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470 - 471 MHz Scanner Users

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Do you utilize a "scanner" to listen to frequencies or channels in the 470 - 471 Megahertz (MHz) band? Do you now hear amateur radio conversations in place of, or along with the stations that you have been trying to monitor?

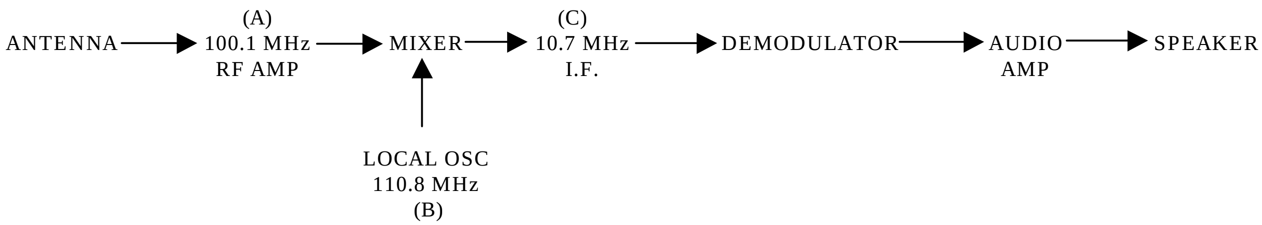
If you are using a scanner and monitoring the 470 - 471 MHz band you are probably interested in reading this article. This article will provide you with a better understanding of the phenomena causing you to hear Amateur radio service (ARS) transmissions. This activity often appears to be on the same frequency or channel as the public safety (police, fire, etc.), business, or industrial service that you are monitoring. You may have noticed that much more of this ARS activity showed up some time after May 1, 1999. If any of these apply to you, then this article is something you should read. The intent of this article is to help you to better understand how and why this happens and what you may be able to do to stop hearing the unwanted ARS transmissions.

The following information will be presented in a very basic technical format with as many examples as possible in order to allow the reader to best understand this phenomena. Please understand that the ARS transmissions you are hearing are not actually occurring on the frequency or channel in the 470 - 471 MHz band that you are monitoring. This article will explain why you hear something that actually isn't there.

A "scanner" is a radio frequency (RF) receiver, just like many other consumer items that we all own such as a television set, a stereo FM broadcast receiver, an AM broadcast radio or a cellular telephone. The scanner is unique in that it has been designed to allow the listener to listen to, or monitor, many different frequencies or channels in a user selectable fashion, sequentially. In other words, you can scan or tune through many channels at a time looking for activity and the scanner will then stop and listen to an individual channel when activity is present.

The scanner shares the same radio frequency receiver design found in your TV, FM or AM radio, or cellular telephone. This design is technically known as the superheterodyne method. This method was invented in the 1920's to better allow the reception of weak radio signals and is just as viable today as it was in the 1920's. Virtually every RF communications device manufactured today uses this technique. Radio frequency signals present in the air (or ether as the English call it) are extremely weak. The superheterodyne method is the most practical technique available to allow amplification and conversion of these signals. These signals must be amplified to a sufficient energy level, and converted in frequency so that they may be successfully and reliably demodulated. Demodulation is the process of converting an RF signal back into the original sound or picture.

The following is a block diagram (a simple method of showing a complex electronic circuit in a "building block" form) of an actual FM broadcast receiver that will illustrate how the superheterodyne principal works:



This example FM broadcast receiver uses only a single local oscillator and is referred to as a single conversion receiver with high side injection. Single conversion means we only heterodyne or change the frequency once. High side injection means the local oscillator oscillates on a radio frequency that is higher than the intended received radio frequency. Injection is a term that refers to the process of injecting or inserting the radio frequency into the mixer stage so that a sum or difference frequency can occur.

The following is a description of just what each block in our example receiver does:

ANTENNA – A passive device that intercepts the low level energy present in the air, in this case at a frequency of 100.1 MHz (the FM station we desire to listen to).

RF AMP – An electronic circuit that amplifies the low level RF energy present in this example at 100.1 MHz (Frequency "A") to a higher level.

