Coastal and Offshore Communications Guide

CRUISING CLUB of AMERICA

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Table of Contents

Introduction

The Cruising Club of America (CCA) published the "Offshore Communications Memorandum" in March 2004. It is stating the obvious that there have been tremendous advances in communications in the last two decades. This "Coastal and Offshore Communications Guide" replaces the 2004 memorandum.

This guide reflects the rise of satellite communications and mobile phones . It recommends them along with VHF as the primary means of maritime communications. Robust, reliable, affordable satellite communications are now well within the budget of cruisers. Mobile phone terrestrial coverage now provides coverage in most coastal regions. Already some mobile phones can communicate using text messaging to satellites. We expect that within a few years there will be essentially global cell phone coverage via satellites for voice, data, and video. We expect both of these areas to continue to explode with new capabilities.

The guide shifts HF single sideband communications from an essential means of long haul communications to an optional means of communications. This reflects the global shift of marine communications to satellite based systems.

We tried not to repeat information that changes regularly and is readily available online. We point readers to that information if it's source is not obvious. We provided information where we added value to what is online. We leave it to the reader to download online information that you judge to be appropriate to have onboard for your maritime adventures.

Sections of the guide were written by different authors. We did not spend much time editing the sections for style so readers will note the differences in writing style between the sections.

Our approach in writing this guide is to get the information out quickly and make the guide publicly available online. Then update the guide regularly based on feedback from mariners. We welcome your feedback. Please email feedback to the chair of the CCA's marine communications subcommittee, Mark Lenci at: marklenci@gmail.com.

Thank you for your interest! We encourage you to send us your feedback on this guide.

VHF Communications

An Introduction to VHF radio

VHF Radio operates in the Very High Frequency marine band (156-162 MHZ). The VHF radio works on a line-of-sight basis, meaning that their FM signals do not follow the curvature of the earth, so antenna height is critical. Basically, the higher your antenna (and the higher the receiving antenna), the farther you can talk. (*Typically 20 miles between sailboats with masthead antennas.*) The USCG and other Coast Guard services have tall antennas that can extend communication range out to 50 Miles.

It is recommended that a boat carry a fixed VHF radio and a handheld. Both types of radios should have GPS and DSC calling. If a sailboat, a remote microphone and/or speaker for the fixed system in the cockpit is very strongly recommended.

This chapter is not intended to replace the user manual or cover in detail what is contained therein, but rather to highlight important elements of its functionality and use.

Reasons for carrying a VHF Radio

- Distress Calling (Mayday-Mayday), either by voice on channel 16 or automatically using DSC (the red button)
- Urgency Calling (PanPan-PanPan), either by voice on channel 16 or by DSC 'All Ships Call'
- Safety Calling (Securite-Securite), either by voice on channel 16 or by DSC 'All Ships Call'
- Receive DSC distress alerts with locations for display on a chart plotter
- Receive AIS distress alerts with locations for display on a chart plotter (for a VHF with AIS receiver only)
- Receive NOAA weather forecasts and alerts
- Monitor other vessel activities on channel 16.
    - Use dual watch when appropriate, for example: when navigating a channel where bridge traffic is on another designated frequency. (16/13)
- Communicating with bridge tenders, commercial vessels, other vessels and shore stations
- Digital Selective Calling to make and receive individual and group VHF calls
- Access to the USCG Rescue 21 system covering the entire U.S. coast with integrated VHF communications, DSC monitoring and direction-finding capability
- Receive and display AIS targets for display on a chart plotter (for a VHF with AIS receiver only)
- Activate Fog Signals using the USCG MRASS system
- Use the loud hailer feature to sound preprogrammed signals (I.e fog of at anchor signals, depends on VHF model)

Licensing and Obtaining an MMSI number

The FCC decided in 1996 that "voluntary users" of VHF and radar need no longer obtain a radio license. Voluntary users are defined as being boats less than 20 meters in length that do not carry

people for hire and do not broadcast outside of U.S. waters. If you meet those criteria, you can operate a VHF, radar and EPIRB without a license. But if you have additional equipment such as a SSB HF radio or a satellite terminal, or if you sail out of the U.S. (Canada, Bermuda, Bahamas, Caribbean, Mexico and Central America for example), you will need to apply to the FCC for a Ship Station License and a lifetime, no test, Restricted Radiotelephone Operator's Permit (see FCC Form 605). Similar rules apply in Canada for Canadian citizens. See section 7 of this guide on regulatory matters.

It is extremely important to obtain a Maritime Mobile Service Identity (MMSI) which is a nine-digit number required for Digital Selective Calling (DSC) and AIS to uniquely identify a ship or a coast radio station.

If you will be in foreign waters (Canada, Bermuda, etc.), FCC regulations require that you obtain your station license, operator license and MMSI from the FCC. Foreign SAR data bases only contain the MMSI obtained from the FCC, and while they will still come to your aid, they will not have your vessel and contact information. *Therefore we recommend that any US based CCA member, near shore cruisers, and offshore cruisers obtain an MMSI through the FCC.*

Mariners who are not required to carry a marine radio--recreational boaters-- who remain in U.S. waters can obtain an MMSI through organizations such as BOATUS, Sea Tow, or the U.S. Power Squadrons. In the U.S. VHF handhelds should use the MMSI assigned to the ship to which the device is primarily associated, even if another radio on that ship uses the same MMSI. Canadian rules differ and a MMSI-like 9-digit MI (Maritime Identity) number will be assigned to devices separate from the vessel.

VHF Radio Communications

All vessels should monitor channel 16 and additionally channel 9 (for shore stations such as marinas) or channel 13 (for vessel traffic systems and other controlled waterways).

See Appendix A, **Radio Crib Sheet** covers standard types of communication.

(It is a good sheet to laminate and keep near the radio.)

Digital Selective calling

"The U.S. Coast Guard offers VHF and MF/HF radiotelephone service to mariners as part of the Global Maritime Distress and Safety System. This service, called digital selective calling (DSC), allows mariners to instantly send an automatically formatted distress alert to the Coast Guard or other rescue authority anywhere in the world. Digital selective calling also allows mariners to initiate or receive distress, urgency, safety and routine radiotelephone calls to or from any similarly equipped vessel or shore station, without requiring either party to be near a radio loudspeaker. DSC acts like the dial and bell of a telephone, allowing you to "direct dial" and

"ring" other radios, or allow others to "ring" you, without having to listen to a speaker. New VHF and HF radiotelephones have DSC capability.", Navcen, USCG.

The areas of coverage for the USCG Rescue 21 system can be found at: https://www.navcen.uscg.gov/rescue-21-distress-system-coverage

This system is designed to be able to receive a call on channel 16 at least 20 NM offshore from a radio 2 meters above the surface transmitting at 1 watt. Therefore the typical cruising sailboat transmitting at 25 watts from a 50 foot masthead antenna should expect coverage well beyond 20 NM offshore. (see Appendix B Antenna characteristics and USCG sample radio range chart for the Southeastern New England Sector).

Digital Selective Calling can be used in the following ways:

- Calling an individual boat by entering its unique MMSI number; or a group of boats using a preprogrammed list or a group MMSI. Each boat will get the DSC call alarm and their radio will be switched to the designated response channel entered by the caller.
- Calling a boat displayed as an AIS target on your chart plotter or radio.
- Conducting a radio check using DSC.

Refer to your user's manual and follow some useful DSC links listed below.

VHF and SSB DSC Calling:

https://cruisingclub.org/article/vhf-and-ssb-dsc-calling

Group DSC Primer for Fleets and Safety: Group Calls on your VHF and SSB

https://cruisingclub.org/communications/dsc-groups

DSC Radio Check: Fast, Easy, and Automatic

https://cruisingclub.org/article/dsc-radio-check-fast-easy-and-automatic

Emergency Distress Calls to CG Rescue 21 and all Vessels in Range

To make a distress call using DSC, lift the red tab on your radio and press the RED Distress button for 3-5 seconds (Check your radio manual). A distress call will be broadcast on channel 70 to all ships and USCG shore stations within listening range. This distress call will be repeated every 4 minutes until acknowledged. Upon acknowledgement, the radio will immediately switch to channel 16 to receive radio communications.

If no acknowledgement it would be appropriate to issue a voice MAYDAY call on channel 16, this will not interfere with the DSC distress call.

All current radios have the ability to select a "Nature Of" distress that can be selected before hitting the Red Distress Button. That tells the CG or other boats what the "nature of" your distress is. This allows the CG to be more prepared knowing what the "nature of" the distress is that they are being called to help with.

