The 630 Meter Band

Introduction

The 630 meter Amateur Radio band is a frequency band allocated by the International Telecommunication Union (ITU) to the Amateur Service, and ranges from 472 to 479 kHz, or equivalently 625.9 to 635.1 meters wavelength. It was formally allocated to the Amateur Service as part of the Final Acts of the 2012 World Radiocommunication Conference (WRC-12). Once approved by the appropriate national regulatory authority, the band is available on a secondary basis to countries in all ITU regions with the limitation that Amateur stations have a maximum radiated power of 1 Watt effective isotropic radiated power (EIRP). Stations more than 800 km from certain countries (listed below) may be permitted to use 5 Watts EIRP however.

The ITU Final Acts took effect 1 January 2013 and after public consultation on all of the ITU allocation changes contained it, the 630 meter band was added to the Canada Table of Frequencies in 2014. Several countries had previously allocated the WRC-12 band to Amateurs domestically. Several other countries had also already authorized temporary allocations or experimental operations on nearby frequencies.

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

The first International Wireless Telegraph Convention, held in Berlin on November 3, 1906, designated 500 kHz as the maritime international distress frequency. For nearly 100 years, the "600-meter band" (495 to 510 kHz) served as the primary calling and distress frequency for maritime communication, first using spark transmissions, and later CW. In the 1980s a transition began to the Global Maritime Distress Signaling System (GMDSS), which uses UHF communication via satellite. In the 1990s most countries ceased using and monitoring CW on 500 kHz. Today, the 600-meter band is idle with the exception of occasional transmissions by historical maritime stations.

The frequencies below 1.8 MHz have been little explored by Radio Amateurs since our banishment to "200 meters and down" in 1912. The 630-meter band (sometimes referred to as the 600-meter band) is located near the geometric mean of the 2200m (137 kHz) and 160m (1.8 MHz) Amateur bands. In addition to the historical significance of this part of the spectrum, the band is of interest to Radio Amateurs for several reasons:

- Ultra-reliable emergency communications via ground wave,
- Unique propagation and noise environment, and
- Experimental work with antennas, modulation, and signal processing.

Band Status in Other Nations

United States
In the FCC Daily Digest of April 28, 2015, the Commission announced that it is taking action with respect to the decisions made at the WRC07 and WRC12 conferences. Specifically, the Commission will:

- *Allocate the 472-479 kHz band (630 meter band) to the amateur service on a secondary basis; and*
- *Amend the amateur service rules to provide for use of the 135.7-137.8 kHz (2200 meter) and 472-479 kHz (630 meter) bands. Amateur stations would share the band with power line carrier (PLC) systems operated by electric utilities.*

United Kingdom
According to the RSGB website, UK amateurs holding a Full License may use the band subject to specific conditions in the license frequency schedule. The website indicates that the IARU has not agreed on a band plan as yet, but it is expected that as more countries gain access to the band, it will be discussed and implemented in the near future. In general, CW is in the lower part of the band, up to about 475 kHz, and data modes above.

Germany
The German administration (BNetzA) announced in the official gazette No. 11/2012 that from 13 June 2012 German Radio Amateurs with a license class A may use the 472-479 kHz band (in anticipation of the normally needed changes in the National Frequency Allocation Table). Power limit is 1 watt ERP (sic), and maximum bandwidth is 800 Hz.

Principality of Monaco
The "Direction des Communications Electroniques" of the Principality of Monaco, by official letter of May 18th 2012, has allocated the segment 472 - 479 kHz, to the Amateur service with secondary status, with a maximum power of 1 Watt EIRP.

Philippines
The Philippines Amateur Radio Association (PARA) has announced that “after countless meetings of the Amateur Radio Consultative Panel (ARCP) and the National Telecommunications Commission (NTC), access to the 472 kHz to 479 kHz band came into effect on August 30, 2012.”