LOCAL OSC – An electronic circuit that generates or oscillates, in this example making energy at 110.8 MHz (Frequency "B") in the FM receiver.

MIXER – An electronic circuit that allows the two energy sources of frequency "A" (100.1 MHz) and frequency "B" (110.8 MHz) to be combined or mixed together to produce a difference frequency of "C" (10.7 MHz).

I.F. AMP – An electronic circuit (Intermediate Frequency Amplifier) that amplifies the energy present at frequency "C" (10.7 MHz) to a higher level.

DEMODULATOR – An electronic circuit that demodulates or separates out the modulation. In this case the audio information is present in FM format on frequency "C" (10.7 MHz) and the demodulator transforms it back to the original audio frequencies (20 Hz – 15 kHz) that were transmitted so that the human ear can hear them.

AUDIO AMP – An electronic circuit that amplifies the low level audio frequencies to a level sufficient to drive a loud speaker.

SPEAKER – An electromechanical device that converts electronic audio frequencies into sound vibrations that the human ear can hear.

Mathematically, we can express the superheterodyne principal for the above FM receiver as follows:

B-A = C or 110.8 MHz - 100.1 MHz = 10.7 MHz

Unfortunately, the superheterodyne technique produces another solution besides the one we have just shown. Exploring this second solution we find:

A-B = C or 100.1 MHz - 110.8 MHz = - 10.7 MHz

In this particular case this is a nonsense solution as the solution is a negative number.

If we continue this process by substituting another frequency for “A” such as 121.5 MHz and “B” remains at 110.8 MHz we get the following:

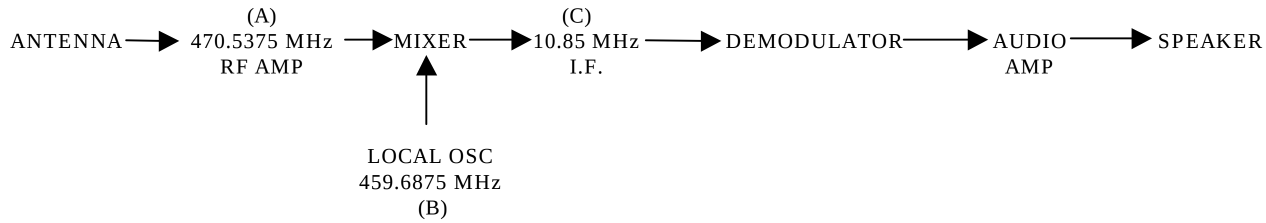
A-B = C or 121.5 MHz - 110.8 MHz = 10.7 MHz

This solution is one that could work, and in fact in the real world it will work under many conditions. This second solution is referred to as the “image frequency”. This is simply the frequency on the other side of the mixer conversion process that mathematically can be present. The receiver cannot tell the difference between these frequencies and will receive them both simultaneously. You will observe that mathematically this “image” occurs at two times the I.F. frequency (frequency “C”) higher than our desired receiver frequency “A”.

A + 2 C = Image Frequency or 100.1 MHz + 2(10.7 MHz) = 121.5 MHz

This image frequency presents a solution that we do not want for our FM broadcast receiver and requires special efforts in the design of the actual receiver to minimize this effect.

Now lets examine the block diagram of a typical single conversion scanner that is listening to 470.5375 MHz (LACO Fire Frequency in the Los Angeles area):



This receiver uses the same principal as the FM receiver we explored above except the local oscillator is now below the receiver frequency. This is called low side injection (the local oscillator is lower in frequency than the desired input frequency, Frequency "A"). Low or high side injection is a designers choice. Either method will work equally well, and the superheterodyne process remains the same.

A-B = C or 470.5375 MHz - 459.6875 MHz = 10.85 MHz

Now lets invoke the image frequency solution and see what we get:

A - 2C = image frequency

We have to subtract now since the local oscillator is on the low side of the frequency "A" we wish to receive.

