 5, B/H, B and A
10	7.000-7.300 MHz	6 kHz	5.142	B and 5, B/H, B and A
11	10.100-10.150 MHz	1 kHz	C6	B and 5, B/H, B and A
12	14.000-14.350 MHz	6 kHz	-	B and 5, B/H, B and A
13	18.068-18.168 MHz	6 kHz	-	B and 5, B/H, B and A
14	21.000-21.450 MHz	6 kHz	-	B and 5, B/H, B and A
15	24.890-24.990 MHz	6 kHz	-	B and 5, B/H, B and A
16	28.000-29.700 MHz	20 kHz	-	B and 5, B/H, B and A
17	50.000-54.000 MHz	30 kHz	-	B
18	144.000-148.000 MHz	30 kHz	-	B

From RBR-4. There are more bands above 144-148 MHz.

19	219.000-220.000 MHz	100 kHz	C11	B
20	220.000-222.000 MHz	100 kHz	C11 – Exceptional circumstances only	B
21	222.000-225.000 MHz	100 kHz	-	B
22	430.000-450.000 MHz	12 MHz	*	B
23	902.000-928.000 MHz	12 MHz	*	B
24	1.240-1.300 GHz	Not specified	*	B
25	2.300-2.450 GHz	Not specified	*	B
26	3.300-3.500 GHz	Not specified	*	B
27	5.650-5.925 GHz	Not specified	*	B
28	10.000-10.500 GHz	Not specified	*	B
29	24.000-24.050 GHz	Not specified	-	B
30	24.050-24.250 GHz	Not specified	*	B
31	47.000-47.200 GHz	Not specified	-	B
32	76.000-77.500 GHz	Not specified	*	B
33	77.500-78.000 GHz	Not specified	-	B
34	78.000-81.000 GHz	Not specified	*	B
35	81.000-81.500 GHz	Not specified	5.561A	B
36	122.250-123.000 GHz	Not specified	*	B
37	134.000-136.000 GHz	Not specified	-	B
38	136.000-141.000 GHz	Not specified	*	B
39	241.000-248.000 GHz	Not specified	*	B
40	248.000-250.000 GHz	Not specified	-	B

Band Plans & Frequency Coordination

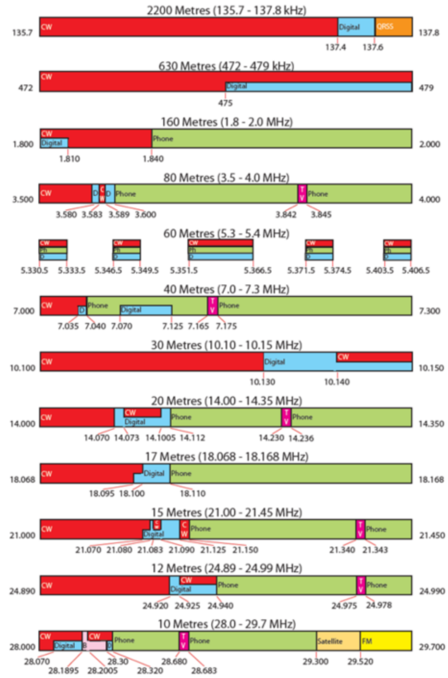
- **Band Plans** are used to coordinate where the various **modes** will be found on the bands.
  - They help prevent mutual interference, especially for modes that cannot detect the presence of other signals, or are incompatible with others.
- **Frequency Coordination** is used on **VHF/UHF** bands to prevent repeaters from interfering with each other.
  - Usually on a provincial or regional basis.

Al Penney
VO1NO

Canadian 0 - 30MHz Band Plan

Effective Date: June 1, 2023

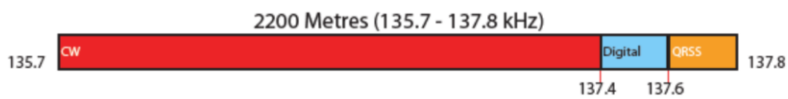
1. Not all permissible modes/activities are represented.
2. LSB is used on 160, 80 and 40m. USB is used on all other bands that permit SSB, including 60m.
3. Consult various online resources for detailed information on what digital modes are used.
4. Maximum bandwidth permitted on 2200m is 100 Hz. Maximum power is 1 Watt EIRP.
5. Canadian Amateurs are allowed a maximum of five watts EIRP on the 630m band, using emissions with a maximum bandwidth of 1 kHz.
6. Canadian Amateurs are allowed a maximum of 100 watts ERP, using emissions with a maximum bandwidth of 2.8 kHz on the 60m band. Refer to the RAC website for full details before operating on the 60m band: https://www.rac.ca/60metres/.



7. Remember not to allow your signal to spill over into adjoining band segments when operating close to the edges. During major weekend contests, activity in certain modes can spill over into other segments. Operators should avoid NCDXF beacons on 14.100, 18.110, 21.150, 24.930 and 28.200 MHz.
8. This graphic is a living document and will be reviewed and updated periodically to reflect changes in the band plans and operating habits.

137 kHz (2200 Meters)

- 135.7 to 137.8 kHz
- Max bandwith 100 Hz
- Max EIRP 1 Watt

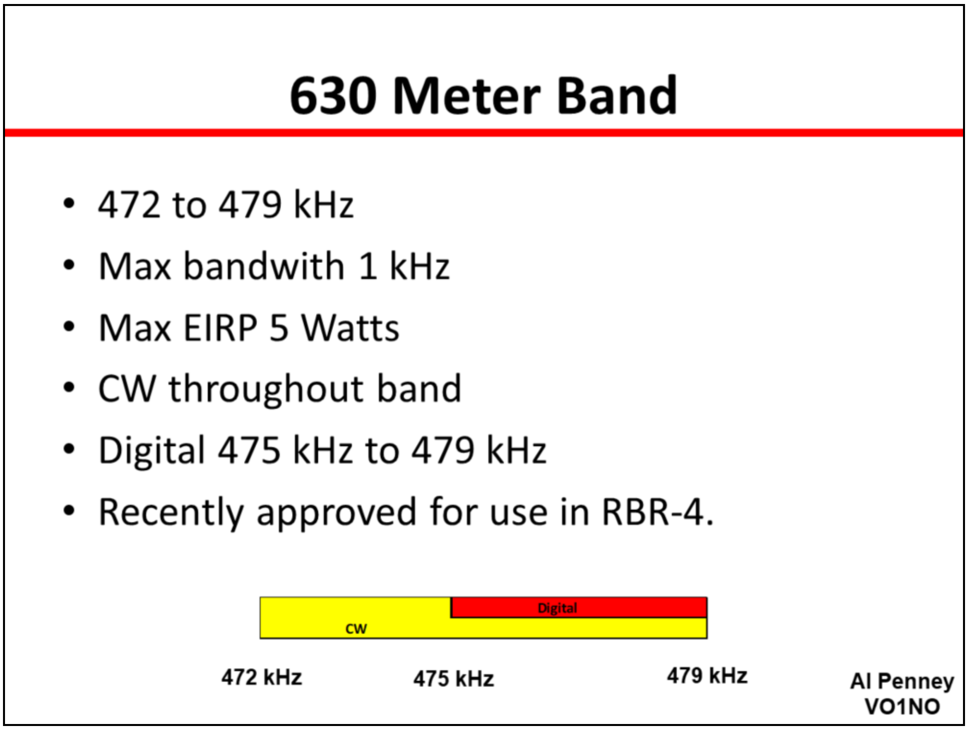


Al Penney
VO1NO

The **2200 meter** or **136 kHz** band is the lowest frequency band in which amateur radio operators are allowed to transmit. It was formally allocated to amateurs at the 2007 World Radiocommunication Conference (WRC-07). The band is available on a secondary basis in all ITU regions with the limitation that amateur stations have maximum radiated power of 1 watt effective isotropic radiated power.

The 2200 meter band is in the low frequency (LF) region, just below the 153–279 kHz longwave broadcasting band.

QRSS is very slow speed CW.



The **630 meter** (or 600 meter) amateur radio band is a frequency band allocated by the International Telecommunication Union (ITU) to amateur radio operators, and it ranges from 472–479 kHz, or equivalently 625.9–635.1 meters wavelength. It was formally allocated to amateurs at the 2012 World Radiocommunication Conference (WRC-12). The band is available on a secondary basis in all ITU regions with the limitation that amateur stations have maximum radiated power of 1 Watt effective isotropic radiated power (EIRP); however, stations more than 800 km from certain countries may be permitted to use 5 Watts EIRP.

The new WRC-12 allocation did not take formal effect until 1 January 2013. However, several countries previously allocated the WRC-12 band to amateurs domestically. Previously, several other countries have authorized temporary allocations or experimental operations on nearby frequencies.

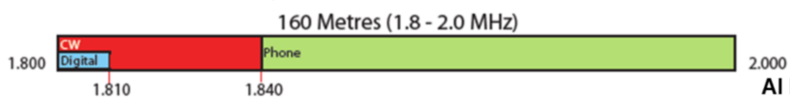
The band is in the Medium Frequency (MF) region, within the 415–526.5 kHz maritime band.