New Zealand
In New Zealand, the 472 kHz to 479 kHz band was allocated to Amateur Radio, on a secondary basis, with an effective date of 20 December 2012. Amateur transmissions are limited to 25 watts EIRP.

Australia
Australian Amateurs have an allocation from 472 to 479 kHz, with a maximum EIRP of 5 Watts. The Wireless Institute of Australia (WIA) has developed a preliminary band plan for the band. It allows CW throughout the entire band, with digital modes from 474 to 479 kHz. The WIA is

trying to include provisions for SSB signals, while recognizing that interference with CW and digital signals is inevitable if SSB is actually used. To quote the WIA website:

*The main problem is the question of how to provide for SSB activity. Use of SSB up to 2.1 kHz bandwidth is permitted by the ACMA (*Australian Communications and Media Authority)*, but it cannot be used on this band without impinging on frequencies used for other modes. It is not appropriate for band plans to recommend operations that will inevitably lead to clashes. It is proposed to add an advisory note mentioning frequencies that have been suggested for SSB use, and the recommendation that operators need to be flexible and tolerant. The proposed updated version is below. Further changes will occur as patterns of activity and favoured modes develop.*

ACMA licence conditions for this band permit the use of any mode with a maximum bandwidth of 2.1 kHz. The following frequencies are based on current CW and digital activity in IARU Region I, and are recommended for DX activity.

CW	*472.500 kHz - recommended centre frequency for international DX*
WSPR	*474.2 kHz USB dial frequency (occupied bandwidth 475.6 - 475.8 kHz)*
ROS	*476.0 kHz USB dial frequency (occupied bandwidth 477.4 - 477.6 kHz)*
QRSS	*476.175 kHz USB dial frequency (occupied bandwidth 477.175 - 477.185 kHz). (Some activity also on 478.9 kHz)*
WSJTX	*477.0 kHz USB dial frequency (occupied bandwidth 478.0 - 478.5 kHz)*
Opera	*477.0 kHz USB dial frequency (occupied bandwidth 478.5 - 478.8 kHz)*

SSB operation is also permitted, with a maximum occupied bandwidth of 2.1 kHz. However it is not possible to run SSB without overlapping frequencies that are used for CW or digital modes. Users of this band will need to exercise tolerance and restraint. One suggested approach is that SSB operators voluntarily restrict their activities to daylight hours. The two SSB frequencies listed below are possible options that have been suggested. The frequencies given assume the use of LSB mode and an audio bandwidth of 300 - 2400 Hz.

SSB	*479.3 kHz LSB dial frequency (occupied bandwidth 476.9 - 479.0 kHz).*
	476.0 kHz LSB dial frequency (occupied bandwidth 473.6 - 475.7 kHz)

Elsewhere on the WIA website, other options are discussed for the inclusion of SSB in the band plan:

There are three main alternative approaches:
Option 1. Time sharing: SSB stations would operate only at certain times, e.g. only during daylight. CW and digital stations would accept interference from SSB stations at those times.
Option 2. Frequency shifting between primary and secondary frequencies: Adopt an alternative set of frequencies for digital modes to move to when SSB activity is occurring.
Option 3. Minimise and tolerate certain level of interference. This could involve choosing an SSB frequency that would cause some conflict with CW or digital activity, but leave most activity unaffected.

Option I has the advantage of simplicity. For option 1, an SSB frequency at the top of the band has been proposed (476.900 - 479.000 kHz).

Option 2 is more complex and is described in detail in the attached proposal by Ron Cook VK3AFW.

Option 3 would involve choosing a frequency that would clash with as little CW and digital activity as possible. For example, 476.000 kHz LSB (occupied bandwidth 473.600 - 475.700 kHz) as suggested by VK4WA. This frequency would only affect WSPR activity and leave other digital operation unaffected. A variation to this option would be: suppressed carrier frequency 475.9 kHz, occupied bandwidth 473.5 -475.6 kHz. This would avoid clashing with WSPR and would overlap only the upper end of the CW range.

