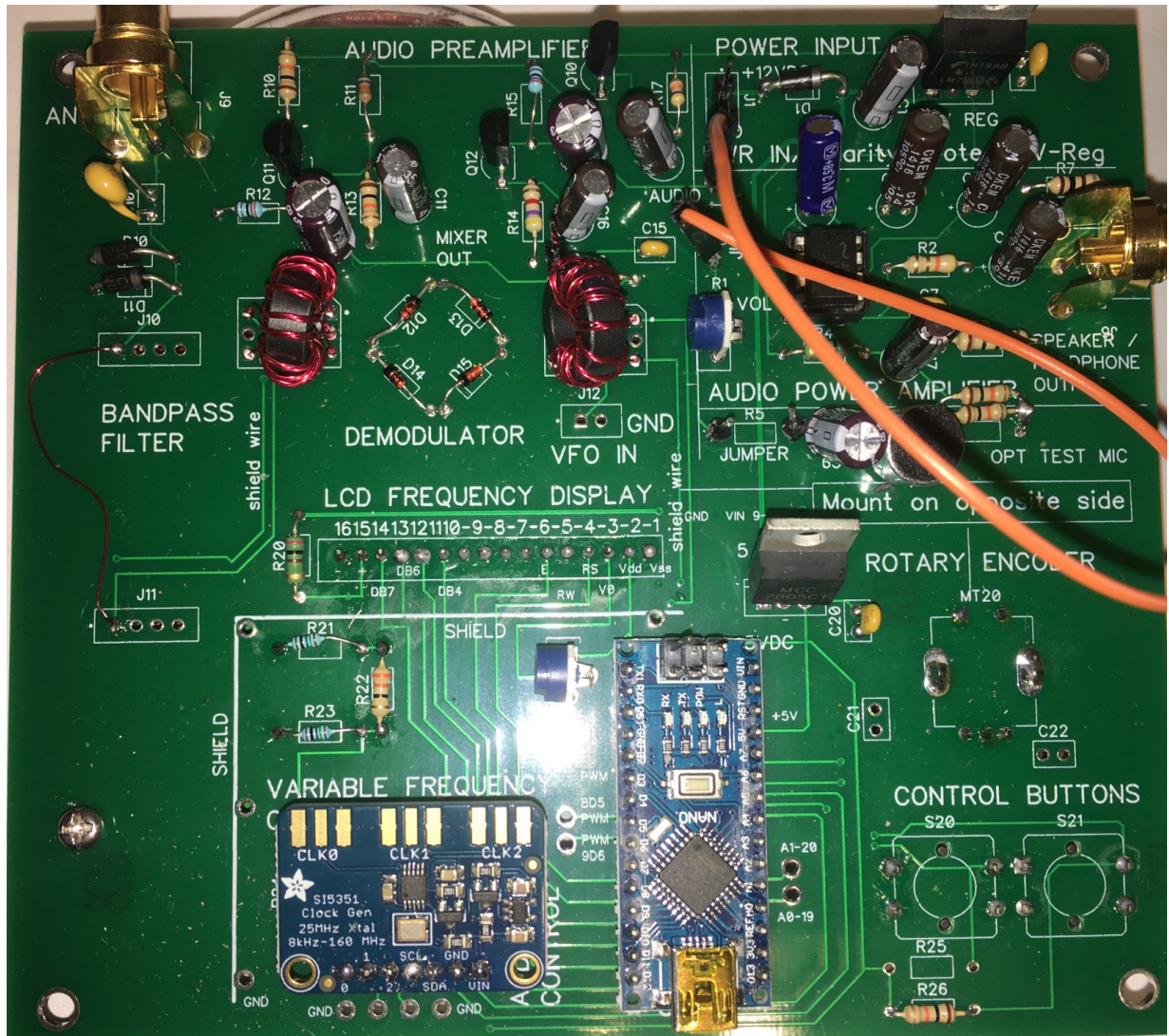


SHORTWAVE RADIO RECEIVER

Direct Conversion Hybrid Analog/Digital



This capable shortwave radio will allow you to investigate the hidden world of high frequency (3-30 MHz) shortwave radio – where governments and individuals are constantly transmitting voice and data information 24 hours a day, over distances from short to trans-oceanic. All you need is to connect up a **shortwave antenna** and if possible, a **ground connection**, to get to hear these shortwave signals.