160 Meter Band

- 1800 – 1810 kHz CW and Digital
- 1810 – 1830 kHz CW
- 1830 – 1840 kHz CW (DX Window)
- 1840 – 1850 kHz LSB (DX Window)
- 1850 – 1999 kHz LSB
- 1999 – 2000 kHz Beacons

Notes:

1. During major contests, activity can spill over into other parts of the band.
2. Digital includes all permitted digital modes.
3. JA CW DX Listening Window is 1905 – 1915 kHz.
4. AM and SSTV may also be found 1850 – 1999 kHz.
5. Voice modes should not be used closer than 3 kHz to edge of bottom of segment.
6. Maximum bandwidth permitted is 6 kHz.



NOTE: Maximum Bandwidth is 6 kHz

Al Penney
VO1NO

160 meters refers to the band of radio frequencies between 1,800 and 2,000 kHz, just above the mediumwave broadcast band. For many decades the lowest radio frequency band allocated for use by amateur radio, before the adoption, at the beginning of the 21st century in most countries, of the 630 and 2200 meter bands. Older amateur operators often refer to 160 meters as the **Top Band** It is also sometimes referred to as the "Gentleman's Band" in contrast to the often-freewheeling activity in the 80 and 20 meter bands.

80 Meter Band

- 3500 – 3510 kHz CW (DX Window)
- 3510 – 3580 kHz CW
- 3580 – 3583 kHz Narrow Digital
- 3583 – 3589 kHz CW
- 3589 – 3590 kHz Digital (RTTY DX)
- 3590 – 3600 kHz Digital
- 3600 – 3775 kHz LSB
- 3775 – 3800 kHz LSB (DX Window)
- 3800 – 3842 kHz LSB
- 3842 – 3845 kHz SSTV
- 3845 – 4000 kHz LSB

Al Penney
VO1NO

The **80 meter** or **3.5 MHz** band is a band of radio frequencies allocated for amateur radio use, from 3.5 to 4.0 MHz in IARU Region 2 (consisting mostly of North and South America), and generally 3.5 to 3.8 or 3.9 MHz in Regions 1 and 3 (the rest of the world) respectively. The upper portion of the band, which is usually used for phone (voice), is sometimes referred to as **75 meters**. In Europe, 75m is a shortwave broadcast band, with a number of national radio services operating between 3.9 & 4.0 MHz.

Because of high D layer absorption that persists until sunset, 80 meters is usually only good for local communications during the day, and hardly ever good for communications over intercontinental distances during the day. But it is a popular band for regional communications networks from the late afternoon through the night time hours. At night, "80" is usually reliable for short to medium distance contacts, with average distances ranging from local contacts within 200 miles/300 km out to a distance of 1,000 miles/1,600 km or more -- even worldwide -- at night, depending on atmospheric and ionospheric conditions.

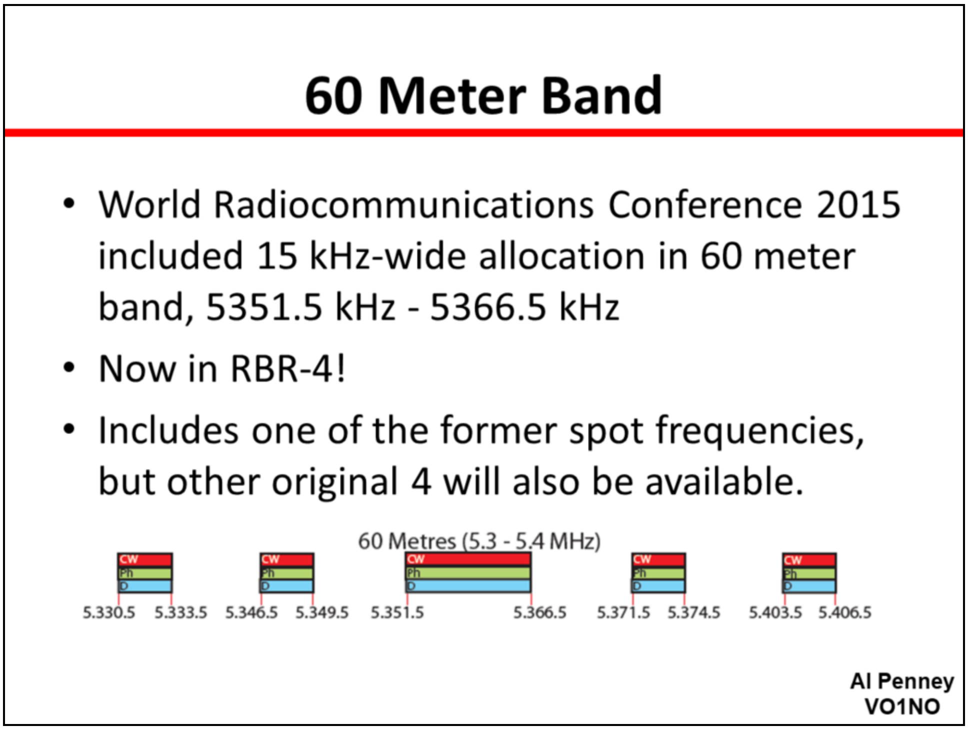
80 Meter Band

Notes

1. During major contests, activity can spill over into other parts of the band.
2. Narrow Digital modes are up to 500 Hz bandwidth.
3. Digital includes all permitted digital modes.
4. Voice modes should not be used closer than 3 kHz to edge of bottom of segment.
5. Maximum bandwidth permitted is 6 kHz.

NOTE: Maximum Bandwidth is 6 kHz

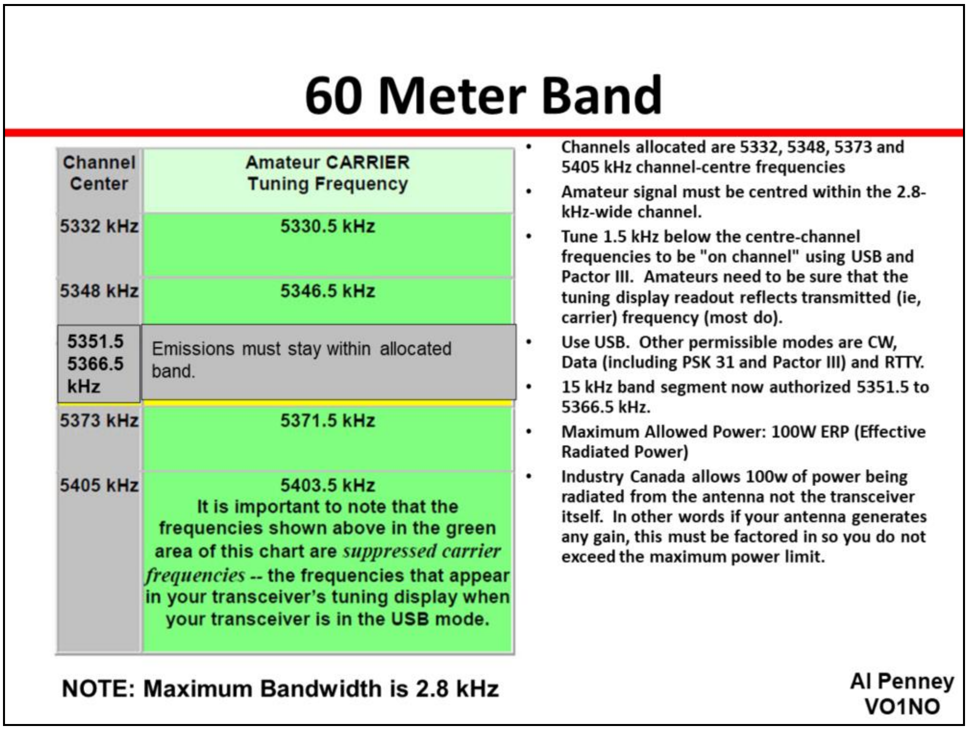
Al Penney VO1NO



We are happy to report that in their release of the Revised Table of Frequency Allocations https://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf10759.html issued on 13 April 2018 ISED has addressed the concerns of the Canadian Amateur Radio community. The Revised Table now allocates the band 5351.5 kHz - 5366.5 kHz (which overlaps one of the previous 60m spot frequencies) and the four previously allocated spot frequencies (5332, 5348, 5373 and 5405 kHz). The conditions for the use of the band and spot frequencies remain the same as those governing the spot frequencies previously: maximum effective radiated power of 100 watts PEP, 2.8 kHz emission bandwidth and permitted modes telephony, data, RTTY and CW. The Table notes that the Amateur 60m allocations are not in accordance with international frequency allocations and that Canadian amateur operations shall not cause interference to fixed or mobile operations in Canada or other countries. As in the previous allocation of the spot frequencies, the Table notes that if interference occurs the amateur service may be required to cease operations. This is a standard condition of domestic allocations and as noted previously by RAC has not occurred during operation on the previously allocated and authorized spot frequencies.