Belgium
On 14 August 2013, a new allocation of 472 to 479 kHz was added to the existing allocation of 501 to 504 kHz for Amateur operators holding a HAREC-class license. The maximum EIRP is 5 Watts. All modes are permitted. It is unsure what will happen to the existing 501 to 504 allocation in the future.

Bulgaria
In an announcement posted on the IARU Region 1 website on 12 February 2014, Bulgarian Amateurs will be able to use the 472-479 kHz band.

Poland
The National Table of Frequency Allocations has been amended to make the 472-479 kHz band available to Polish Amateurs on a secondary basis, with a maximum power of 1 watt EIRP. According to the Regulation of the Council of Ministers of 27th December 2013 (Journal of Laws of the Republic of Poland of 3rd February 2014, item 161), the relevant amendments took effect on 18 February 2014.

Iceland
To quote their website “the national association of Icelandic Radio Amateurs, Í.R.A., is pleased to announce that as of January 16, 2013 Icelandic Radio Amateurs have been granted operating privileges on 472-479 kHz (630 meters). This allocation is granted on secondary basis. Maximum power is 5 watts EIRP and maximum bandwidth is 1 kHz. This new allocation is open to the “G” license class (higher). A previous temporary allocation on 493-510 kHz was closed on December 31, 2012.”

Switzerland
The Swiss Regulator BAKOM announced that from 1 January 2013 Amateurs are allowed to use the 472-479 kHz band with 5 Watts EIRP.

France
According to the website of Réseau des Émetteurs Français (REF), French Amateurs, including those in the French Overseas Departments and Territories, have access to 472–479 kHz, with 1 Watt EIRP.

Norway
In Norway, including Svalbard, Jan Mayen, and the Bouvet Island, Amateurs have an allocation of 472-479 kHz on a secondary basis. Maximum output power is 100 watts, and maximum EIRP of 1 Watt.

IARU Region One
According to the IARU Region One website, the suggested bandplan for the 630m band is CW only from 472 to 475 kHz, and CW and digital modes from 475 to 479 kHz. No maximum bandwidth appears to be specified for the digital modes.

Allocations before WRC-12

In Belgium, Amateurs were allocated 501–504 kHz on a secondary basis on 15 January 2008. Only CW may be used with a maximum ERP of 5 W. In Norway, the band 493–510 kHz was allocated to Radio Amateurs on 6 November 2009. Only radiotelegraphy is permitted. After WRC-12, this allocation was replaced with an allocation of 472 to 479 kHz.

In New Zealand, the band 505–515 kHz was allocated to Amateur Radio temporarily, "pending an international frequency allocation", on 1 March 2010. Amateur use was on a non-interference basis, and transmissions were limited to 25 Watts EIRP, with a bandwidth not exceeding 200 Hz. Now that an international frequency allocation has been made by the ITU and subsequently implemented in New Zealand, this temporarily band has been phased out. A transition period of one year was given for Amateurs to move to the new allocation, and use of this band was not permitted after 31 December 2013.

In the Netherlands 501–505 kHz was allocated to Amateur Radio operators, with a maximum of 100 Watts PEP, on 1 January 2012. The status of this band is not known, nor is there any information of a new allocation at 472 – 479 kHz.

Countries with past or current experimental operation

Other regions have granted experimental uses for selected licensees in advance of any international frequency allocation. The U.S. Federal Communications Commission (FCC) granted the American Radio Relay League an experimental license to explore such uses in September 2006. Subsequently, the UK started to issue Special Research Permits for Amateurs to use 501–504 kHz.

Ireland allows individuals to apply for Test Licenses in the 501 to 504 kHz frequency range. Canada has also allowed individuals to apply for use in the 504 to 509 kHz frequency range in the past. Other regions with experimental operations include Croatia, Czech Republic, Denmark, Iceland, Sweden, Spain and Slovenia.