The following “natures of” distress can be selected from:

Undesignated
Fire Explosion
Flooding
Collision
Grounding
Capsizing
Sinking
Adrift
Abandoning
Piracy
Man Overboard

Interestingly there is no facility for a medical emergency provided in the ITU standard for DSC.

Antenna and cable Selection.

Most sailboats opt for a masthead mounted 3 foot 3db gain stainless steel whip. Motor boats, to compensate for the lower antenna height, may opt for an 8 foot 6db gain fiberglass whip antenna.

Antenna cable considerations depend on the length of the cable run. See your user’s installation manual for recommendations. *It is important to keep all radio connections clean and dry, especially those exposed to weather and moisture.*

Integrating with AIS

Some VHF radios have a built-in AIS receiver that uses your existing VHF antenna so you can identify other AIS equipped vessels (however they will still not be able to see you). Others have both AIS transmit and receive. When an AIS receive-only VHF is installed along with a separate transmitting AIS unit the decision is between two antennas or a single antenna with a splitter. VHF radios that are both transmit and receive similarly offer the option of using a single antenna with a splitter or two separate antennas, one for VHF radio and one for AIS. Because antenna height is critical and minimum antenna separation required, a single masthead antenna with a digital signal splitter in the circuit or in the AIS transceiver may be the best choice, especially for sailboats.

See: *AIS Overview and Installation Considerations, by Frank Cassidy, at https://cruisingclub.org/article/ais-overview-and-installation-considerations*

Integrating your VHF and chartplotter with personal AIS MOB beacons

Current navigation systems and VHF radios allow for integrating transmissions from personal AIS MOB beacons with your radio and your chart plotter. Personal AIS MOB beacons come in several configurations using AIS, DSC and 406 MHz EPIRB technology in different combinations. AIS-only beacons are preprogrammed with a unique MMSI always beginning

with 972 and need no further programming. Units containing a DSC transmitter use that same 972 MMSI number but must be programmed with the vessel's MMSI number to allow direct DSC messages to your vessel. AIS MOB beacons can issue an "all ships" DCS call depending on the country regulations on DSC "all ships" calls. See your users manual.

Appendix C shows the various communication links of an personal AIS Man Overboard Beacon (MOB).

See the following links for information on how to use and set up a personal AIS MOB beacon with combined DSC and AIS transmitters:

https://youtu.be/7KbKdsQr5Po?si=z_-oONBRJl-WwQwZ

https://youtu.be/QWXEpyyauM0?si=1v4LaFD-VqRwKiUs

EPIRBs with AIS distress alert

EPIRB's with both 406 MHz satellite signal and AIS distress alerts are now available. These devices are highly recommended because they will alert both the shore-based rescue services via satellite and other vessels in VHF range via AIS of a vessel's emergency.

Weather radio

NOAA Weather Radio is an "all hazards" radio network, working in conjunction with the Federal Communication Commission's Emergency Alert System. In addition to weather related watches and warnings, the Weather Radio system can provide information on all types of hazards, including Civil and National Emergency Messages. See Appendix D for channels and frequencies.

MARINER RADIO-ACTIVATED SOUNDS SIGNALS (MRASS)

The US Coast Guard has converted many of the nation's fog signals from traditional sensor-activated sound signals to manually activated using a VHF radio. It is indicated on the Chart and in the Light List.

To activate the foghorn in reduced visibility, mariners must turn their VHF radio to Channel 83-A, and key their microphone five times in a ten-second period. They must be within half a nautical mile of the foghorn, or it will not start the horn. Once activated, the foghorn will blast for 45 minutes to an hour. In the Northeast, 82 fog signals are now radio activated. Note that in certain areas, channel 81-A is used and the length of time that the fog signal is operational varies from 45-80 minutes.

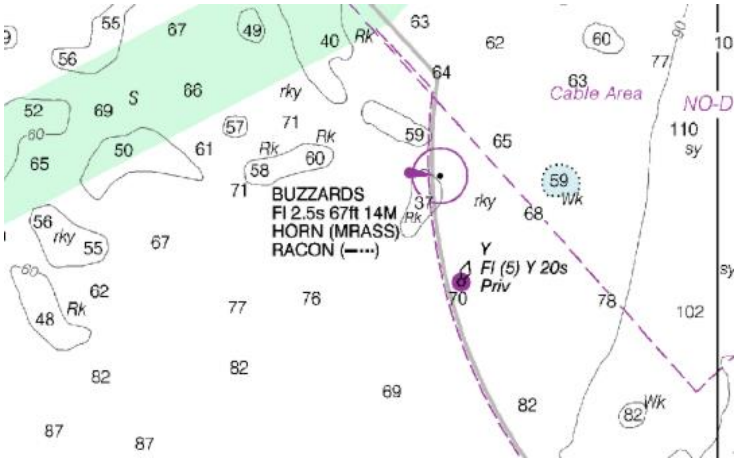


Chart showing MRASS for Buzzards Bay Entrance Buoy

Light List information:

630 15985	**Buzzards Bay Entrance Light**	41-23-49.152N 071-02-04.877W	Fl W 2.5s	67	14	Tower on red square on 3 red piles with large tube in center, worded BUZZARDS on sides. 68	RACON: B (- . . .) HORN: 2 blasts ev 30s (2s bl-2s si-2s bl-24s si). Fog signal is radio activated, during times of reduced visibility, turn marine VHF-FM radio to channel 83A/157.175Mhz. Key microphone 5 times consecutively, to activate fog signal for 45 minutes.

US VHF radio channels

The following is a summary of US radio channels

- **Channel 16:** For hailing, safety and emergency use only
- **Channel 9:** Pleasure-boat hailing channel
- **Channels 68, 69, 71, 72 and 78A:** Recreational working channels
- **Channels 1, 7A, 8, 10, 11, 18A, 19A, 63, 77, 79A, 80A and 88A:** Commercial channels (Pleasure boaters are supposed to stay off them.)
- **Channel 13:** For requesting bridge openings, although in some areas it's channel 09 or 67, check local guides
- **Channels 24, 25, 26, 27, 28, 84, 85, 86 and 87:** Used by marine operators.
- **Channel 22A:** Coast Guard working channel, the one where safety broadcasts are made after they alert you on channel 16 and ask you to switch over
- **Channel 6:** For Inter-ship safety communications
- **Channels 1, 5, 12, 14, 20, 63, 65A, 66A, 73, 74 and 77:** For port operations (Many of these are used by recreational boats in areas where no port operations exist.)
- **Channel 70:** A dedicated Digital Selective Calling (DSC) channel. DSC is an automated distress system that allows us to make digital phone calls through our VHFs. Is your VHF set up properly?

- **Channel 81A and 83A:** Mariner activated sound signals (MRASS) to activate a sound signal (e.g., fog Horn) turn to 81A or 83A, depending on the location, and key your mike 5 times. This will activate the fog signal for typically 45 minutes
- **Weather channels:** 1-10

The use of the letter "A" with a channel name for US channels is being phased out. New 4 digit numbers will replace channels with an "A". Commercial vessels will switch by the end of 2028. Recreational vessels may start switching now. VHF radios with the new channels are not yet available for sale in the USA because the FCC has not yet approved the changes proposed by the radio manufacturers. A complete list of radio channels including **new** channel number assignments is contained in Appendix 4.

Canadian and international waters:

Important when using your radio in Canadian Waters the radio must be switched to Canadian frequencies, likewise for international waters. Refer to your user's manual.

For an informative article on VHF Channel Changes refer to

https://cruisingclub.org/article/vhf-channel-changes

HF

A note on terminology:

Recreational mariners generally use marine single sideband (SSB) radios. Marine SSB radios operate in the High Frequency (HF) spectrum. Thus recreational mariners generally use the term "SSB" rather than HF. This chapter will also use the term SSB for recreational marine HF communications.

The rise of satellite communications:

The coverage and capabilities of satellite communications has increased dramatically and the per megabyte cost of data has dropped precipitously. Handheld, rented, and fixed systems are well within the price range of recreational boaters.

Boaters, governmental agencies, race organizers and others have shifted to satellite communications as the primary means for offshore emergency and routine communications. Compared to the 2004 CCA Offshore Communications guide, this guide also shifts focus to satellite communications and de-emphasizes SSB. The recommended offshore communications suite has satellite communications as a "must" and SSB as "optional".

Comparison of Satellite and SSB

SSB has one unique advantage over satellite communications for a specific group of sailors. SSB offers the ability to set up nets for shared, simultaneous communication between many vessels. There are many active nets around the world meeting on a daily basis passing on news and information of interest to cruisers.

Satellite systems offer a completely different experience with voice, data, and video communications with all the reach that the internet brings.