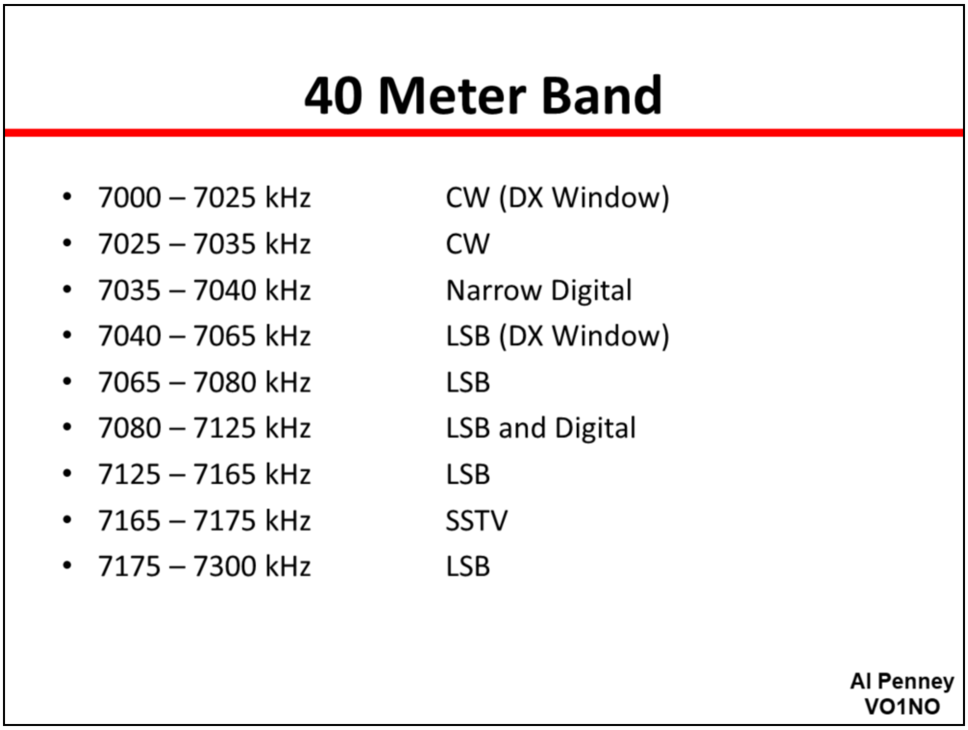
Even though the Canadian Table of Frequency Allocations now identifies this new 60 metre allocation for the Amateur Service, Canadian Amateurs must await authorization by ISED before using the new 15 kHz segment. Such authorization is normally effected via a revised issue of document *RBR-4 – Standards for the Operation of Radio Stations in the Amateur Radio Service* (https://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf10650.html). Radio Amateurs of Canada will be urging ISED to authorize the new 15 kHz segment as soon as possible.

Glenn MacDonell, VE3XRA
RAC President and Chair



The **60-meter band** or **5 MHz band** is a relatively new amateur radio allocation, first introduced in 2002, that was originally only available in a few countries, such as the United States, United Kingdom, Norway, Finland, Denmark, Ireland and Iceland. Over a number of years however, an increasing proportion of countries' telecommunications administrations – together with their government and military users – have permitted Amateur Radio operation in the 5 MHz area on a short or longer term basis, ranging from discrete channels to a frequency band allocation.

At the closing meeting of the 2015 ITU World Radiocommunication Conference (WRC-15) on 27 November 2015, amongst the Final Acts signed into the International Radio Regulations was one approving "A Worldwide Frequency Allocation of 5351.5–5366.5 kHz to the Amateur Service on a secondary basis". The ITU's enhanced band allocation limits most amateurs to 15 watts effective isotropic radiated power (EIRP), with some countries allowed up to 25 W EIRP. The ITU allocation came into effect January 1, 2017, after which each country's national administration must formally revise their rules to permit amateur operation.



The **40-meter** or **7-MHz band** is an amateur radio frequency band, spanning 7.000-7.300 MHz in ITU Region-2, and 7.000-7.200 MHz in Regions 1 & 3. It is allocated to radio amateurs worldwide on a primary basis; however, only 7.000-7.100 MHz is exclusively allocated to amateur radio worldwide. Shortwave broadcasters and land mobile users also have primary allocations in some countries, and amateur stations must share the band with these users.

40 meters is considered one of the most reliable all-season long distance communication (DX) bands.

This band supports both long distance (DX) communications between late afternoon and a few hours after sunrise, and short distance NVIS contacts during most daylight hours.

With its unique combination of intra- and intercontinental communications possibilities, 40 meters is considered a key band in building a winning HF contesting score during any part of the sunspot cycle.

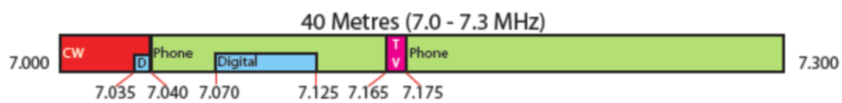
The band is most useful for inter-continental communication for one or two hours before sunset, during the night and for one or two hours after sunrise. It is extremely useful for short to medium distance contacts from local contacts out to a range of 500–1500 km (300–1000 miles) or more, depending on conditions, during the day. In higher latitudes, daytime intercontinental communication is also possible during the short days of winter, for example a good path often opens between Japan and northern Europe in the hours leading up to European midday from late November through late January, with a long path opening to the west coast of the United States and Canada after midday.

Due to the 24-hour nature of the band, the wide variety of ranges that can be spanned with it, and its shared nature, it tends to be extremely crowded, and interference from other amateurs and broadcasters can be a serious limiting factor. In recent years amateurs in east and southeast Asia have also suffered severe interference from illegal users.

40 Meter Band

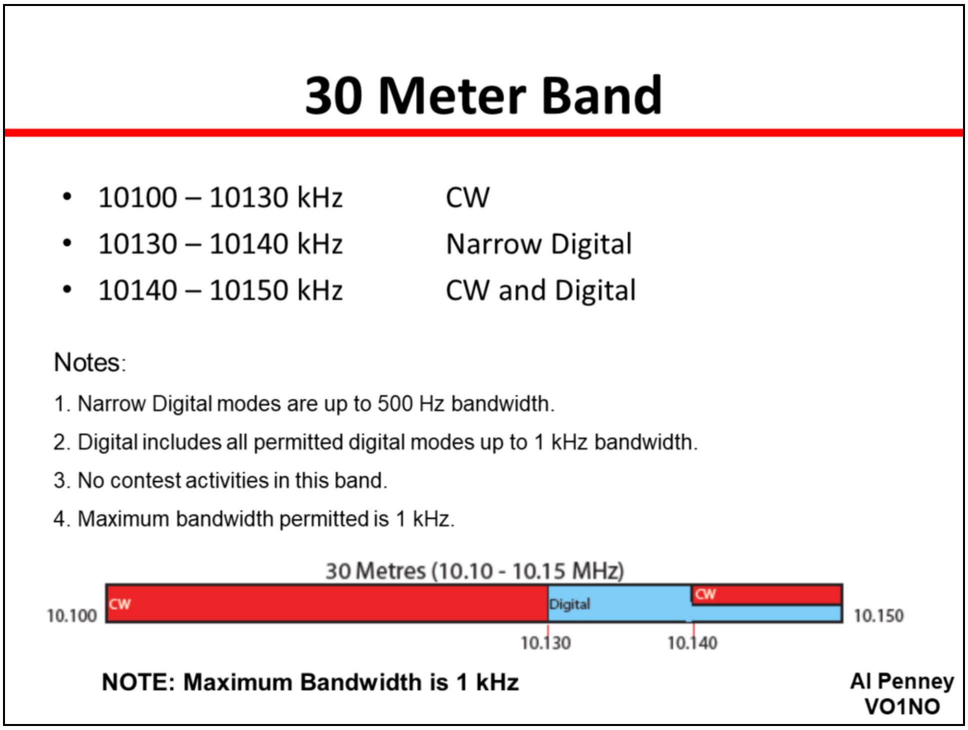
Notes:

1. During major contests, activity can spill over into other parts of the band.
2. Narrow Digital modes are up to 500 Hz bandwidth.
3. Digital includes all permitted digital modes.
4. Voice modes should not be used closer than 3 kHz to edge of bottom of segment.
5. Maximum bandwidth permitted is 6 kHz.