Countries in which operation is prohibited

As part of the compromise to allocate the band, a new footnote was added to the ITU's Table of Frequency Allocations, which prohibits Amateur operation between 472 and 479 kHz in many countries, including:

- Algeria
- Azerbaijan
- Bahrain
- Belarus
- China
- Comoros
- Djibouti
- Egypt
- Iraq
- Jordan
- Kazakhstan
- Kuwait
- Kyrgyzstan
- Lebanon
- Libya
- Mauritania
- Oman
- Qatar
- Russia
- Saudi Arabia
- Somalia
- Sudan
- Syria
- Tunisia

- United Arab Emirates
- Uzbekistan
- Yemen

Countries further than 800 km from these countries may increase allowable power levels to 5 Watts EIRP.

Beacons

A search of beacon databases indicates that two beacons are currently listed as operational in the 630m Amateur band:

- 475 kHz, Beacon "PT" in Petrovskoye, Russia
- 478 kHz, Beacon "MF" in Larionovo, Russia.

Given the power levels and distances involved, mutual interference with Canadian Amateur stations is extremely unlikely.

Propagation

Propagation on the 630m band is different in many respects from that in the HF spectrum. Because propagation will have an impact on how the band will be used, a quick description is in order.

Propagation at MF wavelengths is via both ground waves and skywaves. Ground waves, also know as surface waves, spread out from the transmitter along the surface of the Earth but instead of travelling in a straight line however, the radio signals tend to follow the curvature of the Earth. This is because currents are induced in the surface of the Earth, slowing the wave-front in this region, and causing the wave-front to tilt downwards. With the wave-front tilted in this direction it is able to curve around the Earth and be received well beyond the horizon.

Medium Wave (MW) broadcasting stations use ground waves to cover their listening areas. At MW wavelengths they can diffract over hills, and cover a radius of several hundred kilometers from the transmitter. Terrain with good conductivity gives the best result. Thus soil type and the moisture content are of importance. Sea water is by far the best, and rich agricultural, or marshy land is also good. Dry sandy terrain and city centres are much worse. This means sea paths are optimum, although even these are subject to variations due to the roughness of the sea, resulting on path losses being slightly dependent upon the weather.

As the wavefront of the ground wave travels along the Earth's surface it is attenuated. While the degree of attenuation is dependent upon a variety of factors, the frequency of the radio signal is the major determining factor. Losses rise with increasing frequency. As a result it makes this form of propagation impracticable above the bottom end of the HF portion of the spectrum. Typically a signal at 3.0 MHz will suffer an attenuation that may be in the region of 20 to 60 dB more than one at 0.5 MHz over typical ground wave paths. In view of this it can be seen why even high power HF radio broadcast stations may only be audible for a few kilometers from the transmitting site via the ground wave. The ability for a MW signal to be reliably received hundreds of kilometers away via ground wave is a prime difference between MF and HF propagation.

MF can also travel longer distances via skywave propagation, in which radio waves radiated at an angle into the sky are refracted back to Earth by the ionosphere's E and F layers. The D layer absorbs rather than refracts MF waves, interfering with skywave propagation. This happens when the ionosphere is heavily ionized, such as during the day, in summer and especially at times of high solar activity.

At night, especially in winter months and at times of low solar activity, the ionospheric D layer can virtually disappear. When this happens, MF radio waves can easily be received hundreds or even thousands of kilometers away as the signal will be refracted by the remaining E and F layers. Note that skywave propagation at MF is primarily due to the E layer however, so conventional HF propagation forecast software is often not suitable.