Both systems have atmospheric limitations. SSB is limited by HF propagation whereas satellite communications can be degraded or stopped by heavy rain.

SSB can pass limited data such as weather facsimiles, GRIB's, NAVTEX, email, etc.when an SSB is coupled with additional devices. Satellite communications can deliver much richer weather information and any other kind of information available world wide on the internet. Thus SSB has been replaced by satellite communications for most purposes.

In recognition of the primacy of satellite communications, detailed information on the use of SSB for data has been removed or greatly reduced in this guide.

USCG Distress Watchkeeping Schedule

The USCG no longer uses 2182 kHz as a distress frequency. The USCG has also discontinued voice monitoring of all distress frequencies except in Alaska and Guam. The USCG monitors DSC calling on the distress frequencies.

See Appendix E for the USCG HF distress and contact frequencies.

HF ranges

An approximation on Tx/Rx range by frequency band depending greatly upon conditions is:

Freq Band		Day	Night
2 MHz		100	300
4		300	800
6		400	1000
8		500	1200
12		2000	800
16		4000	Unreliable
22		Worldwide	Unreliable

Literature on setting up an SSB on a recreational vessel is readily available.

The long ranges of HF transmissions are due to bouncing the signals off the ionosphere. There are copious quantities of information available on the extensive topic of HF propagation so there is no further discussion of it in this guide.

A note for HAM operators:

Marine SSB radios "out of the box" can monitor but not transmit on HAM HF bands. Marine SSB radios can usually be enabled for HAM operators with at least a General class license to transmit on HAM HF bands.

Feedback from HAM operators who operate from boats overwhelming favor using radio equipment designed for HAM's rather than Marine SSB radios. A HAM radio can meet the relatively simple needs for operating on the marine SSB bands whereas Marine SSB radios lack many key features that HAM operators use.

HAM SSB's do not have the emergency DSC calling feature of a marine SSB, but this feature is almost never used.

Satellite Communications

To say communications via satellite is developing rapidly would be an understatement. This paper provides a snapshot at this point in time and mentions new capabilities that we foresee in the near future.

Background

A basic understanding of satellite connections is needed to help understand and choose between the many options that are available to mariners.

Once a link is established with a satellite, depending on the capacity of the link, it can be configured to deliver various capabilities. The most basic capability is voice, for example a satellite phone. As the capacity of the satellite link increases, internet data service can be provided by modem over what is essentially a phone line. This is sometimes referred to as "dial up internet". When capacity increases further, the entire link can become a single internet segment. This is "broadband internet" (wide bandwidth data over a high-speed internet connection). With broadband service one or more phone lines can be provided using VoIP (Voice over IP) along with the internet capability.

Technology Considerations

This paper attempts to strike a balance between ease of reading and deep dives into technology. In order to understand the pro's and con's of the many options available to mariners, a review of key elements of satellite communications technologies is necessary.

<u>"Dial-up" versus Broadband</u>

The connection to a satellite is a radio frequency (RF) link. Basic devices such as handheld satellite phones establish an analog connection in a narrow frequency range over the RF link. This is sufficient for the relatively low amount of information needed for a voice connection. While voice is the primary capability of a satellite phone, most handheld satellite phones also have a data modem or can be connected to an external modem. The modem converts digital data such as an email, grib, etc. to a format suitable for transmission over an analog RF link. This enables a satellite phone to serve a low data rate connection for another device such as a laptop to send and receive digital data. This relatively low throughput analog link is often referred to as a "dial-up" connection. This term harkens from the early days of the internet when a user could use a plain old telephone line to "dial-up" an analog connection to an internet service provider. A handheld satellite phone does a similar thing over a RF link.

The term broadband is used in a variety of ways. For our purposes, broadband is the wide-bandwidth transmission that transports multiple signals in a wide range of frequencies and internet traffic types. This enables different types of data to be sent simultaneously and is used in fast internet connections.

The takeaways for mariners are:

- Dial-up devices such as phones can be small, hand held devices. Their primary capability is voice communications. Their secondary capability is low data rate, basic digital data such as text only email, GRIBs, etc.when connected to digital devices such as a laptop. They are typically a single, easily portable unit.
- Broadband systems provide a true “internet” experience similar to your experience ashore. They can provide WiFi throughout the boat. Some broadband providers also provide phone service (an actual phone number for the boat). Other providers rely on the WiFi calling feature of cell phones. The equipment and data plans are at least an order of magnitude greater than a dial-up device (Note: the “per megabyte” cost of data may be far less than a dial-up device, but the available data plans are almost always far more expensive since they provide much more total data.)

Antenna types

Imagine you would like to shine a light on a small object at night like a buoy that is 100 yards away. You could illuminate it with a spotlight pointed directly at it, or you could rely on the light coming from your masthead light. The spotlight with a narrow beam focused on the buoy would illuminate it far more brightly and further away than the masthead light that is dimmer and radiates in all directions (omnidirectional). We can use this analogy to understand the pro’s and con’s of various types of antennas.

Handheld devices typically have an omnidirectional antenna attached to the device or the ability to have a small, external antenna like a GPS or SiriusXM antenna. This is sufficient for analog voice and low throughput data; plus it works well on a moving platform like a boat. Most broadband systems achieve greater throughput by using a directional antenna so that all the RF energy is focused in a tight beam. A shore-based system, such as a microwave relay tower or a satellite TV system can have a “fixed” antenna because the satellite or other receiving antenna does not move in relation to the antenna. Higher throughput broadband systems aboard boats require an antenna that moves so it can track the satellite - a “tracking” antenna. Obviously a tracking antenna is larger, much more complex, and much more expensive than an omnidirectional antenna.

Note that tracking a satellite does not mean that the antenna must physically move. A dish antenna does have to move to track the satellite as the boat moves. However a flat phased array antenna array can electronically steer the beams to track one or more satellites. The antenna does not have to physically move (although it works best when 90 degrees to the satellite). These antennas were initially used in military applications but the cost has come way down. Commercial airliners use phased array antennas to provide TV and internet. Starlink uses them for their service.

The takeaway for mariner is:

- To increase the throughput of a satellite system beyond 2.5kbps for GEO satellites, or beyond 200kbps for LEO satellites, you eventually move from an omnidirectional antenna to a tracking antenna. (see section on satellite orbits)

Frequency and antenna size

The higher the frequency, the more data that can be carried by the link. (explaining why is beyond our scope in this document). The lowest frequencies used for typical satellite systems are in the UHF "L" band (1 - 2 GHz). For example, the Iridium satellites and some Inmarsat satellites use the L band, often with small antennas on a handheld device.

Iridium Certus falls just above dial-up satellite phones below wide bandwidth broadband systems. It is a L-band, IP (internet protocol and thus digital), and with a omnidirectional antenna for Certus 100 and Certus 200. Certus 100 provides 40x the data rate of a handheld phone or Go!, but about half the data rate of a broadband system.

Broadband systems require SHF C band (4 - 8 GHz), SHF Ku band (12 - 18 GHz) or Ka band (18 - 40 GHz). Broadband equipment at the user station is referred to as "Very Small Aperture Terminal" (VSAT). Higher frequencies require dish shaped receiving antennas that generally range from as small as 14 inches to 9 feet in diameter. Starlink maritime service uses a 22 in square, flat, phased array antenna. The latest generation is using Ka band to provide "High Throughput Satellites" (HTS) with spot beams (instead of wide area beams) for downlink from the satellites to provide more bandwidth in the coverage area.

In a rainstorm, a 8 X 10 pan will collect twice the water than will a 5 X 8 pan. Similarly the larger the area of a dish antenna, the more total energy it will receive from the satellite downlink, and the more directional its uplink will be. This is why a larger dish antenna has a larger earth "footprint" in which it can function successfully compared to a smaller antenna receiving the same downlink. For a phased array antenna, the larger antenna additionally allows better "beam forming" so it can steer the beams through a wider upward look angle.

The takeaways for mariners are:

- The lowest throughput will be from a small, omnidirectional, L band antenna. This works well for analog (voice) dial-up systems and has the least expensive equipment by a wide margin.
- The highest throughput will be from a large, tracking Ka band antenna. Factors that increase throughput are tracking (versus omnidirectional), higher frequency, and larger physical size (normally expressed in diameter of the dish) of a dish antenna. Phased array antenna performance also improves with size.
- Lower frequencies are more robust in penetrating rain and light obstructions like trees than higher frequencies.