SHORT WAVE RADIO FREQUENCIES AND STATIONS

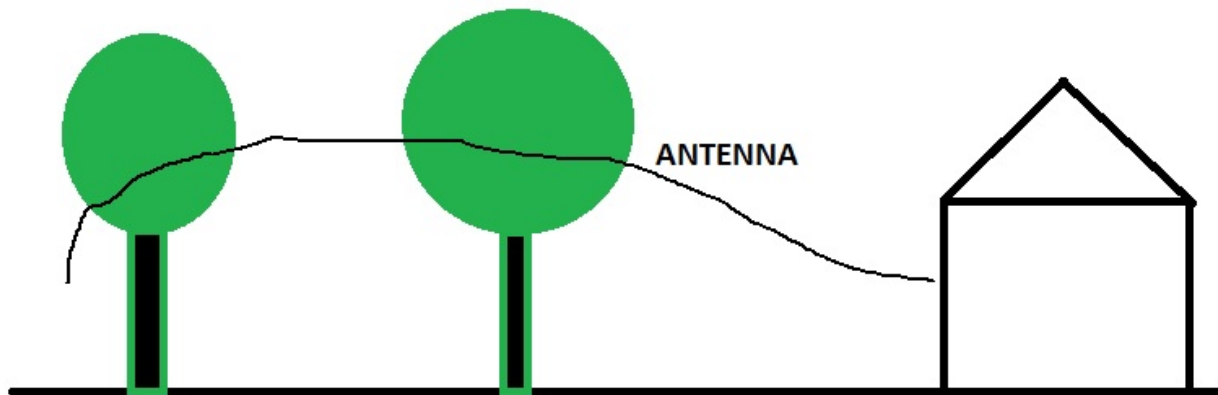
Part I

Useful background information: <https://radiofidelity.com/best-shortwave-radio-stations-sw-radio-stations/>

TIME OF DAY	BEST FREQUENCIES
Sunrise to 9AM	3MHz through 14 MHz
9AM - 4 PM	7MHz through 21 MHz & beyond
4PM - 8 PM	5MHz through 14 MHz
8PM to Sunrise	3 MHz through 8 MHz

FREQUENCY	ACTIVITY
3.5- 4.0 MHz -- (3.574: 3.940 3.950	Amateur Radio digital FT8 -- requires a computer to read) Voice: Florida early ham volunteer net at 7AM most days Voice: Florida ham volunteer net at 9AM Most days
Just above 4MHz:	Mystery RTTY station
5.000 MHz	WWV USA Time/Frequency Station (best heard at night)
5.085	"We transmit world wide" broadcast shortwave station
5.84 MHz	World Music Radio
5.9-6.2	Shortwave broadcast band
7-7.3 MHz 7.074:	Amateur Radio digital FT8 -- requires a computer to read
7.2-7.45	International short wave broadcast (overlaps amateur stations)
9.265 MHz	World International Broadcasting
9.4 MHz	Voice of America Saturday 16:00-16:30
9.4 - 9.9 MHz	Most heavily used broadcast short wave band
10.000 MHz	WWV USA Time/Frequency Station
11.6-12.1	International broadcast shortwave band
13.565	Spy numbers at UTC 9:10-9:15 (There are MANY spy number broadcasting stations)
14-14.350 14.074	Amateur radio digital FT8 -- requires a computer to read
Long distance band.	
15.000 MHz	WWV USA Time/Frequency Station

ANTENNA



Because this is a receiver and not a transmitter, the antenna requirements are much simpler. The simplest antenna is to stretch 30-100 feet of wire AWAY FROM POWER LINES between outdoor trees or other supporting structures, and slip the wire underneath a window to the radio a few feet from the window.

WARNING

DO NOT PLACE YOUR ANTENNA ANYWHERE NEAR TO POWER LINES – IF THE POWER LINE WERE TO FALL OR YOUR RADIO ANTENNA TO COME LOSE, THERE MUST BE NO POSSIBILITY OF THE TWO TOUCHING.

The antenna connector of your radio is the venerable RCA phono-plug jack. You can connect your antenna to the center wire of an audio RCA phono cable to connect to this jack. Twisting bare wires from the two together will work, and you can insulate the connection with a bit of tape. If you're able to solder or crimp the wires together, so much the better!

LENGTH: Your antenna will do a bit better with some length, up to about 120 feet. Shorter than 20 feet won't pull in as many stations. You can connect together shorter wires by twisting, soldering, or crimping together the bare wires to make longer wires.

GET IT UP HIGHER!