470.5375 MHz - 2 (10.85 MHz) = 448.8375 MHz

Just as in our example with the FM broadcast receiver, we find that our scanner receiver when tuned to 470.5375 MHz now has an image frequency of 448.8375 MHz. This 448.8375 MHz frequency is in the ARS service band of 420 - 450 MHz. Remember we said above that in the real world this image frequency solution can and does work. We also said that this image frequency presents a solution that we do not want. Reducing or eliminating the receivers ability to hear signals on this image frequency requires special efforts in the design of the receiver.

Unfortunately the special efforts that are needed to minimize this effect require additional electronic components to be present in the receiver. These generally are in the form of filtering (method of electronically eliminating undesired frequencies) in the RF amplifier stage. This results in additional circuit complexity and most directly results in increased cost. Additionally, with a scanner, the receiver is usually designed to work over the range of at least 400 - 520 MHz. Such a wide range of frequencies requires a very special tracking filter circuit design in this RF amplifier stage. Tracking refers to the filter being electronically tuned to each channel as the "scanner" scans each chosen channel.

The important thing to realize with these single conversion scanner receivers is that they are consumer items and have been economically designed with a minimum of circuitry and components to reduce manufacturing complexity and cost. The end result is that for the most part, these scanners will receive equally well (same sensitivity) on both the intended frequency of operation (470.5375 MHz) and the image frequency (448.8375 MHz). The manufacturers are well aware of this effect, and if you will find and read the manual that came with your scanner, you will most likely find a discussion about the image frequency and how to use it to listen to out of band frequencies. Sometimes contained within this same discussion the manufacturer will mention that this image frequency can also present a problem to the user.

Now that we have discussed the superheterodyne process and the image frequency phenomena, we can now show you why you may have noticed a marked increase in the amount of ARS activity you hear, and why this increase started sometime after May 1, 1999.

The radio frequency spectrum (or frequency) utilization in Southern California is somewhat unique from other portions of the nation. First and most important there are no unused, useable frequencies or channels in Southern California. This is the most dense RF environment in the world! You have probably discovered this fact when traveling about the country with a scanner and comparing what you hear. Second, the 470 - 471 MHz band is used for communications services and not television in Southern California. This spectrum is actually TV channel 14 but is used by agreement in Southern California for land mobile applications such as public safety. In other parts of the country it is commonly used as a TV channel.

The Amateur radio community in Southern California utilizes the 440 - 450 MHz portion of the amateur band (420 - 450 MHz) for repeater operations much like the land mobile services in the 450 - 470 MHz range. Also, this is one of the parts of the county where these repeater stations output frequencies are between 445 - 450 MHz. This means the repeater or mountain top station or tower transmitter repeats or transmits in the 445 - 450 MHz range. The ARS community in Southern California selected this segment for repeater transmitters in the 1960's to minimize interference to and from the myriad of adjacent land mobile services. Southern California Amateurs were the first in the nation to heavily utilize this band for FM repeater service. This decision is as important and viable today as it was in the 1960's, here in the world's most complex RF environment.

The Amateur radio community in Southern California changed the scheme of how they deployed their frequencies or channels on May 1, 1999. It was decided to narrow up the channel spacing to allow for additional channels to accommodate more amateur stations. Before May 1, all amateur repeater stations in this band operated on 25 kHz channel spacing. After May 1, this spacing was reduced to 20 kHz.

The image frequency problems described above have always been present. They are most commonly found in the single conversion scanners or any dual or triple conversion scanner with a first IF frequency of 10.85, 10.7, or 10.8 MHz. You rarely noticed them before as these “images” of the Amateur service repeater transmitters fell on frequencies that were offset by 12.5 kHz from the 470 channels you have been monitoring. You would have needed to tune the scanner to a channel that is half way between the 25 kHz spaced channels that are currently in use on the 470 MHz band.