Satellite orbit

One parameter used to characterize satellite orbits is the altitude above the earth. Satellites in Geosynchronous orbits appear to remain at a constant longitude although they may move north and south. Geosynchronous orbits are 22,236 miles above the earth. Medium Earth Orbits (MEO) are the region below the geosynchronous orbits and above 1,243 miles. Low Earth Orbits (LEO) are the region below MEO.

For the purposes of up and downlinks for maritime user communications, we are interested in satellites in LEO and geosynchronous orbits. Iridium uses LEO satellites. INMARSAT uses geosynchronous satellites. KVH and others use Intelsat's geosynchronous satellites. Starlink uses thousands of LEO satellites.

LEO satellites complete at least 11 orbits per day. This means they require a constellation of satellites to provide continuous coverage. For example, the name for the Iridium system which are LEO satellites came from the number 77 (the atomic number of Iridium). It was originally calculated that 77 LEO satellites would be required to provide coverage for handheld satphones operating in the L Band. (Actually fewer have been needed). Iridium satellites use orbits that pass over the poles. The Iridium system provides the only truly 100% global coverage including the poles. As of January 2024, Starlink has over 5,000 LEO satellites with plans to reach 12,000.

LEO satellites provide high bandwidth, low latency up/down links because they are at a low altitude. The low latency and high throughput can be illustrated by the fact that in the time it takes data to go to and from a GEO satellite one time, the same amount of data could go 70 times to and from a LEO satellite.

Geosynchronous satellites are used in several ways. The earliest communications satellites used global beams. This arrangements allowed 4 satellites to cover most of the globe. The tradeoff for the wide area covered by a single beam is low throughput. Global beams are still used today primarily for low throughput applications such as satellite phones.

The newer geosynchronous satellites are equipped with many spot beams. The spot beams, as mentioned previously, provide significantly more data rates in the coverage area compared to global beams.

Geosynchronous satellites cannot use the lower frequencies in L band. The lower frequency simply cannot reach the higher altitude with sufficient power with practical dish sizes

The takeaways for mariners are:

- Products/systems using LEO satellites (e.g. Iridium, GlobalStar, Starlink) offer lower latency and better weather/obstruction resilience. Iridium offers the only true global coverage (poles). They can have high throughput depending on the design.
- Products/systems using geosynchronous satellites can cover most of the earth's surface with global beams. Global beams have low data rates. Newer satellites have multiple spot

beams that have high data rates. Spot beam coverage varies depending on the provider and generally does not cover less traveled areas.

Phone capability:

Phone capability takes two forms. (1) The form most people are familiar with is a telephone type of device that has a standard 10 digit phone number that can be reached from any standard phone in the world. Most standard features we are accustomed to can be added such as voice mail, call forwarding, etc. Dialup systems that are primarily phones and most broadband services provide this type of phone service. The provider has the equipment and agreements to connect to the world's phone system to provide standard phone service. (2) The second form is WiFi calling. This approach is used most notably by Starlink. Starlink provides internet service, just like your internet service provider (ISP) at home. Starlink does not provide a phone number/phone service. You use your own phone's service. You can use Starlink's internet service with your mobile phone if your device and plan have WiFi calling.

There are some significant differences in how phone service actually works that maritime users should be aware of. First, if you have a service that provide a phone number, the least expensive plan uses a ISD "country code" like +8816. Depending on your plan, the cost for calling these numbers can be $30 - $50 ***per minute***. This cost is the cost charged to the person calling to the satellite phone by their phone plan . Most providers have an option that will reduce the per minute rate for calling a 8816 type number but the caller needs to be aware and activate that option. There are additional charges incurred for data usage by the phone owner/renter. Therefore most users would see these plans as emergency use only.

Callers to a satellite phone number with a standard country code (e.g. +1 for the USA) normally incur same cost as they would for any other standard number according to their plan.

We are just beginning to understand the practical aspects of WiFi calling over broadband satellite internet as boaters gain more experience with Starlink. You can see how your phone does with WiFi calling by turning off your cellular connection (go to airplane mode) and then turning WiFi back on and turning on WiFi calling.

We are seeing some challenges with using WiFi calling on Starlink. First, your phone has to have the WiFi calling feature. Second, your phone service plan has to provide WiFi calling service. Finally the various agreements between phone providers and government regulations for your phone service plan with your home country phone number have to all work for WiFi calling.

This is a fast moving area as Starlink and phone providers are working to make agreements. So a boater relying on WiFi calling needs to thoroughly research how WiFi calling will work with their phone service provider. As an example, at the time of this writing we have reports that in Canada WiFi calling from satellite internet can only connect to phone numbers from other Canadian phone service providers.

Comparison of Satellite Communications Capabilities

After this admittedly lengthy technological discussion, we can most easily sort through the options by considering the various use cases for satellite systems.

1. **The minimum offshore communication for safety:**
    a. A satellite phone will provide the minimum offshore communication capability for routine and emergency voice communications.
    b. Satellite phones can be rented economically for cruisers that only occasionally venture offshore or for specific events such as a delivery.
    c. Some devices and data plans offer text messaging.
    d. You should be able to program an "address book" or similar feature with important phone numbers such as rescue coordination centers so that you can rapidly dial them.
    e. A feature that differentiates models and data plans is if a phone plan is offered and how the phone number for the phone is handled. The least expensive plans use a ISD "country code" like +8816 followed by a nine digit number. Users should be aware that calling one of these numbers with a normal phone plan is unbelievably expensive ($30/min). If you anticipate incoming calls, you should pay the additional fee for a normal phone number (which use an Arizona area code unless you pay an additional fee for a custom number).
    f. Most units have or can be connected to a modem for a VERY limited data capability. This is suitable for text only email and better if the email is filtered (e.g. stripped of attachments) and compressed by a service provider. Limited weather information such as GRIB's and text forecasts can also be obtained. Web browsing is essentially not possible except websites specifically designed for low bandwidth users.
    g. Handheld units have the added advantage of being able to be used ashore, e.g. while exploring in remote areas.
    h. Some units have GPS built in. If they have GPS, some units may also have a "SOS" feature.
    i. Some units are offered as a "black box". These require another device to interface with them for operation. This is normally a cellular phone app or a laptop. Sailors with this type of unit should ensure that more than one person has access to the cellular phone or laptop that controls the satphone.
    j. Most units have the optional ability to connect to an external antenna. This is important when the unit is below decks.
2. **Offshore Communication with limited web browsing and few users:**
    a. The Iridium Certus and broadband systems by other vendors with tracking antennas using a "per MB" or lower end data plan provide this capability.
    b. These systems provide voice and data. Again it is important to pay attention to how the data plan handles the phone number(s). See item 1.d. above.
    c. These systems normally have a WiFi router built in or are connected to one.
    d. The better systems provide a sophisticated user interface that allows the operator control access to the satellite internet. The low end data plans generally have very

steep fees for exceeding the monthly data limit. Typically video streaming, large file transfers, etc. are blocked. It is advisable to block social media.

e. Day to day use web browsing typically consumes 70% or more of the total data usage. This is because websites download a tremendous amount of content such as advertising, animated advertising, and code that have nothing to do with why the user is on the website. Therefore web browsing should be limited to website specifically designed for low bandwidth or strictly limited to minimize the use of bandwidth.
f. It is easier to manage the data usage on these systems if there are only one or two users. It is important to configure users' devices to not automatically use data in the background, e.g. daily operating system updates, automatic updates to applications, notifications, etc.
g. Some boats set up firewall "whitelists" that only allow data communications to selected servers e.g. Saildocs, Predictwind, Squid, Expedition, race information pages, and selected email servers. These whitelists will block efforts by other programs on a PC to "phone home" and update.

3. Offshore communications with "at home" internet experience:

a. Broadband systems with tracking antennas using higher end data plans can provide an experience identical to the internet experience you have at home.
b. These systems provide an internet connection, normally via WiFi, and may provide one or more phone lines using VoIP (Voice over IP).
c. The higher end data plans have the lowest cost per MB of any satellite system and are the only way to afford this type of internet experience. The better high end data plans are set up to reduce data speed rather than charge overage fees if the plan's monthly limit is exceeded.
d. These systems are well suited for rich, graphical weather data; operating a business while cruising; conducting regular household financial transactions, researching parts or cruising destinations, etc.
e. These systems have higher power requirements which are a consideration for recreational sailboats.
f. However, even these systems cannot at this time affordably deliver unlimited web browsing, video streaming, and other things that use a lot of data (e.g. heavy social media use). The precautions for controlling access, limiting web browsing, and configuring users' devices discussed in section 2 still apply when using systems with these robust capabilities.
g. Again it is important to pay attention to how the data plan handles the phone number(s). See item 1.d. above.