Multiple techniques can be used to get your antenna up 12-25 feet above the ground through tree limbs. Using a baseball, bow-and-arrow, slingshot have all proven effective. Be careful that you do not HIT SOMETHING when you throw something through a tree! The wire can lay against branches or brush without any ill effects. IN GENERAL you never want your wire to be the “highest thing around” for a long distance. When other trees or objects are TALLER than your wire, you greatly reduce the small chance that lightning would ever hit your antenna. So aim for branches that aren't at the tip top of the tree!

Nevertheless, it is a good idea when you aren't using the antenna, to simply *drop it back outside your window*. A small bit of non-conductive plastic fishing line tied to it makes it easy to retrieve it, and having it outside your house during stormy days adds a sense of relief to parents. Later on, you'll learn how to put a LIGHTNING ARRESTER circuit on the outside connection of your wire, before you bring it into your house. While there are many commercial devices for this, you can make your own for only a few dollars and learn in the process!

GROUND

If possible, you should connect the shield(ground) wire of your jack or phono cable to a “ground wire” connection. The easiest way to do this is to use the **center screw of an electrical outlet** (NOT one of the powererred jacks). An alternate is to connect it to a copper water pipe, typically the cold water pipe. However, so many water systems interpose insulating PVC plastic pipes that this isn't as good an option as it was many years ago. The most advanced option is to literally place a ground rod into the ground, but this isn't necessary in general, and requires knowledge of where buried pipes are to avoid hitting them. (Talk with your parents before pounding ANYTHING into the ground!)



FREQUENCIES Part II

All of the world's governments put their stations all over the frequency map. There are "general" agreements between governments where to place powerful High Frequency Broadcast stations. You can find dozens of these. In general, frequencies above 10 MHz will work better during the daylight hours, and frequencies below 10 MHz will work better during nighttime, but DUSK and DAWN are "magic times" when you may hear very far away stations along the "gray line" circling the world. All of this is because of the way God ordered the IONOSPHERE that covers the earth and largely protects us from very high energy cosmic particles....and also acts like a reflector for high frequency radio waves. This was first discovered in the early part of the 1900's by radio amateurs.

Radio Amateurs are licensed by most of the nations of the world (except for very authoritarian governments such as North Korea) and make innocent transmissions on voice and data techniques at all hours of the day and night on certain frequency bands. The frequency chart below comes from the American Radio Relay League, a national organization devoted to the amateur radio hobby, which allows Americans to gain skills and fun in the radio hobby. Another page will give you more information about the vast world of shortwave frequencies.