NOTE: Maximum Bandwidth is 6 kHz

Al Penney
VO1NO



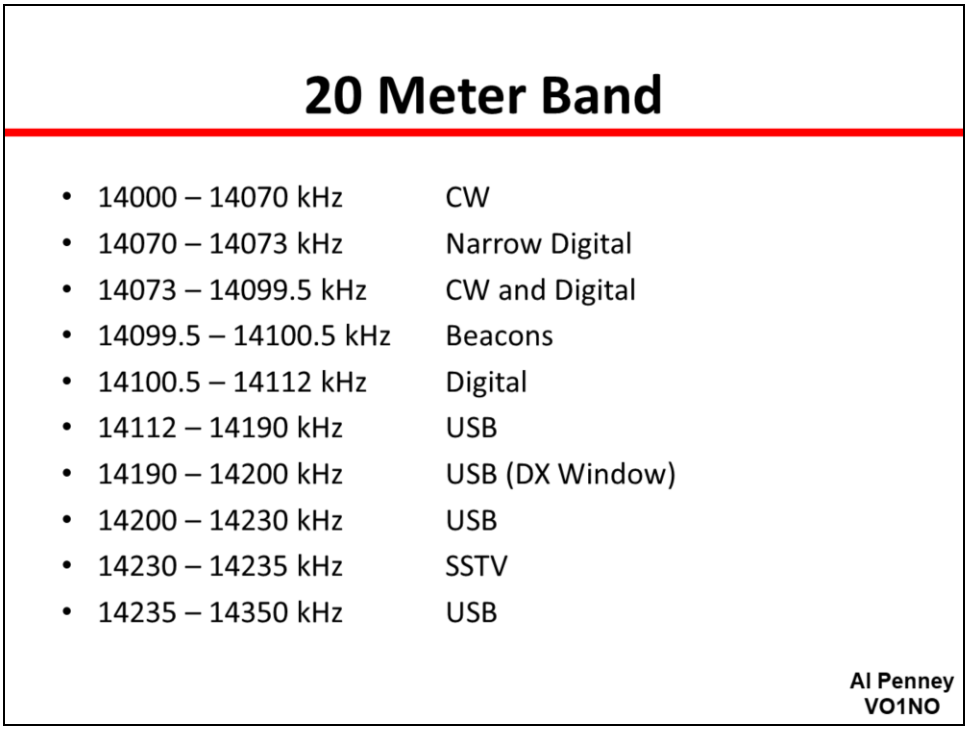
30 meters – 10.1–10.15 MHz – a very narrow band, which is shared with non-amateur services. It is recommended that only Morse Code and data transmissions be used here, and in some countries amateur voice transmission is actually prohibited. For example, in the US, data, RTTY and CW are the only modes allowed at a maximum 200 W peak envelope power (PEP) output. Not released for amateur use in a small number of countries. Due to its location in the centre of the shortwave spectrum, this band provides significant opportunities for long-distance communication at all points of the solar cycle. 30 meters is a WARC band. "WARC" bands are so called due to the 1979 special World Administrative Radio Conference allocation of these newer bands to amateur radio use. Amateur radio contests are not run on the WARC bands.

The **World Administrative Radio Conference (WARC) bands** are three portions of the shortwave radio spectrum used by licensed and/or certified amateur radio operators. They consist of 30 meters (10.100–10.150 MHz), 17 meters (18.068–18.168 MHz) and 12 meters (24.890–24.990 MHz). They were named after the World Administrative Radio Conference, which in 1979 created a worldwide allocation of these bands for amateur use. The bands were opened for use in the early

1980s. Due to their relatively small bandwidth of 100 kHz or less, there is a gentlemen's agreement that the WARC bands may not be used for general contesting. This agreement has been codified in official recommendations, such as the IARU Region 1 HF Manager's Handbook, which states:

Contest activity shall not take place on the 10, 18 and 24 MHz bands.

Non-contesting radio amateurs are recommended to use the contest-free HF bands (30, 17 and 12m) during the largest international contests.

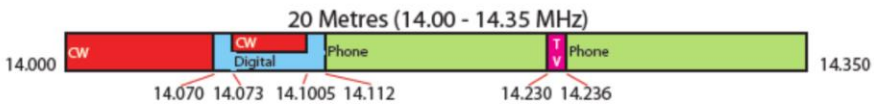


The **20-meter** or **14-MHz** amateur radio band is a portion of the shortwave radio spectrum, comprising frequencies stretching from 14.000 MHz to 14.350 MHz. The 20-meter band is widely considered among the best for long-distance communication (Dxing), and is one of the most popular—and crowded—during contests. Several factors contribute to this, including the band's large size, the relatively small size of antennas tuned to it (especially as compared to antennas for the 40-meter band or the 80-meter band) and its good potential for daytime DX operation even in unfavorable propagation conditions.

20 Meter Band

Notes:

1. During major contests, activity can spill over into other parts of the band.
2. Narrow Digital modes are up to 500 Hz bandwidth.
3. Digital includes all permitted digital modes.
4. Voice modes should not be used closer than 3 kHz to edge of top of segment.
5. Maximum bandwidth permitted is 6 kHz.



NOTE: Maximum Bandwidth is 6 kHz

Al Penney
VO1NO

17 Meter Band

- 18068 – 18095 kHz CW
- 18095 – 18100 kHz CW and Digital
- 18100 – 18103 kHz Narrow Digital
- 18103 – 18109.5 kHz Digital
- 18109.5 – 18110.5 kHz Beacons
- 18110.5 – 18168 kHz USB

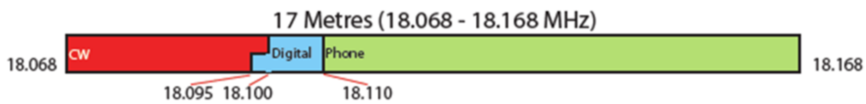
Al Penney
VO1NO

17 meters – 18.068–18.168 MHz – Similar to 20 meters, but more sensitive to solar propagation minima and maxima. 17 meters is a WARC band.

17 Meter Band

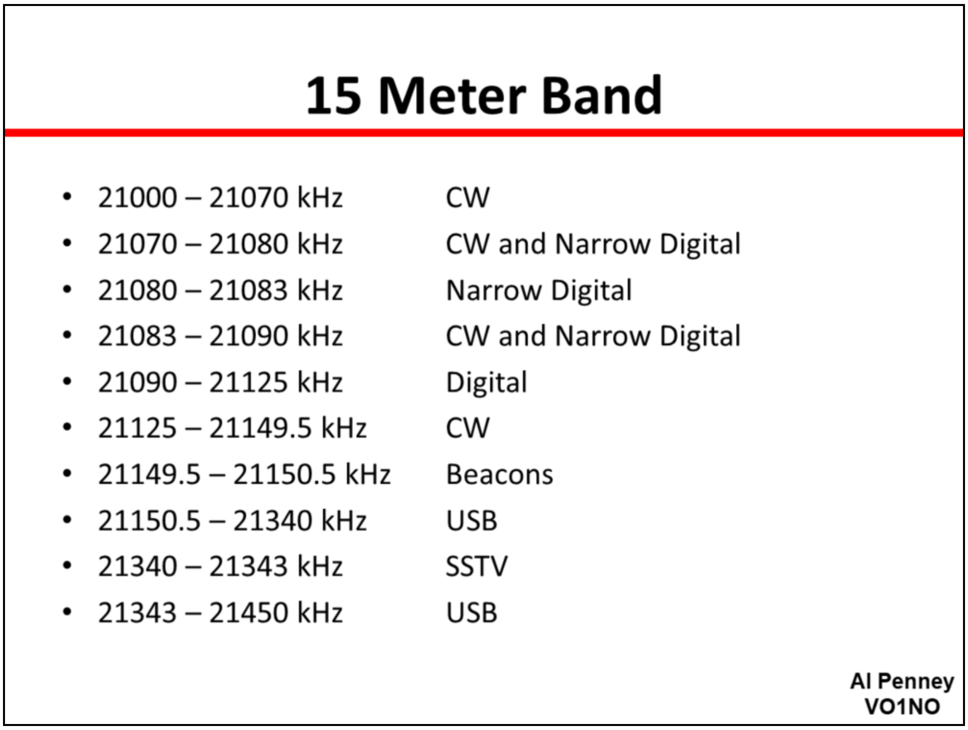
Notes:

1. Narrow Digital modes are up to 500 Hz bandwidth.
2. Digital includes all permitted digital modes.
3. Voice modes should not be used closer than 3 kHz to edge of top of segment.
4. Maximum bandwidth permitted is 6 kHz.



NOTE: Maximum Bandwidth is 6 kHz

Al Penney
VO1NO



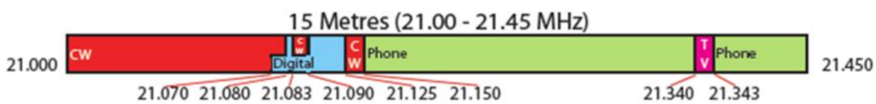
The **15-meter band** (also called the **21-MHz band** or **15 meters**) is an amateur radio frequency band spanning the shortwave spectrum from 21 to 21.45 MHz. The band is suitable for amateur long-distance communications, and such use is permitted in nearly all countries.

Because 15-meter waves propagate primarily via reflection off of the F-2 layer of the ionosphere, the band is most useful for intercontinental communication during daylight hours, especially in years close to solar maxima, but the band permits long-distance without high-power station equipment outside such ideal windows. The 15-meter wavelength is harmonically related to that of the 40-meter band, so it is often possible to use an antenna designed for 40 meters.

15 Meter Band

Notes:

1. During major contests, activity can spill over into other parts of the band.
2. Narrow Digital modes are up to 500 Hz bandwidth.
3. Digital includes all permitted digital modes.
4. Voice modes should not be used closer than 3 kHz to edge of top of segment.
5. Maximum bandwidth permitted is 6 kHz.