Comparison of Satellite Communications Products

Prices for the equipment and data plans as well as types of data plans are very dynamic. This table was prepared in 2024. It should be considered a snapshot. Readers contemplating a satellite system should check for current information, particularly on data plans.

Many of the systems listed below have a wide variety of data plans. The data plans represent typical plans for an offshore cruising sailboat. Additionally there are many vendors providing

similar services so this list is not intended to be complete. The unit costs are based on all components required for the unit to be functional. There may be additional costs to provide power, connections to boat systems, mounting the antenna, etc. The table simply shows the relative capabilities and costs of representative systems.

system	unit cost	speed & typical data cost	antenna	notes
IridiumGo	$1,700 (with external antenna) Also available as a rental.	$315/month - 2.5 kbps, 125 minutes voice & 125 MB data, min one year. Does not include low bandwidth services that are likely needed or a US phone number.	External optional fixed antenna required, L-Band	several significant hidden costs: external antenna, low bandwidth email and data services, US phone number, etc.
Iridium Certus 100 (Blue Sky Network - Skylink 6100), Iridium Go! exec.	$3,100 Also available as a rental	$210/month - 88 kbps up/down, 80 MB, outbound voice $0.80/min, inbound free, 2 phone lines,	External fixed, L-Band LEO	truly global Iridium coverage, not restricted to low bandwidth applications.
Iridium C700 Certus (Intellian)	$5,500	$700/month - 352 kbps uplink, 704 kbps downlink, 100MB, 3 phone lines, $0.60/min voice	External, fixed, L-Band LEO	truly global Iridium coverage, not restricted to low bandwidth applications.
FleetOne Inmarsat (Intellian)	$3,500	$249/month - 50 MB, 150 kbps, 100 min voice, $0.60/min voice	tracking dish, L-Band, geostationary	not as fast and generally more expensive than Certus systems,
KVH V30 TracPhone	$10,000	200 MB - $164/month; 1 GB - $500/month; 1000 kbps, - and unlimited data at a lower speed after 200 MB. 6 mbps down / 2 mbps up. Outbound voice $0.59/min, inbound free	tracking dish, Ku band, geostationary	Highest equipment cost, lower per MB cost, faster speed. Higher power consumption. “like at home” experience.
Starlink	-$2,500 –	Mobile Priority plan -	22 inch	No phone plans.

maritime	with the flat high performance antenna.	50 GB @ $250/mo; 1 TB @ $1,000/mo.	square flat array. Ku & Ka band	Lower per MB cost, fastest speed. Higher power consumption. “like at home” experience.

Notes:

- **IMPORTANT:** Be sure to check that the area coverage for the system you are using will match your planned voyages. Only Iridium provides truly global service.
- **Caution:** Broadband rate plans are highly competitive so pricing is changing regularly. Costs in this table is a snapshot in time.
- Most data systems have an activation fee and a minimum contract length varying from 3 months to a year (except monthly rentals).
- A satellite phone number e.g. (+8816 ISD “country code”) is *extremely* expensive for inbound callers so a US number is valuable.
- None of these services are practical (affordable for a typical recreational user) for streaming video (Netflix) as you would do at home.
- All data plans have a fee and restrictions for deactivation & reactivation (e.g. winter storage).

Other satellite services for mariners

Text messaging via satellite is available now using the iPhone 14 and 15. This capability is developing quickly. See the section of this guide on “Capabilities coming in the near future.”

A number of low bandwidth services, free or paid, are available. These services are important, and arguably essential, for the low bandwidth systems such as IridiumGo. For example email services will strip out attachments, pictures, etc. to reduce data usage. They can also filter mail, send only headers, etc. There are many options. Other services include low bandwidth weather and general data compression. There are numerous sources for these services.

Another category of service is SiriusXM marine weather. This service uses a small fixed external antenna with a receiver for the navigation system. Graphical weather overlays and data are presented on the navigation system’s chart plotter. The weather data is prepared in a dedicated weather service center and is a fusion of multiple weather information sources. This service provides near real time information and forecasts (wind, waves, etc.) over the US and Canada out to at least 200 NM. An added benefit is the full range of SiriusXM audio channels.

Specialized Satellite Communication

For our purposes specialized satellite communications include satellite messenger devices/services, personal locator beacons (PLB), and various forms of EPIRB’s (Emergency Position Indicating Radio Beacon). These devices are used primarily for emergency

communications in our marine context. They are now being offered in combination with line of sight functions. The following table lists characteristics of both satellite and line of sight devices for comparison.

	Use	Rescue coordination	satellite	Line of sight	Note
text messaging from mobile phones	person	none	X		available with iPhone 14 & 15, more on the way.
Satellite messenger	person	private	X		2-way communications at sea or ashore (Garmin inReach, ACR Bivy Stick, etc.)
PLB	person	government	X		at sea or ashore
ELT	aircraft		X		
EPIRB	marine		X		
EPRIB w/AIS	marine	government & on scene	X	X	AIS to vessels & satellite to rescue service
NextGen EPIRB w/ AIS	marine	government & on scene	X	X	AIS to vessels & satellite to rescue service with return link
AIS MOB Beacon	marine	on scene		X	
AIS MOB w/ DSC				X	Loud alarm on VHF radio
AIS MOB & PLB	marine & person	On scene & government	X	X	AIS to vessels & satellite to rescue service w/return link
Satellite phone and broadband systems	All	government	X		Phone call to rescue center

Capabilities coming in the near future

StarLink is working with phone providers (e.g. T-Mobile) to develop direct cell phone to satellite calling. This is likely a few years off but when it becomes available, it could effectively offer near global cell phone coverage for voice and data. Additionally Starlinks coverage both in its service footprint and total throughput is continuing to increase.

Amazon's Project Kuiper is an upcoming LEO system of great interest. It will use approximately 3,000 satellites connected by laser data transmission to form a global mesh. Prototype satellites have been launched and are working successfully. Amazon has not yet announced when this system will be available for use. It has characteristics similar to StarLink and is designed to make video streaming affordable.

Concluding remarks

There are a dizzying array of satellite capabilities and options. New capabilities are coming online that were unthinkable for recreational users only a few years ago. The field will continue to develop rapidly. The best advice we can offer is:

- Spend time up front prioritizing the capabilities you want from satellite communications.
    - Do you need only low data weather information and voice?
    - Will you need to conduct personal business online such as banking? This takes a more robust connection to handle the extra security. Remember if a site requires two factor authentication you may not be able to get that via text. It will need to come via email.
    - Will you do web browsing beyond lower bandwidth marine websites? You will find sites such as news and Amazon push an enormous amount of data to ads and such. This will quickly consume data so you may want to be able to get an affordable higher data limit plan.
- Understand your expected pattern of operations.
    - For example if you have robust internet ashore or via cell phone once a week you may be able to do fine with more limited capability at sea.
    - Other satellite services such as SiriusXM maritime weather could inexpensively augment your communications suite.
    - On the other hand, if you run a home office off your boat in remote areas, you may need a higher capability system.
- Talk to other sailors about their experience with satellite systems. How well do their systems do what you are looking for? What are the real initial and ongoing costs? How much do they use the phone? What do they do online? How well does it work?
- Shop for data plans. This is an extremely competitive market.

Mobile Phones

Mobile phones in the maritime world

This is a new chapter in the guide. The capabilities of mobile phones and other mobile devices is exploding. Technological advances for the devices, ever improving connectivity, and global demand is driving this hot market.

Most people are very familiar with email, text, and web browsing on mobile phones. Mobile phones can deliver the rich experience of information available on the internet. New maritime applications for mobile phones appear daily.

We decided to add this chapter because connectivity for mobile devices has greatly improved, making the use of mobile phones on a regular basis viable worldwide for coastal cruising. Already the newer iPhone models have text messaging via satellite. Plans are underway to provide what will essentially be a universally available global cell phone network via satellite with Starlink. This will make cell phones useful for offshore cruising.

Many governments have programs to bring the internet to rural and remote areas. This was accelerated by COVID. The improved mobile phone connectivity is noticeable for mariners.