The 470 - 471 MHz band is currently on 25 kHz channel spacing (0.025 MHz) with the band starting with the first channel at 470.0125 MHz. An example of this spacing is:

470.5125 MHz + 0.025 MHz = 470.5375 MHz

An example of three adjacent channels:

470.5125 MHz 470.5375 MHz 470.5625 MHz

A 12.5 kHz (0.0125 MHz) “offset” channel would then occur at:

470.5125 MHz + 0.0125 MHz = 470.525 MHz
(which is halfway in-between 470.5125 & 470.5375 MHz)

Therefore the image frequency for 470.525 MHz with a 10.85 MHz I.F. is:

A - 2 C = image frequency
or
470.525 MHz - 2 (10.85 MHz) = 448.825 MHz

The previous Amateur service channel plan was on 25 kHz spacing starting at 445.000 MHz. An example:

448.800 MHz, 448.825 MHz, 448.850 MHz, 448.875 MHz

Before May 1, 1999 tuning your scanner to 470.525 MHz would cause you to hear the image channel of 448.825 MHz, as well as any traffic on the selected 470.525 MHz channel. There typically is no activity on 470.525 MHz, or similar “offset” channel.

The new Amateur service channel plan is now on 20 kHz channel spacing again starting with 445.000 MHz. An example:

448.800 MHz, 448.820 MHz, 448.840 MHz, 448.860 MHz, 448.880 MHz

Now, when the scanner is tuned to 470.5375 MHz its image frequency, as we calculated above, occurs at 448.8375 MHz.

448.840 MHz - 448.8375 MHz = 0.0025 MHz or 2.5 kHz

The 470.5375 MHz image frequency is now only 2.5 kHz away from the actual ARS frequency of 448.840 MHz. This is well within the "passband" of the scanner receiver and therefore you now hear the ARS activity that has always been present.

The difference to the 470 - 471 MHz scanner user is this shift in channel spacing has resulted in the image of some ARS channels falling within 2.5 or 7.5 kHz of the scanner frequency. Please see the "470 - 471 MHz Scanner Image Frequencies for 10.85, 10.7 and 10.8 MHz 1st IF" chart at the end of this article. This has now made the ARS signal, that has always been there, close enough to the scanner frequency so that it is demodulated along with the desired 470 - 471 MHz signal.

Now that we understand some of the how and why your scanner is hearing ARS activity along with the public safety activity in the 470 - 471 MHz band, what can we do about it? There are several things that can be done to eliminate or at least minimize the interference depending on how the scanner is used.

If you only use your scanner for the limited spectrum from 470 - 473 MHz you could install a band pass filter, cavity filter, or similar type filter to attenuate the unwanted 448.300 - 449.600 MHz spectrum from the input of the scanner. These types of filters are passive (they require no electric power) and function to electronically pass only the desired band of frequencies, (example 470.5375 MHz) and to reject all others (example 448.840 MHz). This is only a solution for those who have no desire to listen to any other spectrum with the scanner. The band pass filter technique will render all other bands such as 30 - 50, 118 - 136, 150 - 170, 406 - 470, and 800 - 940 MHz unusable. These types of filters may be purchased from mobile communications companies (the facilities that sell and repair 2-way radios for business and public safety use).

A more effective solution may be to purchase a new scanner that is triple conversion and has the first I.F. selected to place the image frequencies in portions of the spectrum that will not produce troublesome interference. Also, if you are a serious listener, the purchase of an actual receiver that scans (which is very much different from a "scanner") may be a very good selection for you to use in the complex radio frequency environment of Southern California. This is a receiver that is designed to be a receiver first, and to allow scanning as an additional function. Typically, these receivers have properly designed RF amplifier stages that employ some of the "tracking" filtering techniques discussed above. These receivers will also be of the triple conversion type thus placing image frequencies into spectrum of little interference. An example of such a receiver is an ICOM R8500. Please see Icom's web site at: www.icomamerica.com for further information.

Before spending money on a triple conversion scanner, ask to see the technical specifications on the scanner, and then make some calculations for the frequencies that you are interested in and make sure the image frequencies fall into areas of minimal concern. Generally, the better triple conversions scanners will convert to a much higher first I.F. frequency than 10 MHz. To eliminate the problem with 448 - 449 MHz images for 470 - 471 MHz you do not want a first I.F. anywhere near 10 MHz.