NOTE: Maximum Bandwidth is 6 kHz

Al Penney VO1NO

12 Meter Band

- 24890 – 24920 kHz CW
- 24920 – 24925 kHz Narrow Digital
- 24925 – 24929.5 kHz CW and Digital
- 24929.5 – 24930.5 kHz Beacons
- 24930.5 – 24940 kHz CW and Digital
- 24940 – 24975 kHz USB
- 24975 – 24978 kHz SSTV
- 24978 – 24990 kHz USB

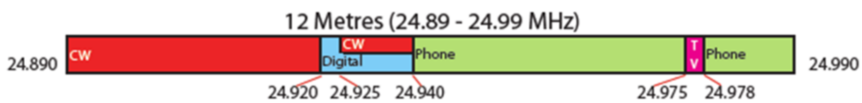
Al Penney
VO1NO

12 meters – 24.89–24.99 MHz – Mostly useful during daytime, but opens up for DX activity at night during solar maximum. 12 meters is one of the WARC bands. Propagates via Sporadic E and by F2 propagation.

12 Meter Band

Notes:

1. Narrow Digital modes are up to 500 Hz bandwidth.
2. Digital includes all permitted digital modes.
3. Voice modes should not be used closer than 3 kHz to edge of top of segment.
4. Maximum bandwidth permitted is 6 kHz.



NOTE: Maximum Bandwidth is 6 kHz

Al Penney
VO1NO

10 Meter Band

28000 – 28070 kHz	CW
28070 – 28123 kHz	CW and Narrow Digital
28123 – 28189.5 kHz	CW and Digital
28189.5 – 28200.5 kHz	Beacons
28200.5 – 28300 kHz	CW and Beacons
28300 – 28320 kHz	CW and Digital
28320 – 28680 kHz	USB
28680 – 28683 kHz	SSTV
28683 – 29000 kHz	USB
29000 – 29200 kHz	AM
29200 – 29300 kHz	USB
29300 – 29510 kHz	Satellite Up/Downlinks
29510 – 29520 kHz	Guard band – No transmissions allowed
29520 – 29590 kHz	FM Repeater Inputs
29600 kHz	FM Simplex
29620 – 29700 kHz	FM Repeater Outputs

Al Penney
VO1NO

The **10-meter band** is a portion of the shortwave radio spectrum internationally allocated to amateur radio and amateur satellite use on a primary basis. The band consists of frequencies stretching from 28.000 to 29.700 MHz.

Being a very wide band in HF terms, many different transmission modes can be found on 10 meters. Morse code and other narrowband modes are found toward the bottom portion of the band, SSB from 28.300 MHz up, and wideband modes (AM and FM) are found near the upper part of the bottom portion of the band. Digital modes, such as PSK-31, are also allowed in the upper portion of the band, with 28.120 being a popular PSK-31 frequency.

Beacons

Because the propagation on 10 meters can vary drastically throughout the day, propagation beacons are very important to gauge the current conditions of the band. With some differences in each ITU Regions and also from country to country, the beacon sub-bands fall between 28.100 MHz and 28.300 MHz. ITU Region 1 is generally 28.190 MHz - 28.225 MHz and ITU Region 2 is generally 28.200 MHz - 28.300 MHz.

AM sub-band

From 29.000 MHz to 29.200 MHz. Formerly-common practice was to use the band in 10 kHz steps: e.g. 29.010, 29.020, 29.030,... etc. This has not been the case since the 1970s, which saw an influx of surplus 23-channel CB equipment modified for use on the 10-meter amateur band. The surplus equipment would land in 10 kHz steps on the 5 kHz step such as: 29.015, 29.025, 29.035, etc. Users of the surplus equipment also inherited those radios' odd channel spacing, which on CB skipped channels that were not used there, because they were set aside for remote control operations.

Satellite sub-band

From 29.300 MHz to 29.510 MHz the satellite sub band allows amateur radio operators to communicate with orbiting OSCARs.

Satellite operation

Many amateur radio satellites have either an uplink or a downlink in the 29 MHz range. Information about particular satellites and operational modes is available from AMSAT.

As of the current writing, only AO-7's 10m downlink is active.

FM sub-band

From 29.510 MHz to 29.700, The FM sub-band is usually channelized into repeater and simplex frequencies. The channels are commonly grouped into repeater inputs, simplex, and repeater output frequencies.

Repeater Input Channels: 29.520, 29.540, 29.560, and 29.580 MHz.

Simplex Channel, Worldwide calling FM: 29.600 MHz

Repeater Output Channels: 29.620, 29.640, 29.660, and 29.680 MHz.

Repeater operation

Common practice for 10-meter repeaters is to use a 100 kHz negative offset for repeater operation. Due to the very few available repeater channels, "odd-splits" (offsets differing from 100 kHz) and non-standard frequencies are not uncommon. Since 10 meters can frequently open up to propagate globally, most 10-meter repeaters use a CTCSS sub-audible access tone. 16 kHz wide signals with 5 kHz deviation is normal in this band. 8 kHz narrow signals with 2.5 kHz deviation can also be found.

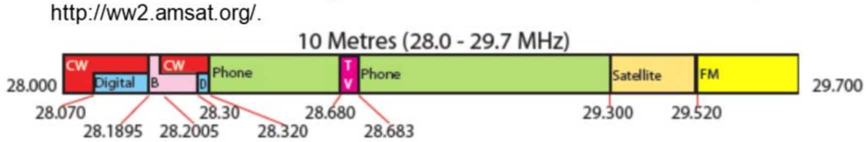
FM simplex channels

29.300 MHz is a common frequency to find JA hams on. British hams commonly use the 29.400 to 29.500 MHz band for FM as well with 29.400, 29.450, and 29.500 MHz being common. USA hams can be found on FM anywhere above 29.000 MHz, commonly on the above frequencies talking to overseas hams. 29.200 to 29.300 MHz is set aside in some area band plans for FM Simplex use.

10 Meter Band

Notes:

1. During major contests, activity can spill over into other parts of the band.
2. Narrow Digital modes include PSK31, RTTY etc.
3. Digital includes most permitted digital modes but not necessarily all.
4. USB should not be used with an indicated carrier frequency closer than 3 kHz to edge of top of band segment.
5. FM bandwidth not to exceed 6 kHz.
6. Note that 29.500 MHz is often used as a secondary FM Simplex calling frequency. While such use is not illegal under Canadian regulations, avoid using that frequency if operational satellites are using 10M. Consult AMSAT for satellite status reports: http://ww2.amsat.org/.



NOTE: Maximum Bandwidth is 20 kHz

Al Penney
VO1NO

6 Meter Band	Frequency	Use
	50.000 - 50.080	CW (Beacons, Terrestrial and EME)
	50.080 - 50.1	CW (Terrestrial 2 Way)
	50.095	National CW Calling Frequency. Note 1
	50.1 - 50.120	CW and SSB DX Window. Note 3
	50.125	National SSB Calling Frequency
	50.125 - 50.220	SSB voice modes
	50.220 - 50.250	EME
	50.250 - 50.400	Narrow Band Digital. Note 2
	50.260	Meteor Scatter Frequency
	50.275	WSJT Frequency
	50.313	FT8 North America
	50.315	FT4
	50.323	Intercontinental DX. Note 4
	50.400	National AM Calling Frequency. Note 1
	50.400 - 50.800	
	50.620	National Packet Frequency
	50.800 - 51.000	Radio Remote Control (20 kHz channels)
	51.000 - 51.100	Experimental
	51.120 - 51.480	Repeater Inputs (20 kHz channels).
	51.500 - 51.600	FM Simplex (20 kHz channels).
	51.620 - 51.920	Repeater Outputs (paired with 51.120 - 51.480)
	52.000 - 52.480	Repeater Inputs (20 kHz channels).
	52.525	National FM Calling Frequency. Note 1
	52.500 - 52.980	Repeater Outputs (paired with 52.000 - 52.480).
	53.000 - 53.480	Repeater Inputs (20 kHz channels).
	53.500 - 53.980	Repeater Outputs (paired with 53.000 - 53.480).

The **6-meter band** is the lowest portion of the very high frequency (VHF) radio spectrum allocated to amateur radio use. The term refers to the average signal wavelength of 6 meters.

Although located in the lower portion of the VHF band, it nonetheless occasionally displays propagation mechanisms characteristic of the high frequency (HF) bands. This normally occurs close to sunspot maximum, when solar activity increases ionization levels in the upper atmosphere. During the last sunspot peak of 2005, worldwide 6-meter propagation occurred making 6-meter communications as good as or in some instances and locations, better than HF frequencies. The prevalence of HF characteristics on this VHF band has inspired amateur operators to dub it the "**magic band**".

In the northern hemisphere, activity peaks from May through early August, when regular sporadic E propagation enables long-distance contacts spanning up to 2,500 kilometres (1,600 mi) for single-hop propagation. Multiple-hop sporadic E propagation allows intercontinental communications at distances of up to 10,000 kilometres (6,200 mi). In the southern hemisphere, sporadic E propagation is most common from November through early February.