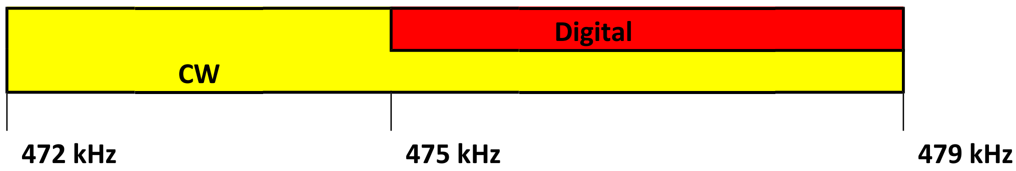
Latitude is also a very significant factor in determining the received strength of a sky-wave signal. MW skywave field strength decreases with increasing geomagnetic latitude. There is not much that Canadian Amateurs can do about that. The good news is that European broadcast band and MW DX'ers (listeners) at higher latitudes than most Canadians have still had much success copying weak signals.

The MF Amateur band is characterized by relatively stable carrier phase on received signals, accompanied by low Doppler shift. The band has very strong lightning interference, but this is mostly local, not the background of random impulse noise typical of the lower HF spectrum. There can also be considerable man-made interference. While there is multi-path reception, the path changes are slow. The slow fades can be very deep, and signals can be quite weak, so in order to have a conversation at typing speed on 630m, what is needed is a mode that is very sensitive, narrow band, has excellent impulse noise tolerance, but need not have strong phase or Doppler tolerance. Some options are discussed next.

Suitable Operating Modes

The 630m band is only 7 kHz wide, so operating modes used on the band must be narrow if mutual interference is to be avoided. As well, given the deep fading that occurs on skywave signals, the natural and man-made noise present on the band, and the relative inefficiencies in practical antenna designs that will make even the 5 Watt EIRP limit difficult to obtain, digital modes that incorporate digital signal processing, Forward Error Correction (FEC) and other weak signal attributes will be the most common modes, especially for DX QSOs outside ground wave coverage.

The attempts by the Wireless Institute of Australia notwithstanding, RAC believes that SSB, and any mode greater than 1 kHz in bandwidth, are not practical modes for the 7 kHz wide 630m band. While detailed band plans are still being developed as more users become operational on the band, RAC anticipates that the general approach advocated by the IARU, RSGB and others will be adopted, i.e.: CW only 472 – 475 kHz, and Digital and CW 475 – 479 kHz.



While actual Amateur experience on the 630m band will ultimately decide which digital modes will be employed, based on Amateur experience on the 2200m band, there are several preferred candidates. Some examples of the available digital modes and their bandwidths include:

Mode	Bandwidth	Remarks
QRSS	0.3 Hz	Very slow speed CW
Jason	~200 Hz	Keyboard to keyboard but slow
Olivia	125, 250, 500, 1000 and 2000 Hz	Most common versions use 1000 Hz bandwidth or less.
CMSK	12.5 to 200 Hz	Keyboard to keyboard, 32 WPM typing
WSQ	64.4 Hz	Keyboard to keyboard 5 to 7 WPM typing
Domino EX4	140 Hz	Keyboard to keyboard but slow
JT65	200 Hz	WSJT suite
WSPR	6 Hz	Propagation path testing system, not for communications
PSK31	80 Hz	Keyboard to keyboard, quick
MFSK16	316 Hz	Keyboard to keyboard, 42 WPM typing

It appears that only Germany and Iceland have specified a maximum bandwidth for operations on the 630m band, 800 Hz for Germany and 1 kHz for Iceland. Based on the probable digital modes that will be used on this band, limiting maximum bandwidth to 1 kHz would be prudent as an initial starting point, subject to review based on actual activity on the band.

Antennas

Effective antennas on the 630m band will be a challenge for many Amateurs. The wavelength at 475 kHz is 631.2 meters so a $\lambda/4$ vertical would be approximately 157.8 meters (518 feet) high. Most Amateurs do not live on extensive acreage and/or have unlimited funds and in many cases their antennas will have to fit in urban or suburban back yards. Such an antenna is literally beyond the reach of the vast majority of Amateurs.