If the current scanner you have will allow operation up to at least 495 MHz, then you can try using the image frequency phenomena to your advantage. To do this tune (input a frequency or channel) the scanner to the frequency that causes the image frequency to fall on the desired channel. In the greater Los Angeles area TV channel 17 (488 - 494 MHz) is not used. A scanner tuned to a 492 MHz channel will hear the image frequency with little interference because there are no signals on the 492 MHz frequency. Due to the poor performance of most TV receivers the lower adjacent TV channel is not assigned. Los Angeles has TV channel 18 (494 - 500 MHz) so TV channel 17 is not used. An example of this is as follows:

You wish to listen to 470.5375 MHz but are bothered by the ARS activity that occurs near the image frequency of 448.8375 MHz.

This example assumes a first I.F. frequency of 10.85 MHz (one of the most common).

To find the correct frequency to use in the 488 - 494 MHz area, make the following calculation:

Desired channel to monitor + 2 (I.F.) = Actual channel to tune (488 - 494 MHz)
or
470.5375 MHz + 2 (10.85 MHz) = 492.2375 MHz.

If you now tune the scanner to 492.2375 MHz, you will be listening to this frequency (part of the spectrum that belongs to TV channel 17) and the image frequency of 470.5375 MHz. Because there is no activity on 492.2375 MHz, you will now hear the LACO Fire Dispatch and no amateur activity.

Please see the “470 - 471 MHz Scanner Channels as an Image Frequency for 10.85, 10.7, and 10.8 MHz 1st I.F.” chart at the end of this article. This chart depicts 470 - 471 MHz channels and the three most commonly used I.F.s and gives the appropriate TV channel 17 frequency to use.

At this point you should have a better understanding of the image frequency phenomena and scanners as they relate to the 470 - 471 MHz portion of the “T” band and the 445 - 450 MHz Amateur radio service band in Southern California. Southern California is probably the most complex radio frequency environment in the world where all useable frequencies and channels are in use. The image frequency phenomenon with your scanner receiver is an issue of physics and the design of the equipment. Please remember that if you were not in Southern California you probably would have never experienced this issue with your scanner.

For additional information about the very high frequency (VHF) and above Amateur Radio Service bands in Southern California see the following web sites:

Southern California Repeater and Remote Base Association (SCRRBA)
www.scrrba.org

Two Meter Area Spectrum Management Association (TASMA)
www.qsl.net/tasma

220MHz Spectrum Management Association (220SMA)
www.220sma.org

For information about Amateur Service VHF and above activity in other portions of the country see the following web site:

National Frequency Coordinators' Council, Inc. (NFCC)
www.arrl.org/nfcc

For additional information about the Amateur Radio Service in general see the following web site:

The National Association for Amateur Radio (ARRL)
(American Radio Relay League)
www.arrl.org

470 - 471 MHz Scanner Channels as an Image Frequency for 10.85, 10.7, and 10.8 MHz 1st I.F.

	470 MHz Channel MHz	10.85 MHz I.F. Frequency MHz	10.7 MHz I.F. Frequency MHz	10.80 MHz I.F. Frequency MHz
1.	470.0125	491.7125	491.4125	491.6125
2.	470.0375	491.7375	491.4375	491.6375
3.	470.0625	491.7625	491.4625	491.6625
4.	470.0875	491.7875	491.4875	491.6875
5.	470.1125	491.8125	491.5125	491.7125
6.	470.1375	491.8375	491.5375	491.7375
7.	470.1625	491.8625	491.5625	491.7625
8.	470.1875	491.8875	491.5875	491.7875
9.	470.2125	491.9125	491.6125	491.8125
10.	470.2375	491.9375	491.6375	491.8375
11.	470.2625	491.9625	491.6625	491.8625
12.	470.2875	491.9875	491.6875	491.8875
13.	470.3125	492.0125	491.7125	491.9125
14.	470.3375	492.0375	491.7375	491.9375
15.	470.3675	492.0675	491.7675	491.9675
16.	470.3875	492.0875	491.7875	491.9875
17.	470.4125	492.1125	491.8125	492.0125
18.	470.4375	492.1375	491.8375	492.0375
19.	470.4625	492.1625	491.8625	492.0625
20.	470.4875	492.1875	491.8875	492.0875
21.	470.5125	492.2125	491.9125	492.1125
22.	470.5375	492.2375	491.9375	492.1375
23.	470.5625	492.2625	491.9625	492.1625
24.	470.5875	492.2875	491.9875	492.1875
25.	470.6125	492.3125	492.0125	492.2125
26.	470.6375	492.3375	492.0375	492.2375
27.	470.6625	492.3625	492.0625	492.2625
28.	470.6875	492.3875	492.0875	492.2875
29.	470.7125	492.4125	492.1125	492.3125
30.	470.7375	492.4375	492.1375	492.3375
31.	470.7625	492.4625	492.1625	492.3625
32.	470.7875	492.4875	492.1875	492.3875
33.	470.8125	492.5125	492.2125	492.4125
34.	470.8375	492.5375	492.2375	492.4375
35.	470.8625	492.5625	492.2625	492.4625
36.	470.8875	492.5875	492.2875	492.4875
37.	470.9125	492.6125	492.3125	492.5125
38.	470.9375	492.6375	492.3375	492.5375
39.	470.9625	492.6625	492.3625	492.5625
40.	470.9875	492.6875	492.3875	492.5875