The Radio Regulations of the International Telecommunication Union allow amateur radio operations in the frequency range from 50.000 to

54.000 MHz in ITU Region 2 and 3. At ITU level, Region 1 is allocated to broadcasting. However, in practice a large number of ITU Region 1 countries allow amateur use of at least some of the 6-meter band. Over the years portions have been vacated by VHF television broadcasting channels for one reason or another. In November 2015 the ITU World Radio Conference (WRC-15) agreed that for their next conference in 2019, Agenda Item 1.1 will study a future allocation of 50–54 MHz to amateur radio in Region 1.

In North America, especially in the United States and Canada, the 6-meter band may be used by licensed amateurs for the safe operation of radio-controlled (RC) aircraft and other types of radio control hobby miniatures. By general agreement among the amateur radio community, 200 kHz of the 6-meter band is reserved for the telecommand of models, by licensed amateurs using amateur frequencies The sub-band reserved for this use is 50.79 to 50.99 MHz with ten "specified" frequencies, numbered "00" to "09" spaced at 20 kHz apart from 50.800 to 50.980 MHz. The upper end of the band, starting at 53.0 MHz, and going upwards in 100 kHz steps to 53.8 MHz, used to be similarly reserved for RC modelers, but with the rise of amateur repeater stations operating above 53 MHz in the United States, and very few 53 MHz RC units in Canada, the move to the lower end of the 6-meter spectrum for radio-controlled model *flying* activities by amateur radio operators was undertaken in North America, starting in the early 1980s, and more-or-less completed by 1991. It is still completely legal for ground-level RC model operation (cars, boats, etc.) to be accomplished on any frequency within the band, above 50.1 MHz, by any licensed amateur operator in the United States; however, an indiscriminate choice of frequencies for RC operations is discouraged by the amateur radio community.

In Canada, Industry Canada's RBR-4, Standards for the Operation of Radio Stations in the Amateur Radio Service, limits radio control of craft, for those models intended for use on any amateur radio-allocated frequency, to amateur service frequencies above 30 MHz

6 Meter Band

NOTES	
1	Once contact is established on a Calling Frequency, operators should QSY to another frequency.
2	Narrow Band Digital 2M modes are those with bandwidths of 3 kHz or less, e.g.: WSJT modes. Wide Band Digital 2M modes are those with bandwidths greater than 3 kHz but less than 30 kHz, e.g.: Packet.
3	The purpose of the DX window is to create a low QRM area to listen for DX. If you hear DX you may call them, however you do not CALL CQ DX in the window. If you want to call CQ DX QSY below or above the Window.
4	During Sporadic E openings outside of North America, stations are urged to move to this frequency to reduce congestion and QRM / sequencing issues .

Version 2 of RAC Draft Band Plan – not yet official.

NOTE: Maximum Bandwidth is 30 kHz

Al Penney
VO1NO

2 Meter Band (1)

Frequency	Use
144.000 - 144.100	EME, Narrow Band Digital, CW, Weak Signal Modes. See Note 1. JT65 centred on 144.085 JA Window. See Note 2.
144.100 - 144.180	CW, SSB, Narrow Band Digital, EME, Weak Signal Modes. See Note 1. 144.174 FT8, 144.144/144.150 MSK144 Meteor Scatter, 144.115 – 144.135 Digital EME centred on 144.125 MHz. See Note 2
144.180 – 144.265	CW, SSB, Narrow Band Digital, EME, Weak Signal and other Narrow Band Modes. See Note 1. Other modes with bandwidths less than 3 kHz, including FAX and SSTV. 144.200 SSB and CW Calling Frequency – See Note 3.
144.265 - 144.270	No transmissions - Guard Band to protect Beacon Network.
144.270 – 144.300	Propagation Beacon Network Exclusive. Note that 144.300 is the IARU Region 1 Calling Frequency, and could be used for Trans-Atlantic Attempts.
144.300 – 144.310	No transmissions - Guard Band to protect Beacon Network.
144.310 – 144.500	Wide Band Digital Modes (e.g.: Packet, APRS). See Notes 1 and 4. 144.340 - National ATV Voice Coordination Frequency FM. 144.390 - National APRS Frequency. See Note 5. 144.489 - National WSPR Frequency.

Al Penney
VO1NO

The **2-meter** amateur radio band is a portion of the VHF radio spectrum, comprising frequencies stretching from 144 MHz to 148 MHz in International Telecommunication Union region (ITU) Region 2 (North and South America plus Hawaii) and 3 (Asia and Oceania) and from 144 MHz to 146 MHz in ITU Region 1 (Europe, Africa, and Russia). The license privileges of amateur radio operators include the use of frequencies within this band for telecommunication, usually conducted locally within a range of about 100 miles (160 km).

Because it is local and reliable, and because the licensing requirements to transmit on the 2-meter band are easy to meet in many parts of the world, this band is one of the most popular non-HF ham bands. This popularity, the compact size of needed radios and antennas, and this band's ability to provide easy reliable local communications also means that it is also the most used band for local emergency communications efforts, such as providing communications between Red Cross shelters and local authorities. In the US, that role in emergency communications is furthered by the fact that most amateur-radio operators have a 2-meter handheld transceiver (HT), handie-talkie or walkie-talkie.

Much of 2-meter FM operation uses a radio repeater, a radio receiver and transmitter that instantly retransmits a received signal on a separate frequency. Repeaters are normally located in high locations such as a tall building or a hill top overlooking expanses of territory. On VHF frequencies such as 2-meters, antenna height greatly influences how far one can talk. Typical reliable repeater range is about 25 miles (40 km).

While the 2 meter band is best known as a local band using the FM mode, there are many opportunities for long distance (DX) communications using other modes. A well-placed antenna and high-power equipment can achieve distances of up to a few hundred miles, and fortuitous propagation conditions called "signal enhancements" can on occasion reach across oceans.

The typical 2 meter station using CW (Morse code) or SSB (single side band) modes consists of a radio driving a power amplifier generating about 200–500 Watts of RF power. This extra power is usually fed to a multi-element, compound antenna, usually a Yagi-Uda or *Yagi*, which can beam most of the signal power towards the intended receiving station. "Beam antennas" provide substantial increase in signal directivity over ordinary dipole or vertical antennas. Antennas used for distance work are usually horizontally polarized instead of the vertical polarization customarily used for local contacts.

2 Meter Band (2)

Frequency	Use
144.500 – 144.900	FM / Digital / Linear Repeater Inputs. See Note 6.
144.900 – 145.100	Wide Band Digital. See Notes 1 and 7.
145.100 – 145.500	FM / Digital / Linear Repeater Outputs. See Note 6.
145.500 – 145.590	ARISS Links – Space Communication Exclusive.
145.590 – 145.790	Wide Band Digital Modes. See Notes 1 and 8.
145.790 – 145.800	No transmissions. Guard Band to protect Satellite Sub-band.
145.800 – 146.000	Amateur Satellite Uplink / Downlink and ARISS Exclusive.
146.000 – 146.010	No transmissions. Guard Band to protect Satellite Sub-band.
146.010 – 146.370	FM / Digital / Linear Repeater Inputs. See Note 6.
146.400 – 146.595	FM Simplex. See Notes 9 and 10.
	146.520 - National FM Calling Frequency. See Note 3
146.610 – 147.390	FM / Digital / Linear Repeater Outputs. See Note 6.
147.420 – 147.570	FM Simplex and Digital Hotspots using a 30 kHz raster. See Notes 11 and 12.
	Note that Digital channels are interwoven between these FM Simplex channels.
147.435 - 147.585	Wide Band Digital. See Notes 1 and 13.
	Note that these Digital channels are interwoven between the FM Simplex channels at 147.420 - 147.570.
147.600 – 147.990	FM / Digital / Linear Repeater inputs. See Note 6.

Al Penney
VO1NO

Stations that have antennas located in relatively high locations with views (from the antenna) clear to the horizon have a big advantage over other stations. Such stations are able to communicate 100–300 miles (160–480 km) consistently. It is usual for them to be heard at distances far beyond line of sight on a daily basis without help from signal enhancements. *Signal enhancements* are unusual circumstances in the atmosphere and ionosphere that bend the signal path into an arc that better follows the curve of the Earth, instead of the radio waves traveling in the usual straight line off into space. The best known of these are:

•tropospheric ducting

•sporadic E

•meteor scatter

These and other well-known forms of VHF signal enhancement that allow trans-oceanic and trans-continental contacts on 2 meters are described in the subsections that follow within this section.

With the exception of sporadic E, directional antennas such as Yagis or log periodic antennas are almost essential to take advantage of signal enhancements. When a well-equipped station with its antenna well-located “high and in the clear” is operating during a signal enhancement, astonishing distances can be bridged, momentarily approaching what is regularly possible on shortwave and mediumwave.