Mobile phone experience & tips reported by sailors:

- Sailors along the two US coasts report mobile phone connectivity between 5 to 10 NM from shore, and sometimes greater.
- The biggest single factor in mobile phone range offshore seems to be the height of antenna onboard the vessel. Boats with a mobile phone antenna on the masthead get the best range.
- There are many mobile phone boosters that have varying degrees of success in boosting the mobile phone signal. You can't beat the laws of physics, so these devices are the most effective with larger antennas mounted as high as possible on the boat. Booster for use ashore often use directional antennas aimed at the nearest cell phone tower. Boats use omnidirectional antennas that are not as effective as directional antennas. Sailors have reported robust mobile phone connectivity out to 40 NM from shore using a masthead antenna and a booster.
- We have reports from sailors in many regions regarding mobile phone coverage. A few are:
    - Central America & the Caribbean – generally very good coverage.
    - Canada has an aggressive program to get the internet to all citizens. During the 2022 CCA cruise in Newfoundland, sailors had good connectivity all along the shore – even on the sparsely or uninhabited south coast.
    - Sailors have reported good connectivity along the coast of South America with some exceptions.
- Consider using local SIM cards. Often connectivity is best using a local SIM card. These are readily available in most countries. For example, one CCA member reports that rural

areas of Central America and Columbia they could be purchased at grocery stores. They are easy to use, particularly with newer iPhones that can have dual SIM cards.

This is a fast developing area so sailors would be well advised to talk to other sailors about their experience in the various geographies, the devices they use, the applications they have found useful, phone plans they use, etc.

Distress and emergency calling:

United States: Support for vessels in distress and emergencies is coordinated by two Rescue Coordination Centers (RCC). They coordinate a national network of regional centers. Detailed information is available on the USCG website. The phone numbers for the two RCC's are:

- Atlantic: +1 757 398 6700 (Norfolk, VA)
- Pacific: +1 510 437 3701 (Alameda, CA)

Canada: The Canadian Coast Guard jointly staffs three Rescue Coordination Centres (JRCCs) with the Canadian Forces. The JRCCs are located at Victoria, British Columbia, Trenton, Ontario, and Halifax, Nova Scotia. Detailed information on all Canadian rescue centers and resources are available on the "Maritime Search and Rescue (SAR) in Canada" webpage. The phone numbers are:

- Atlantic: +1 902 427 8200 (Halifax, NS)
- Central: +1 613 965 3870 (Trenton, ON)
- Pacific: +1 250 413 8933 (Victoria, BC)

Weather

Introduction

Rich and vast amounts of weather information are available online and through various broadcasts. The use of graphics and video improves daily making weather easier to understand. We won't try to describe all the content that is available. You can do that at home. Rather our focus is how to get this information while underway.

While this guide covers receiving weather data via communications systems, it should be noted that some data such as tides and currents are available on navigation systems as overlays and graphs depending on the manufacturer of the system. This data requires no source of external communication.

Weather via VHF (voice)

The NOAA Weather Radio network of the National Weather Service continuously broadcasts local and nearshore coastal marine forecasts produced by local Weather Forecast Offices. Coastal stations broadcast predicted tides and real time observations from buoys and coastal meteorological stations operated by the National Data Buoy Center. Based on user demand, where feasible, NWS also broadcasts Offshore and Open Lake forecasts.

NOAA broadcasts are received on the weather channels of a VHF receiver. They are commonly designed with the unofficial channel names WX1 through WX7. See appendix D for frequencies.

USCG broadcasts coastal forecasts, storm warnings, and weather alerts on channel 22A (initial alerts on channel 16).

Weather via SSB (MF/HF)

Voice

The U.S. Coast Guard broadcasts National Weather Service high seas forecasts and storm warnings from six high seas communication stations. These broadcasts are prepared cooperatively by the Ocean Prediction Center, National Hurricane Center, Honolulu Forecast Office. Offshore and coastal forecasts are available in areas such as Alaska. See National Weather Service website ("Marine Weather Broadcasts from the USCG") for frequencies and schedules.

NAVTEX

NAVTEX (**NAV**igational **TE**le**X**) is an international automated medium frequency (518 kHz) direct-printing service for delivery of navigational and meteorological warnings and forecasts, as well as urgent marine safety information to ships. It was developed to provide a low-cost, simple, and automated means of receiving this information aboard ships at sea within approximately 200 nautical miles of shore. NAVTEX stations in the U.S. are operated by the U.S. Coast Guard. There are no user fees associated with

receiving NAVTEX broadcasts. Within the U.S. there are no NAVTEX broadcasts on the alternate designated frequencies of 490.

Specifically tailored content for the USCG NAVTEX broadcast is prepared by the US National Weather Service. Schedules are available online.

NAVTEX broadcasts can be received by a dedicated NAVTEX receiver or by SSB and displayed by a PC with appropriate software.

The International Maritime Organization has designated NAVTEX as the primary means for transmitting coastal urgent marine safety information to ships worldwide.

The USCG has proposed shutting down their NAVTEX in favor of satellite communications.

Radiofax

Radiofax, also known as HF FAX, radiofacsimile or weatherfax, is a means of broadcasting graphic weather maps and other graphic images via HF radio. Maps are received using a dedicated radiofax receiver or a single sideband (SSB) shortwave receiver connected to an external facsimile recorder or PC equipped with a radiofax interface and application software.

The US National Weather Service provides weather faxes on HF. There are HF weather fax services throughout the world. The US National Weather Service "Marine Radio Fax" webpage provides both the same faxes you would receive by HF and information on equipment, frequencies, broadcast schedules. etc.

Weather via mobile phones

Numerous marine weather apps such as Buoyweather, Fishweather Noaa marine weather Forecast, NOAA weather and radar alerts, Predictwind Sailflow, etc. are available. Some have free versions and some have user fees. Mobile phones can also provide local severe weather and emergency local alerts.

Obviously a mobile phone or device with internet access can provide all the same rich weather information available via satellite.

Weather via satellite

Dial up systems can provide weather data formatted for low bandwidth connections such as GRIB's and text only data from sources that provide this data specifically for mariners with low bandwidth internet connections.

Broadband systems offer access to all the rich, graphical weather information available from any source worldwide as well as the ability to search the internet for specific weather/navigation information such as tide and current tables, etc.

SiriusXM marine weather offers an interesting option for North American mariners. This service provides data from a "weather fusion center" (in Baddeck, NS). The fused

information is from many sources. It includes weather radar, lightning, storm tracks, alerts, wind/wave predictions for 48 hours, buoy data, zone forecasts, and more. The information extends to at least 200 NM from the US & Canadian coasts. Two very useful features of this service are near real time weather radar and displaying the information on the chartplotter.

The system uses its own small, fixed antenna and a receiver that integrates with the navigation system to select and display the information on your chartplotter. You can also add the SiriusXM audio channels for an additional fee.

Other sources of weather information:

Mariners are limited on sources of weather information only by our imagination and efforts to seek it out. For example, TV and AM/FM radio can provide “big picture” weather information albeit not normally tailored for mariners.

Regulatory Matters

MMSI

Maritime Mobile Service Identities (MMSIs) are nine-digit numbers used by maritime digital selective calling (DSC), automatic identification systems (AIS) and certain other equipment to uniquely identify a ship or a coast radio station. MMSIs are regulated and managed internationally by the International Telecommunications Union in Geneva, Switzerland, just as radio call signs are regulated.

If you have a marine radio with DSC capability (fixed or handheld), you must obtain a nine-digit maritime mobile service identity number, and have it programmed into the unit before you transmit. The same requirement applies to AIS units that transmit. Each vessel requires only one MMSI number.

An MMSI is a vital data point for both domestic and international emergency personnel. Maintaining updated and accurate data in your license record is critical to ensuring maritime safety. In the USA this is done through the FCC's Universal Licencing System (ULS).

The first 3 digits of the MMSI number indicate the issuing country. The USA has several: 536 (Marinas), 366, 367, 368, 369, 338, 303 (Alaska).

A MMSI number may only be used for one vessel and may not be re-used except for the special case of a vessel transfer (e.g. you sell or purchase a boat you may transfer the MMSI with the boat to avoid reprogramming all the devices).

MMSI numbers in the USA may be obtained through the FCC, Boat US, and US Power Squadrons.

> **IMPORTANT:** Vessels registered in the USA that travel to foreign ports must have a MMSI issued by the FCC. Since the primary audience for this guide travels to foreign ports we strongly recommend that your vessel have an MMSI issued by the FCC.

Unfortunately there is no way to convert a non-FCC MMSI to a FCC MMSI. You must obtain a new FCC issued MMSI and cancel the non-FCC MMSI.

> **NOTE:** The FCC has announced that in 2024 they are increasing enforcement of the requirement that boats registered in the USA that travel outside the USA have an FCC issued MMSI. The FCC notes this is mainly power boats in Florida. The USCG, if contacted by a vessel with a non-FCC registered MMSI who are outside of US Coastal Boundaries will be turned over to the FCC who is responsible for enforcement and assessing fines.

FCC Station License

If you obtain a FCC issued MMSI, you will also get a FCC station license. Vessels that use HF SSB, satellite systems that transmit, or travel outside the USA - as vessels of the target audience for this guide are - must have a station license.