	471 MHz Channel MHz	10.85 MHz I.F. Frequency MHz	10.7 MHz I.F. Frequency MHz	10.80 MHz I.F. Frequency MHz
41.	471.0125	492.7125	492.4125	492.6125
42.	471.0375	492.7375	492.4375	492.6375
43.	471.0625	492.7625	492.4625	492.6625
44.	471.0875	492.7875	492.4875	492.6875
45.	471.1125	492.8125	492.5125	492.7125
46.	471.1375	492.8375	492.5375	492.7375
47.	471.1625	492.8625	492.5625	492.7625
48.	471.1875	492.8875	492.5875	492.7875
49.	471.2125	492.9125	492.6125	492.8125
50.	471.2375	492.9375	492.6375	492.8375
51.	471.2625	492.9625	492.6625	492.8625
52.	471.2875	492.9875	492.6875	492.8875
53.	471.3125	493.0125	492.7125	492.9125
54.	471.3375	493.0375	492.7375	492.9375
55.	471.3675	493.0675	492.7675	492.9675
56.	471.3875	493.0875	492.7875	492.9875
57.	471.4125	493.1125		493.0125
58.	471.4375	493.1375		493.0375
59.	471.4625	493.1625		493.0625
60.	471.4875	493.1875		493.0875
61.	471.5125	493.2125		493.1125
62.	471.5375	493.2375		493.1375
63.	471.5625	493.2625		493.1625
64.	471.5875	493.2875		493.1875
65.	471.6125	493.3125		
66.	471.6375	493.3375		
67.	471.6625	493.3625		
68.	471.6875	493.3875		

NOTES:
Frequency MHz = Frequency to set "Scanner" to for selected 1st I.F.

470-471 MHz Scanner Image Frequncies For 10.85, 10.7, and 10.8 MHz 1st I.F.