2 Meter Band Notes

NOTES	
1	Narrow Band Digital 2M modes are those with bandwidths of 3 kHz or less, e.g.: WSJT modes. Wide Band Digital 2M modes are those with bandwidths greater than 3 kHz but less than 30 kHz, e.g.: Packet.
2	Consult with WSJT community regarding frequencies for EME and Terrestrial operations as these change with modulation schemes.
3	Once contact is established on a Calling Frequency, operators should QSY to another frequency. For 144.200 MHz it is generally down for CW, and up for SSB. For 146.520 MHz FM, it is to any other clear FM simplex channel.
4	Seven frequencies on a 20 kHz channel raster 144.37, 144.39, 144.41, 144.43, 144.45, 144.47, 144.49. Occupancy to occur ONLY when available Digital frequencies within the sub bands 144.9 – 145.1 MHz and 145.59 – 145.79 MHz are exhausted. Consult with yo
5	Consult with your local coordination body.
6	Repeaters include FM, Digital (DMR, Fusion, DSTAR and related) and linear modes. Consult with your local coordination body for frequencies and modulation scheme allocations specific to your area, if available. Hotspots are not to be used on Repeater fre

Al Penney
VO1NO

2 Meter Band Notes

NOTES	
7	Ten frequencies on a 20 kHz channel raster: 144.91, 144.93, 144.95, 144.97, 144.99, 145.01, 145.03, 145.05, 145.07, 145.09. Consult with your local coordination body.
8	Eleven frequencies on a 20 kHz channel raster 145.59, 145.61, 145.63, 145.65, 145.67, 145.69, 145.71, 145.73, 145.75, 145.77, 145.79 MHz. Consult with your local coordination body.
9	The frequencies 146.40, 146.43, 146.46 MHz continue to be used as repeater inputs in some areas. Consult with your local coordination body.
10	Thirteen Channels on a 15 kHz channel raster: 146.415, 146.430, 146.445, 146.460, 146.475, 146.490, 146.505, 146.520, 146.535, 146.550, 146.565, 146.580, 146.595 MHz.
11	Six Channels on a 30 kHz channel raster, 147.420, 147.450, 147.480, 147.510, 147.540, 147.570 MHz.
12	The use of Digital Hotspots is not recommended on 2M. If they are used however, maximum power output should not exceed 500 mW. Gain antennas should not be used. The control operator must monitor the Hotspot whenever it is operating.
13	Six Channels on a 30 kHz channel raster: 147.435, 147.465, 147.495, 147.525, 147.555, 147.585 MHz. Consult your local coordination body for available frequencies, ERP and bandwidth.

NOTE: Maximum Bandwidth is 30 kHz

**Al Penney
VO1NO**

IARU Band Plans

- International Amateur Radio Union has band plans based on IARU Region.
- Region 2 Band Plan is at: https://www.iaru-r2.org/wp-content/uploads/2020/02/IARU-Region-2-Band-plan.pdf
- National Regulators can make modifications as necessary.

Al Penney
VO1NO

The three IARU regional organizations develop band plans to offer guidance to radio amateurs on how the different operating interests and modes of emission can be best accommodated in the limited spectrum available. Observing band plans is good amateur operating practice. In most cases observance is voluntary although some administrations incorporate the band plan for their region into national regulations. Also, many contest sponsors require that competitors adhere to band plans.

To the extent possible, the IARU R2 band plan is harmonized this with those of the other regions. It is suggested that Member Societies, in coordination with the authorities, incorporate it in their regulations and promote it widely with their radio amateur communities. Of course, if a band plan conflicts with national regulations the national regulations must be observed.


Questions?

Review Question 1

What term means the number of times per second that an alternating current flows back and forth?

- Frequency
- Speed
- Pulse rate
- Inductance

Al Penney
VO1NO

Review Question 1

What term means the number of times per second that an alternating current flows back and forth?

- Frequency
- Speed
- Pulse rate
- Inductance

< Frequency >

Al Penney
VO1NO

Review Question 2

Electrical energy at a frequency of 7125 kHz is in what frequency range?

- Audio
- Hyper
- Super-high
- Radio

Al Penney
VO1NO

Review Question 2

Electrical energy at a frequency of 7125 kHz is in what frequency range?

- Audio
- Hyper
- Super-high
- Radio

< Radio >

Al Penney
VO1NO

Review Question 3

What is the name for the distance an AC signal travels during one complete cycle?

- Wave spread
- Wavelength
- Wave speed
- Waveform

Al Penney
VO1NO

Review Question 3

What is the name for the distance an AC signal travels during one complete cycle?

- Wave spread
- Wavelength
- Wave speed
- Waveform

< Wavelength >

Al Penney
VO1NO

Review Question 4

What happens to a signal's wavelength as its frequency increases?

- It stays the same
- It disappears
- It gets shorter
- It gets longer

Al Penney
VO1NO

Review Question 4

What happens to a signal's wavelength as its frequency increases?

- It stays the same
- It disappears
- It gets shorter
- It gets longer

< It gets shorter >

Al Penney
VO1NO

Review Question 5

What happens to a signal's frequency as its wavelength gets longer?

- It goes up
- It goes down
- It disappears
- It stays the same

Al Penney
VO1NO

Review Question 5

What happens to a signal's frequency as its wavelength gets longer?

- It goes up
- It goes down
- It disappears
- It stays the same

< It goes down >

Al Penney
VO1NO

Review Question 6

What does 60 hertz (Hz) mean?

- 60 metres per second
- 6000 cycles per second
- 60 cycles per second
- 6000 metres per second

Al Penney
VO1NO

Review Question 6

What does 60 hertz (Hz) mean?

- 60 metres per second
- 6000 cycles per second
- 60 cycles per second
- 6000 metres per second

< 60 cycles per second >

Al Penney
VO1NO

Review Question 7

If the frequency of the waveform is 100 Hz, the time for one cycle is:

- 0.01 second
- 10 seconds
- 0.0001 second
- 1 second

Al Penney
VO1NO

Review Question 7

If the frequency of the waveform is 100 Hz, the time for one cycle is:

- 0.01 second
- 10 seconds
- 0.0001 second
- 1 second

< 0.01 second >

Al Penney
VO1NO

Review Question 8

The maximum bandwidth of an amateur station's transmission allowed in the band 50 to 54 MHz is:

- 30 kHz
- 20 kHz
- 6 kHz
- 15 kHz

Al Penney
VO1NO

Review Question 8

The maximum bandwidth of an amateur station's transmission allowed in the band 50 to 54 MHz is:

- 30 kHz
- 20 kHz
- 6 kHz
- 15 kHz

< 30 kHz >

Al Penney
VO1NO

Review Question 9

A signal is composed of a fundamental frequency of 2 kHz and another of 4 kHz. This 4 kHz signal is referred to as:

- the DC component of the main signal
- a dielectric signal of the main signal
- a harmonic of the 2 kHz signal
- a fundamental of the 2 kHz signal

Al Penney
VO1NO

Review Question 9

A signal is composed of a fundamental frequency of 2 kHz and another of 4 kHz. This 4 kHz signal is referred to as:

- the DC component of the main signal
- a dielectric signal of the main signal
- a harmonic of the 2 kHz signal
- a fundamental of the 2 kHz signal

< a harmonic of the 2 kHz signal >

Al Penney
VO1NO

Review Question 10

In Canada, the 75/80 metre amateur band corresponds in frequency to:

- 4.0 to 4.5 MHz
- 4.5 to 5.0 MH z
- 3.5 to 4.0 MHz
- 3.0 to 3.5 MHz

Al Penney
VO1NO

Review Question 10

In Canada, the 75/80 metre amateur band corresponds in frequency to:

- 4.0 to 4.5 MHz
- 4.5 to 5.0 MH z
- 3.5 to 4.0 MHz
- 3.0 to 3.5 MHz

< 3.5 to 4.0 MHz >

Al Penney
VO1NO

Review Question 11

In Canada, the 10 metre amateur band corresponds in frequency to:

- 21.000 to 21.450 MHz
- 50.000 to 54.000 MHz
- 28.000 to 29.700 MHz
- 24.890 to 24.990 MHz

Al Penney
VO1NO

Review Question 11

In Canada, the 10 metre amateur band corresponds in frequency to:

- 21.000 to 21.450 MHz
- 50.000 to 54.000 MHz
- 28.000 to 29.700 MHz
- 24.890 to 24.990 MHz

< 28.000 to 29.700 MHz >

Al Penney
VO1NO

Review Question 12

In Canada, radio amateurs may use which of the following for radio control of models:

- 50 to 54, 144 to 148, and 220 to 225 MHz only
- all amateur frequency bands above 30 MHz
- 50 to 54 MHz only
- all amateur frequency bands

Al Penney
VO1NO

Review Question 12

In Canada, radio amateurs may use which of the following for radio control of models:

- 50 to 54, 144 to 148, and 220 to 225 MHz only
- all amateur frequency bands above 30 MHz
- 50 to 54 MHz only
- all amateur frequency bands

< all amateur frequency bands above 30 MHz >

Al Penney
VO1NO

Review Question 13

Except for one band, the maximum bandwidth of an amateur station's transmission allowed between 7 and 28 MHz is:

- 30 kHz
- 6 kHz
- 15 kHz
- 20 kHz

Al Penney
VO1NO

Review Question 13

Except for one band, the maximum bandwidth of an amateur station's transmission allowed between 7 and 28 MHz is:

- 30 kHz
- 6 kHz
- 15 kHz
- 20 kHz

< 6 kHz >

Al Penney
VO1NO

Review Question 14

What is the maximum authorized bandwidth within the frequency range of 50 to 148 MHz?