Although this likely does not apply to readers of this guide, you do not need a station license to use marine VHF radios, any type of EPIRB, any type of radar, GPS or LORAN receivers, depth finders, or CB radio in US waters.

FCC Radio Operator's License

If you are required to have a US station license, you are also required to have a radio operators license. The basic Restricted Radiotelephone Operator Permit (RR) is sufficient and is valid for a lifetime but a Marine Radio Operator Permit (MP) is more appropriate.

These licenses are valid for your lifetime. The Marine Radio Operator Permit is obtained through a 24 question written examination on basic radio law and operating practice with which every maritime radio operator should be familiar. The exams are designated examiners for the FCC. You can find them online.

Registering EPIRB's and PLB's

EPIRB's and PLB's are made with a unique hexadecimal identification number. In order to associate this identification number with your vessel (EPIRB) or you (PLB), the EPIRB or PLB must be registered in NOAA's Beacon Registration system. There is no charge to register the beacon. NOAA prompts you to verify the data every two years.

HAM licenses

You may listen to HAM bands with a marine SSB but may not transmit on them without a HAM license. A HAM "general" or "amateur extra" license is required to transmit HAM HF bands.

Recommended Communications Suite

Please refer to the appropriate chapter of this guide for detailed information on the various capabilities.

Capabilities	Coastal	Offshore	Recommendations
Fixed VHF with DSC	**X**	**X**	1 - Masthead antenna not split with AIS 2 - Integrated with navigation system (2 way with NMEA 2000) 3 - Microphones in the cockpit and below decks are STRONGLY recommended. 4 - An emergency antenna is a good practice. 5 - FCC issued MMSI
Handheld VHF with GPS/DSC	**X**	**X**	FCC issued MMSI
AIS	**X**	**X**	1 - Class B AIS transmit and receive 2 - Separate antenna from VHF radio 3 - FCC issued MMSI 4 - Integrated with chartplotter (NMEA 2000)
HF SSB		optional	
Broadband Satellite	optional	**X**	1 - dial up system are not recommended 2 - Iridium Certus with fixed antenna is the minimum capability recommended 3 - Consider higher throughput systems with tracking antennas such as KVH & Starlink. 4 - Carefully evaluate the characteristics of the phone capability.
Mobile phone	**X**	**X**	1 - Consider local SIM cards 2 - Check the international plan from your phone provider. 3 - If the phone is used to operate the satellite phone, provide access for all crew members. 4 - consider a range extender device 5 - Cell phones with satellite capabilities will become increasingly available.

SiriusXM marine weather	optional	optional	Highly recommended for boats operating in North America.
Personal satellite communicators	optional	optional	1 - Various two way communications 2 - Cell phones with satellite capabilities will become increasingly available.
EPIRB	X	X	1 - register with NOAA 2 - EPIRB with AIS is highly recommended
Personal AIS MOB beacon	X	X	1 - one for each crewmember 2 - AIS MOB beacon with DSC recommended for double-handers/small crews. 3 - Consider AIS MOB beacon with PLB for offshore.

General notes:

- The importance of testing all communications devices cannot be overemphasized. Newer VHF radios have a DSC test call feature. EPIRBs should be tested monthly. Personal AIS MOB beacons have built in test features. Etc.
- "Partyline" text or email communications are straightforward via satellite, by group texts or group emails, and minimize confusion. This is handy for organized cruises or cruising in company.

Appendix A - Radio Crib Sheet

Vessel Name: **Windsong** Radio Call sign: **W**hisky, **D**elta, **E**cho, **3244**

RED distress button

Weather

Push to talk

Speak slowly and clearly.

Avoid chatter.

Radio Channels and their use						
16	**9**	**13**	**22A**	**68, 69, 71, 72, 78A**	**1 – 10**	**81A, 83A**
Always monitor, Emergency Calling	Monitoring & calling shore stations	Navigation, bridge to bridge, locks, harbors, VTS	USCG working channel, USCG safety notices	Recreational vessel to vessel communications	Weather	"Mariner Radio Activated Sound Signals (MRASS)
1. All vessels must continuously monitor channel 16 when underway. 2. Dual channel monitoring of 16 and 13 or 9 as appropriate is advised and sometime required in harbors, in Vessel Traffic Service (VTS) control areas, canals, etc.						

***Safety/emergency calling*:**

Mayday, Mayday, Mayday – **or DSC 'Distress Call' (red button) –** immediate danger of life or property

Pan Pan, Pan Pan, Pan Pan – **or DSC 'All Ships Call' (Urgency Category) -** moderate danger, not imminent

Securite, Securite, Securite – **or DSC 'All Ships Call' (Safety Category) -** safety and weather alerts

***USCG Rescue 21* (US waters) or distress anywhere worldwide:**

press and hold the red **Distress** button (3 – 5 seconds depending on the radio manufacturer). If no response, then make a voice Mayday distress call on channel 16.

Mayday, Mayday, Mayday

State your vessel's name, location, latitude and longitude,

a brief description of your boat, and the nature of your emergency

Hailing another vessel, Channel 16 or 13:

"Seadog, Seadog, Seadog, this is ***Windsong***"

"This is ***Seadog***, switch to channel 68", ***Windsong***, "switching 68"

"This is ***Windsong,*** I wish to pass you on your Port side"

"Seadog, "come on along"

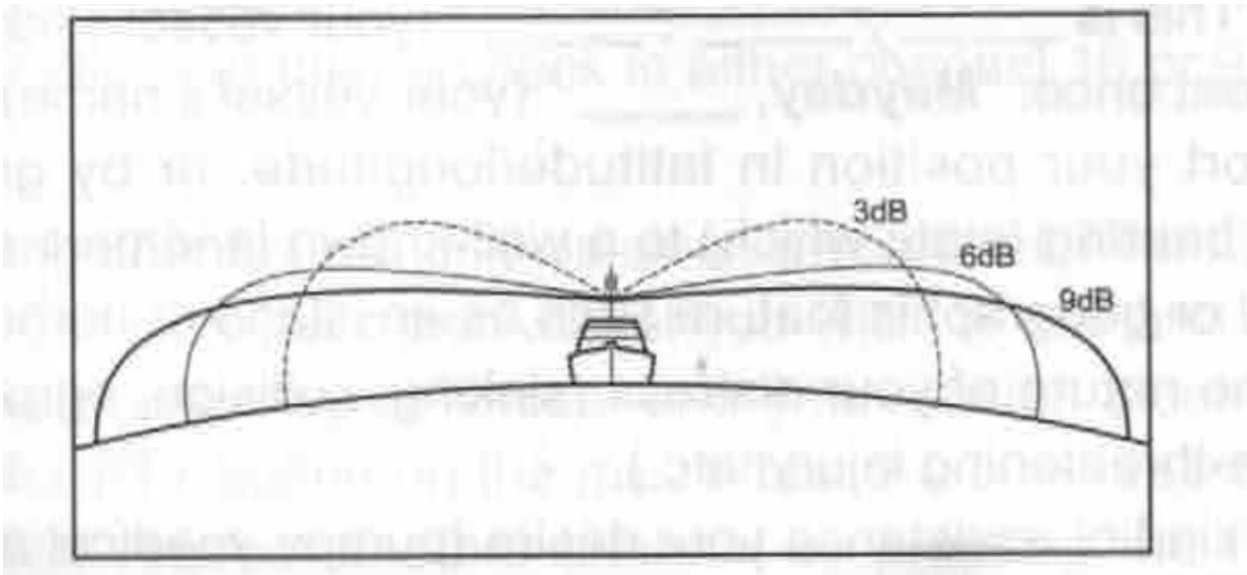
"Windsong, Thank you, returning to channel 16, out"