	470 MHz Channel MHz	10.85 MHz I.F. Image Frequency MHz	ARS Channel MHz	ARS Freq. Offset kHz	10.7 MHz I.F. Image Frequency MHz	ARS Channel MHz	ARS Freq. Offset kHz	10.80 MHz I.F. Image Frequency MHz	ARS Channel MHz	ARS Freq. Offset kHz
1.	470.0125	448.3125	448.320	7.5	448.6125	448.620	7.5	448.4125	448.420	7.5
2.	470.0375	448.3375	448.340	2.5	448.6375	448.640	2.5	448.4375	448.440	2.5
3.	470.0625	448.3625	448.360	-2.5	448.6625	448.660	-2.5	448.4625	448.460	-2.5
4.	470.0875	448.3875	448.380	-7.5	448.6875	448.680	-7.5	448.4875	448.480	-7.5
5.	470.1125	448.4125	448.420	7.5	448.7125	448.720	7.5	448.5125	448.520	7.5
6.	470.1375	448.4375	448.440	2.5	448.7375	448.740	2.5	448.5375	448.540	2.5
7.	470.1625	448.4625	448.460	-2.5	448.7625	448.760	-2.5	448.5625	448.560	-2.5
8.	470.1875	448.4875	448.480	-7.5	448.7875	448.780	-7.5	448.5875	448.580	-7.5
9.	470.2125	448.5125	448.520	7.5	448.8125	448.820	7.5	448.6125	448.620	7.5
10.	470.2375	448.5375	448.540	2.5	448.8375	448.840	2.5	448.6375	448.640	2.5
11.	470.2625	448.5625	448.560	-2.5	448.8625	448.860	-2.5	448.6625	448.660	-2.5
12.	470.2875	448.5875	448.580	-7.5	448.8875	448.880	-7.5	448.6875	448.680	-7.5
13.	470.3125	448.6125	448.620	7.5	448.9125	448.920	7.5	448.7125	448.720	7.5
14.	470.3375	448.6375	448.640	2.5	448.9375	448.940	2.5	448.7375	448.740	2.5
15.	470.3675	448.6675	448.660	-7.5	448.9675	448.960	-7.5	448.7675	448.760	-7.5
16.	470.3875	448.6875	448.680	-7.5	448.9875	448.980	-7.5	448.7875	448.780	-7.5
17.	470.4125	448.7125	448.720	7.5	449.0125	449.020	7.5	448.8125	448.820	7.5
18.	470.4375	448.7375	448.740	2.5	449.0375	449.040	2.5	448.8375	448.840	2.5
19.	470.4625	448.7625	448.760	-2.5	449.0625	449.060	-2.5	448.8625	448.860	-2.5
20.	470.4875	448.7875	448.780	-7.5	449.0875	449.080	-7.5	448.8875	448.880	-7.5
21.	470.5125	448.8125	448.820	7.5	449.1125	449.120	7.5	448.9125	448.920	7.5
22.	470.5375	448.8375	448.840	2.5	449.1375	449.140	2.5	448.9375	448.940	2.5
23.	470.5625	448.8625	448.860	-2.5	449.1625	449.160	-2.5	448.9625	448.960	-2.5
24.	470.5875	448.8875	448.880	-7.5	449.1875	449.180	-7.5	448.9875	448.980	-7.5
25.	470.6125	448.9125	448.920	7.5	449.2125	449.220	7.5	449.0125	449.020	7.5
26.	470.6375	448.9375	448.940	2.5	449.2375	449.240	2.5	449.0375	449.040	2.5
27.	470.6625	448.9625	448.960	-2.5	449.2625	449.260	-2.5	449.0625	449.060	-2.5
28.	470.6875	448.9875	448.980	-7.5	449.2875	449.280	-7.5	449.0875	449.080	-7.5
29.	470.7125	449.0125	449.020	7.5	449.3125	449.320	7.5	449.1125	449.120	7.5
30.	470.7375	449.0375	449.040	2.5	449.3375	449.340	2.5	449.1375	449.140	2.5
31.	470.7625	449.0625	449.060	-2.5	449.3625	449.360	-2.5	449.1625	449.160	-2.5
32.	470.7875	449.0875	449.080	-7.5	449.3875	449.380	-7.5	449.1875	449.180	-7.5
33.	470.8125	449.1125	449.120	7.5	449.4125	449.420	7.5	449.2125	449.220	7.5
34.	470.8375	449.1375	449.140	2.5	449.4375	449.440	2.5	449.2375	449.240	2.5
35.	470.8625	449.1625	449.160	-2.5	449.4625	449.460	-2.5	449.2625	449.260	-2.5
36.	470.8875	449.1875	449.180	-7.5	449.4875	449.480	-7.5	449.2875	449.280	-7.5
37.	470.9125	449.2125	449.220	7.5	449.5125	449.520	7.5	449.3125	449.320	7.5
38.	470.9375	449.2375	449.240	2.5	449.5375	449.540	2.5	449.3375	449.340	2.5
39.	470.9625	449.2625	449.260	-2.5	449.5625	449.560	-2.5	449.3625	449.360	-2.5
40.	470.9875	449.2875	449.280	-7.5	449.5875	449.580	-7.5	449.3875	449.380	-7.5

NOTES:
I.F. Image Frequency = Frequency of image for selected 1st Intermediate Frequency of Scanner
ARS Channel = Closest Amateur Radio Service channel to selected image frequency
ARS Freq. Offset = Offset in kHz of ARS Channel from selected image frequency

470-471 MHz Scanner Image Frequncies For
10.85, 10.7, and 10.8 MHz 1st I.F.