- The total bandwidth shall not exceed 10 times that of a CW emission
- 30 kHz
- 20 kHz
- The total bandwidth shall not exceed that of a single-sideband phone emission

Al Penney
VO1NO

Review Question 14

What is the maximum authorized bandwidth within the frequency range of 50 to 148 MHz?

- The total bandwidth shall not exceed 10 times that of a CW emission
- 30 kHz
- 20 kHz
- The total bandwidth shall not exceed that of a single-sideband phone emission

<30 kHz >

Al Penney
VO1NO

Review Question 15

What is a band plan?

• A guideline for deviating from amateur frequency band allocations

• A guideline for using different operating modes within an amateur band

• A plan of operating schedules within an amateur band published by Industry Canada

• A plan devised by a club to best use a frequency band during a contest

Al Penney
VO1NO

Review Question 15

What is a band plan?

• A guideline for deviating from amateur frequency band allocations

• A guideline for using different operating modes within an amateur band

• A plan of operating schedules within an amateur band published by Industry Canada

• A plan devised by a club to best use a frequency band during a contest

< A guideline for using different operating modes within an amateur band >

Al Penney
VO1NO

Review Question 16

The velocity of propagation of radio frequency energy in free space is:

- 186 000 kilometres per second
- 300 000 kilometres per second
- 3000 kilometres per second
- 150 kilometres per second

Al Penney
VO1NO

Review Question 16

The velocity of propagation of radio frequency energy in free space is:

- 186 000 kilometres per second
- 300 000 kilometres per second
- 3000 kilometres per second
- 150 kilometres per second

< 300 000 kilometres per second >

Al Penney
VO1NO

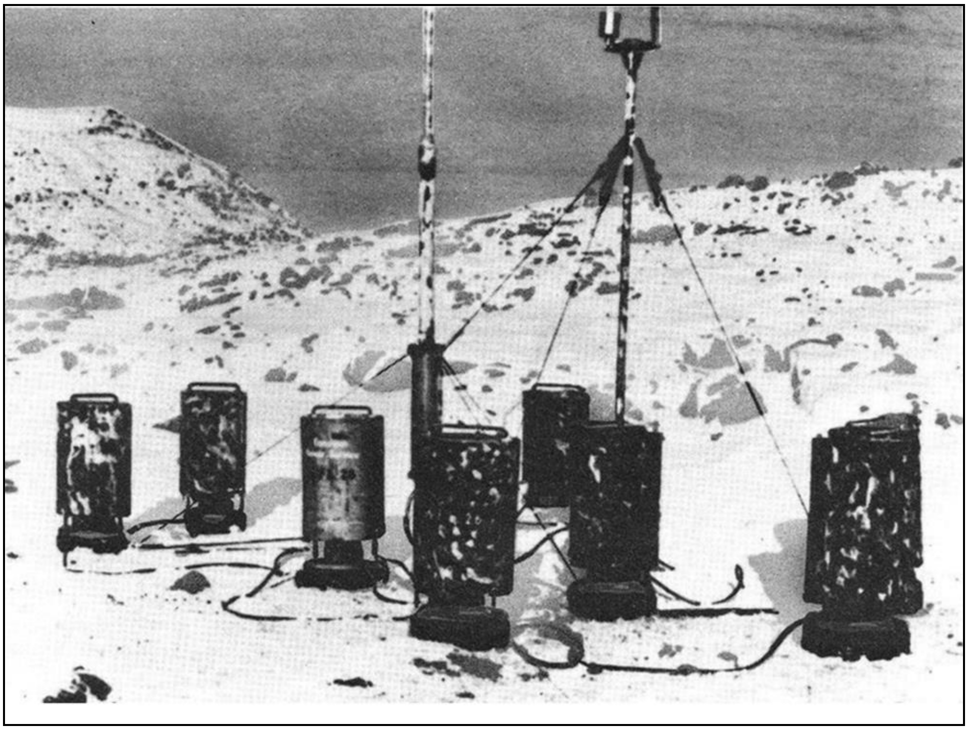
For Next Class:

- Review Chapter 5 of Basic Study Guide;
- Read Chapter 6 of Basic Study Guide; and
- Read RBR-4:
  - https://www.ic.gc.ca/eic/site/smt-gst.nsf/vwapj/rbr-4-issue2-2014.pdf/$file/rbr-4-issue2-2014.pdf

Al Penney
VO1NO


Questions?


Canadian



Weather Station Kurt (**Wetter-Funkgerät Land-26**) was an automatic weather station, erected by a German U-boat crew in northern Labrador, Dominion of Newfoundland in October 1943. Installing the equipment for the station was the only known armed German military operation on land in North America during the Second World War. After the war it was forgotten until its rediscovery in 1977.[1]

To gather more weather information, the Germans developed the *Wetter-Funkgerät Land* (WFL) automatic weather station. It was designed by Dr. Ernst Ploetze and Edwin Stoebe. Twenty-six were manufactured by Siemens. The WFL had an array of measuring instruments, a telemetry system and a 150 watt, Lorenz 150 FK-type transmitter.[4] It consisted of ten cylindrical canisters, each 1 metre (3.3 ft) by c.47 cm diameter (1.5 metres (4.9 ft) circumference) and weighing around 100 kilograms (220 lb).[2] One canister contained the instruments and was attached to a 10-metre (33 ft) antenna mast.[2] A second, shorter mast carried an anemometer and wind vane. The other canisters contained the nickel-cadmium batteries] that powered the system. The WFL would send weather readings every three hours during a two-minute transmission on 3940 kHz. The system could work for up to six months, depending on the number of battery canisters.

Fourteen stations were deployed in Arctic and sub-Arctic regions (Greenland, Bear Island, Spitsbergen, and Franz Josef Land) and five were placed around the Barents Sea. Two were intended for North America. One was deployed in 1943 by the German submarine *U-537*, but the submarine carrying the other, *U-867*, was sunk with depth charges in September 1944 northwest of Bergen, Norway, by a British air attack.[2]

On September 18, 1943, *U-537*, commanded by *Kapitänleutnant* Peter Schrewe, departed from Kiel, Germany on her first combat patrol. She carried WFL-26, codenamed "Kurt", a meteorologist, Dr. Kurt Sommermeyer, and his assistant, Walter Hildebrant.[2] En route, the U-boat was caught in a storm and a large breaker produced significant damage, including leaks in the hull and the loss of the submarine's quadruple anti-aircraft cannon, leaving it both unable to dive and defenceless against Allied aircraft.

On 22 October *U-537* arrived at Martin Bay in Northern Labrador, at a position 60°5′0.2″N 64°22′50.8″WCoordinates: 60°5′0.2″N 64°22′50.8″W. This is close to Cape Chidley at the north-eastern tip of the Labrador Peninsula. Schrewe selected a site this far north as he believed this would minimize the risk of the station being discovered by Inuit people.[2] Within an hour of dropping anchor, a scouting party had located a suitable site, and soon after Dr. Sommermeyer, his assistant, and ten sailors disembarked to install the station. Armed lookouts were posted on nearby high ground, and other crew members set to repair the submarine's storm damage.[2]

For concealment, the station was camouflaged. Empty American cigarette packets were left around the site to deceive any Allied personnel that chanced upon it. One canister was marked and misspelled "*Canadian Meteor Service*", in order to simulate *“Canadian Weather Service”*, as a German attempt to avoid suspicion if discovered. No such agency existed in Canada. In addition, the area was part of the Dominion of Newfoundland and not part of Canada until 1949. The crew worked through the night to install Kurt and repair their U-boat. They finished just 28 hours after dropping anchor and, after confirming the station was working, *U-537* departed. The weather station functioned for only a month before it permanently failed under mysterious circumstances, possibly because its radio transmissions were jammed.[7] The U-boat undertook a combat patrol in the area of the Grand Banks of Newfoundland, during which she survived three attacks by Canadian aircraft, but sank no ships.[8] The submarine reached port at Lorient, France on December 8, after seventy days at sea. She was sunk with all hands eleven months later on November 11, 1944 by the submarine USS *Flounder* near the Dutch East Indies.

The station was forgotten until 1977 when Peter Johnson, a geomorphologist working on an unrelated project, stumbled upon the German weather station. He suspected it was a Canadian military installation, and named it "Martin Bay 7".

Around the same time, retired Siemens engineer Franz Selinger, who was writing a history of the company, went through Sommermeyer's papers and learned of the station's existence.[3] He contacted Canadian Department of National Defence historian W.A.B. Douglas, who went to the site with a team in 1981 and found the station still there, although the canisters had been opened and components strewn about the site. Weather Station Kurt was brought to Ottawa and is now on display at the Canadian War Museum in Ottawa.

Inflatable rubber rafts on the after deck of German U-537 in Martin Bay, Labrador, Dominion of Newfoundland (now Canada) on 22 Oct 1943. The rafts were used to take pieces of Weather Station Kurt ashore to the Hutton Peninsula.

Civilian technician Dr. Kurt Sommermeyer aboard U-537 in the Labrador Sea listening to signals transmitted by Weather Station Kurt (named for Sommermeyer) broadcasting from the Labrador coast, 24 Oct 1943


Questions?