LIMITATIONS

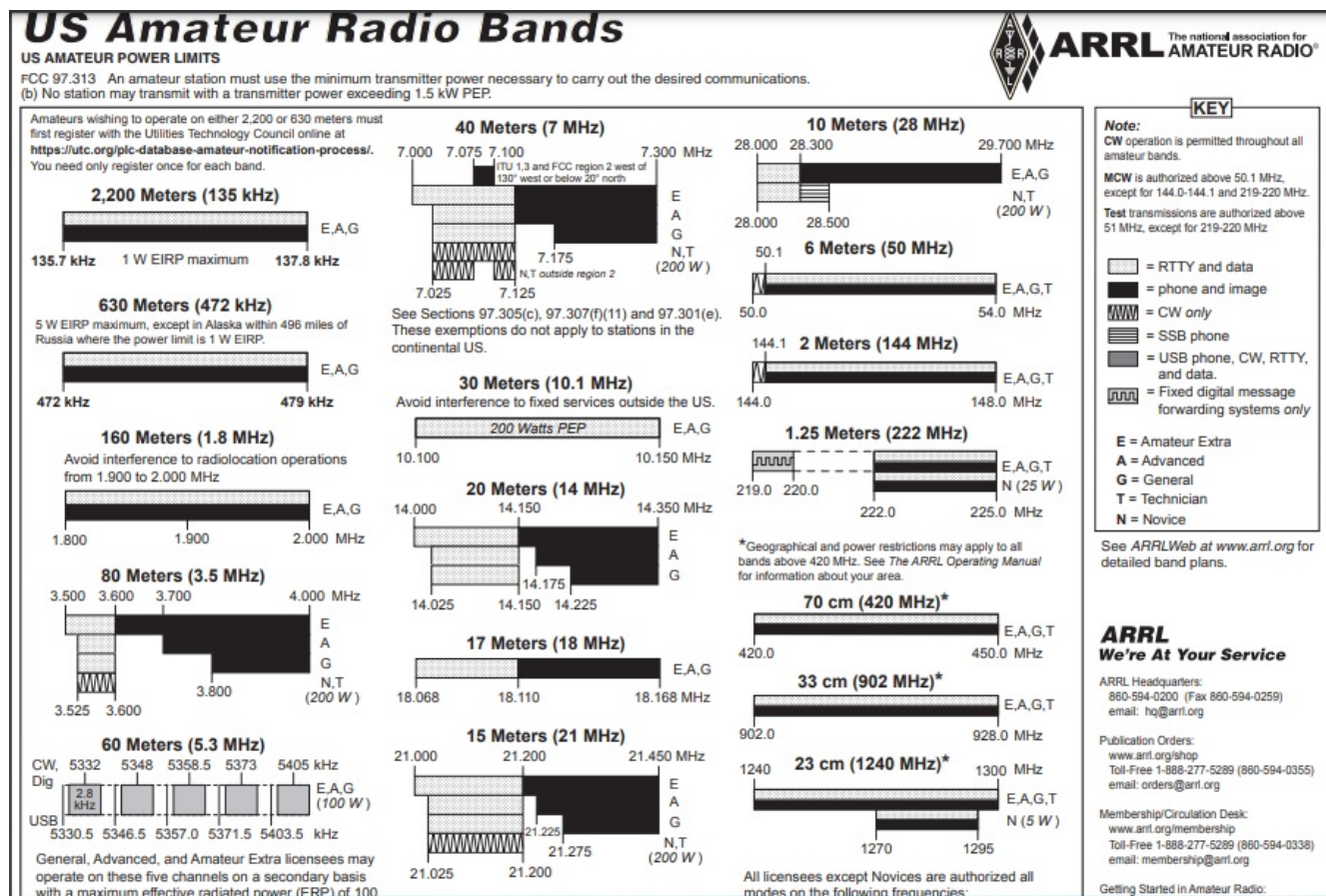
Your radio is a VERY simple radio and doesn't have advanced filtering. Strong nearby stations can overwhelm the radio and block out reception of other stations. It is so sensitive, and so un-filtered, that at night with a good antenna, you may find short-wave broadcast stations that can overwhelm half a megahertz or so of space! These limitations can be improved, and as you learn more, you may find out how to do that.

IF YOU ARE NEAR TO AN AM BROADCAST STATION -- then you're going to hear them loud and clear EVERYWHERE. You will need a simple RF filter circuit between your antenna and your radio to avoid your simple radio from being "overloaded" by a nearby AM radio station. Those can be made easily.

POSSIBILITIES

This little radio receiver can do amazing things, and its frequency accuracy is excellent -- far beyond what most short-wave radios display. It can very adequately receive amplitude modulation (AM), morse code (CW), and single sideband voice transmissions (SSB). With a bit more equipment or a simple connection to the microphone input of a personal computer and free software, you can decode a large number of "data" transmissions -- most of which were developed in the last 20 years and are an exciting new sphere of radio telecommunications. Its digital frequency generation system (the Si5351 chip) has two additional variable frequency oscillators that aren't even yet used! As you grow in your understanding of radio and electronics, you may find many useful ways to take advantage of those available signals, and ways to utilize this receiver as a "module" in a more complicated project. But for now, it will give you an education in very simple but very important concepts like connections, frequencies, signals.

The big advantage of your radio is its accurate DIGITAL frequency display – which will allow you to accurately tune in any desired frequency.



You can find the original of this chart here:
<http://www.arrl.org/graphical-frequency-allocations>
 in either color or black and white.

You can find more information about the fascinating hobby of amateur radio here:
[http://www.arrl.org/what-is-ham-radio#:~:text=Amateur Radio \(ham radio\) is,lifeline during times of need.](http://www.arrl.org/what-is-ham-radio#:~:text=Amateur Radio (ham radio) is,lifeline during times of need.) (Google “amateur radio introduction” to find this easily)

Our local Amateur Radio Emergency Services group has an introduction to amateur radio available here:

<https://qsl.net/nf4rc/LearnAboutAmateurRadio.html>

Links to Construction Documents
https://qsl.net/nf4rc/2021/DirectConversionReceiverOverview.pdf
https://qsl.net/nf4rc/2021/SolderingPart1.pdf
https://qsl.net/nf4rc/2021/SolderingPart2.pdf
https://qsl.net/nf4rc/2021/SolderingPart3.pdf
https://qsl.net/nf4rc/2021/SolderingPart4.pdf
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