	471 MHz Channel MHz	10.85 MHz I.F. Image Frequency MHz	ARS Channel MHz	ARS Freq. Offset kHz	10.7 MHz I.F. Image Frequency MHz	ARS Channel MHz	ARS Freq. Offset kHz	10.80 MHz I.F. Image Frequency MHz	ARS Channel MHz	ARS Freq. Offset kHz
41.	471.0125	449.3125	449.320	7.5	449.6125	449.620	7.5	449.4125	449.420	7.5
42.	471.0375	449.3375	449.340	2.5	449.6375	449.640	2.5	449.4375	449.440	2.5
43.	471.0625	449.3625	449.360	-2.5	449.6625	449.660	-2.5	449.4625	449.460	-2.5
44.	471.0875	449.3875	449.380	-7.5	449.6875	449.680	-7.5	449.4875	449.480	-7.5
45.	471.1125	449.4125	449.420	7.5	449.7125	449.720	7.5	449.5125	449.520	7.5
46.	471.1375	449.4375	449.440	2.5	449.7375	449.740	2.5	449.5375	449.540	2.5
47.	471.1625	449.4625	449.460	-2.5	449.7625	449.760	-2.5	449.5625	449.560	-2.5
48.	471.1875	449.4875	449.480	-7.5	449.7875	449.780	-7.5	449.5875	449.580	-7.5
49.	471.2125	449.5125	449.520	7.5	449.8125	449.820	7.5	449.6125	449.620	7.5
50.	471.2375	449.5375	449.540	2.5	449.8375	449.840	2.5	449.6375	449.640	2.5
51.	471.2625	449.5625	449.560	-2.5	449.8625	449.860	-2.5	449.6625	449.660	-2.5
52.	471.2875	449.5875	449.580	-7.5	449.8875	449.880	-7.5	449.6875	449.680	-7.5
53.	471.3125	449.6125	449.620	7.5	449.9125	449.920	7.5	449.7125	449.720	7.5
54.	471.3375	449.6375	449.640	2.5	449.9375	449.940	2.5	449.7375	449.740	2.5
55.	471.3675	449.6675	449.660	-7.5	449.9675	449.960	-7.5	449.7675	449.760	-7.5
56.	471.3875	449.6875	449.680	-7.5	449.9875	449.980	-7.5	449.7875	449.780	-7.5
57.	471.4125	449.7125	449.720	7.5				449.8125	449.820	7.5
58.	471.4375	449.7375	449.740	2.5				449.8375	449.840	2.5
59.	471.4625	449.7625	449.760	-2.5				449.8625	449.860	-2.5
60.	471.4875	449.7875	449.780	-7.5				449.8875	449.880	-7.5
61.	471.5125	449.8125	449.820	7.5				449.9125	449.920	7.5
62.	471.5375	449.8375	449.840	2.5				449.9375	449.940	2.5
63.	471.5625	449.8625	449.860	-2.5				449.9625	449.960	-2.5
64.	471.5875	449.8875	449.880	-7.5				449.9875	449.980	-7.5
65.	471.6125	449.9125	449.920	7.5						
66.	471.6375	449.9375	449.940	2.5						
67.	471.6625	449.9625	449.960	-2.5						
68.	471.6875	449.9875	449.980	-7.5						

NOTES:
I.F. Image Frequency = Frequency of image for selected 1st Intermediate Frequency of Scanner
ARS Channel = Closest Amateur Radio Service channel to selected image frequency
ARS Freq. Offset = Offset in kHz of ARS Channel from selected image frequency