Limited to much more practical heights, Amateur transmit antennas for the 630m band will be characterized by a low radiation resistance, narrow operating bandwidth, and large losses. For example, a 15 meter (49.5 foot) vertical tower would have an efficiency of less than 2%. To achieve the maximum legal output (5 watts EIRP), 156 watts will have to be delivered to the feedpoint. Note that this assumes a perfect ground system. This is very difficult (and expensive) to achieve at these frequencies. In reality then, higher power will be necessary to reach the 5 watt EIRP limit. Because physically short antennas have narrow bandwidths and a high “Q”, very high voltages can be present even at relatively low power levels. Special precautions are therefore necessary to avoid coronal discharge, overheating of antenna components, and danger to people.

In terms of wavelengths, the majority of Amateur dipole antennas will be extremely low to the ground, resulting in most power being absorbed by the Earth. Mobile and temporary portable antennas (for emergency use for example) will be very inefficient regardless of their design.

The type of antenna and its polarization has a major effect on ground wave propagation. Vertical polarization is subject to considerably less attenuation than horizontally polarized signals. In some cases the difference can amount to several tens of decibels. It is for this reason that medium wave broadcast stations use vertical antennas, even if they have to be made physically short by adding inductive loading.

It is anticipated that most Amateurs will use heavily loaded vertical antennas, possibly with capacitive tophats, for transmitting, with some using Inverted L or T antennas. All these will require extensive radial systems in order to reduce ground losses. Separate receive-only directional antennas will likely be employed, such as the K9AY, Pennant, "magnetic" loops, or Beverage antennas for those who have the room.

Uses of the Band

As already indicated, the band is of interest to Radio Amateurs for several reasons:

• Ultra-reliable emergency communications via ground wave
Because ground wave propagation does not rely on the ionosphere, it is relatively unaffected by disturbances in that medium. As well, it has the ability to "fill in" shadow zones where VHF/UHF communications systems cannot operate in hilly or mountainous areas. The 630m band could therefore conceivably be used as part of a medium range (several hundred kilometer) reliable emergency communications system when the HF bands are rendered useless by ionospheric disturbances, or where the terrain precludes VHF/UHF operations.

Such ionospheric conditions could develop due to large solar storms, including another Carrington Event. This was a massive geomagnetic solar storm that was observed in 1859. A solar coronal mass ejection hit Earth's magnetosphere and induced one of the largest geomagnetic storms on record. Studies have shown that a solar storm of this magnitude occurring today would likely cause widespread problems for modern civilization, including disabling most communications systems, especially HF and satellite links. A solar storm in 2012 was of similar magnitude, but it passed Earth's orbit without striking the planet.

• Unique propagation and noise environment
The MW part of the spectrum is distinctly different from what Amateurs have become familiar with on the higher frequencies. Ground wave propagation is just one of those unique differences. Amateurs have often lead the way in discovering new propagation techniques, and RAC expects the same will be true of the 630m band.

• Experimental work with antennas, modulation, and signal processing
This is an area where Amateurs will be able to break new ground. Antennas pose a major challenge on this band. Amateurs will experiment and develop practical designs that will work reasonably well despite the limitations of insufficient space. Access to the 630m band will stimulate developments into new digital modes and DSP techniques that are better suited for MF, and Amateurs will continue their tradition of overcoming technical and propagation difficulties in order to communicate with other hams.

Conclusion

There are many challenges that will have to be overcome when Amateur Radio operators populate the 630m band. Antennas, especially mobile and portable, are inefficient. There is very little commercial equipment available. Bandwidth is limited. Propagation is very different from what Amateurs are accustomed to.

Amateur Radio operators have a very proud tradition of overcoming adversity and technical challenges that dates back to the very beginnings of radio however! Examples include the discovery of numerous propagation modes, radio circuit and antenna improvements, the development of advanced digital modes, and the introduction of miniature satellites, now in common use by governments, science and industry. RAC is very confident that Amateur Radio operators will step up to the plate and meet these challenges head-on. It has taken more than a century, but Amateur Radio is finally back to its birthplace.

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