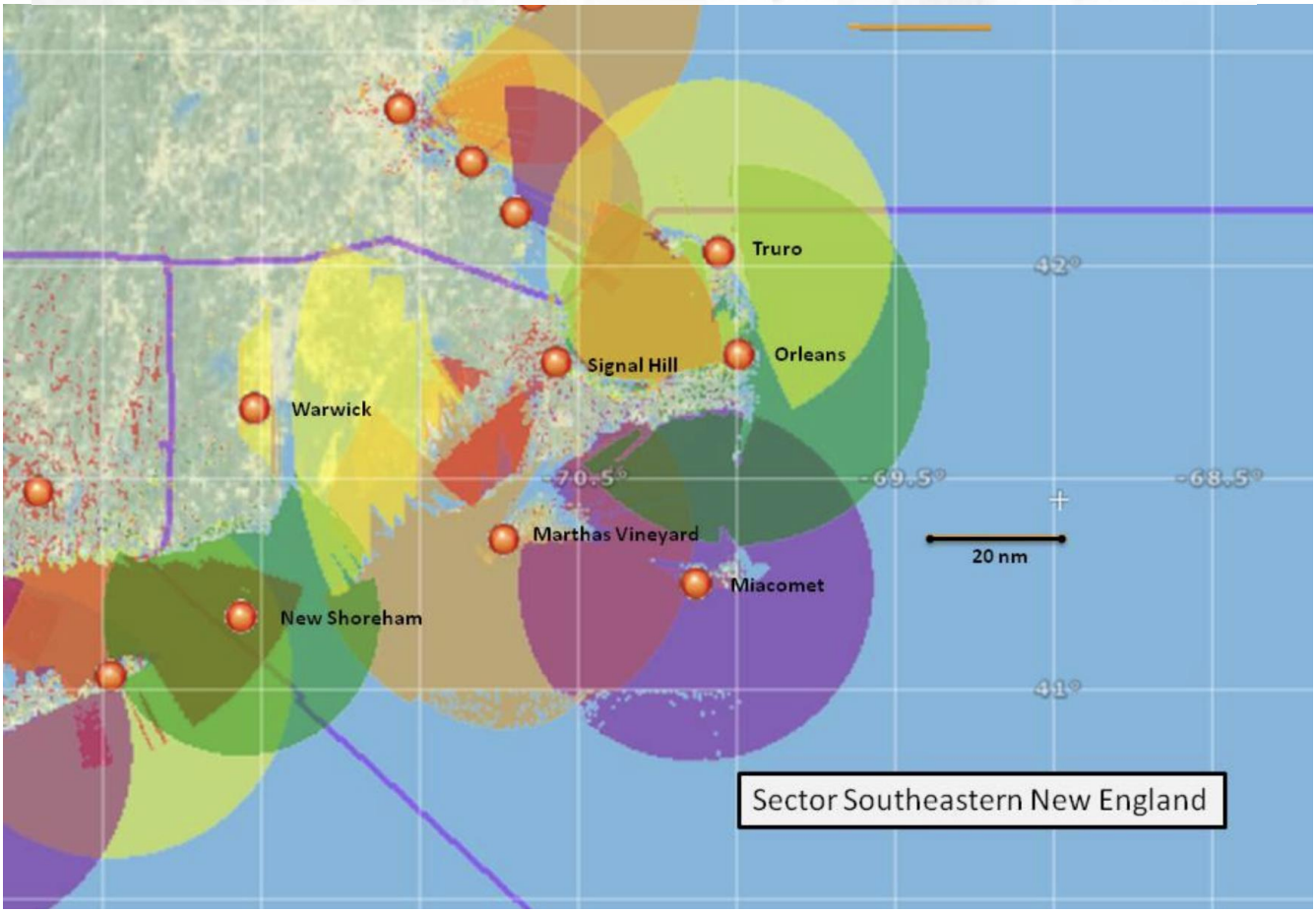
NATO Phonetic Alphabet

A	Alpha	N	November
B	Bravo	O	Oscar
C	Charlie	P	Papa
D	Delta	Q	Quebec
E	Echo	R	Romeo
F	Foxtrot	S	Sierra
G	Golf	T	Tango
H	Hotel	U	Uniform
I	India	V	Victor
J	Juliet	W	Whiskey
K	Kilo	X	X-ray
L	Lima	Y	Yankee
M	Mike	Z	Zulu

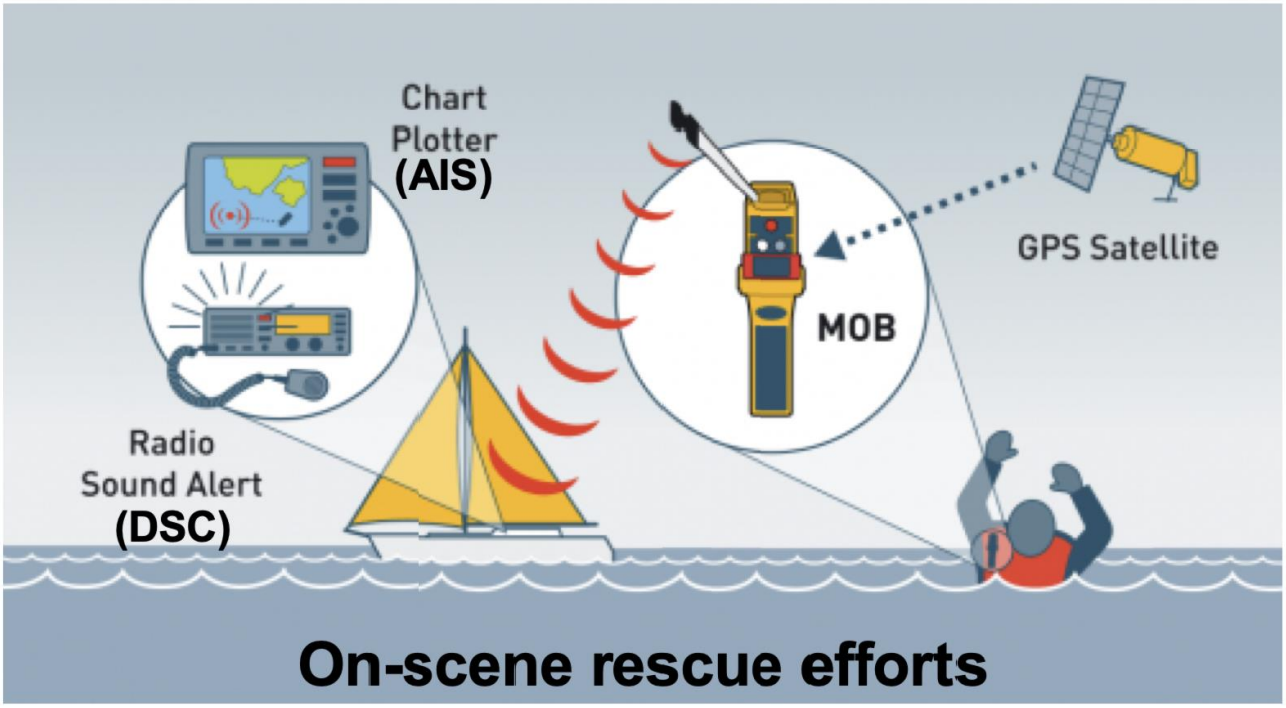
Appendix B - Antenna characteristics and USCG sample radio range chart

for the USCG sector Southeast New England





Appendix C - AIS MOB Beacon with DSC



Source: Brian Flowers, LRSE

Note: A personal AIS MOB beacon with DSC is line of sight of sight transmission for both AIS and DSC. The GPS satellite is shown because the beacon receives a GPS position that is reported with the AIS and DSC transmission. There is no transmission from this personal AIS MOB beacon.

Appendix D - VHF Marine Radio Channels

New Channel Number	Old Channel Number	Ship Transmit MHz	Ship Receive MHz	Use
1001	01A	156.050	156.050	Port Operations and Commercial, VTS. Available only in New Orleans / Lower Mississippi area.
1005	05A	156.250	156.250	Port Operations or VTS in the Houston, New Orleans and Seattle areas.
06	06	156.300	156.300	Inter-ship Safety
1007	07A	156.350	156.350	Commercial. VDSMS
08	08	156.400	156.400	Commercial (Inter-ship only). VDSMS
09	**09**	**156.450**	**156.450**	**Boater Calling. Commercial and Non-Commercial. VDSMS**
10	10	156.500	156.500	Commercial. VDSMS
11	11	156.550	156.550	Commercial. VTS in selected areas. VDSMS
12	12	156.600	156.600	Port Operations. VTS in selected areas.
13	**13**	**156.650**	**156.650**	**Inter-ship Navigation Safety (Bridge-to-bridge). Ships >20m length maintain a listening watch on this channel in US waters.**
14	14	156.700	156.700	Port Operations. VTS in selected areas.
15	15	—	156.750	Environmental (Receive only). Used by Class C EPIRBs.
16	**16**	**156.800**	**156.800**	**International Distress, Safety and Calling. Ships required to carry radio, USCG, and most coast stations maintain a listening watch on this channel.** See our Watchkeeping Regulations page.
17	17	156.850	156.850	State & local govt maritime control
1018	18A	156.900	156.900	Commercial. VDSMS
1019	19A	156.950	156.950	Commercial. VDSMS
20	20	157.000	161.600	Port Operations (duplex)
1020	20A	157.000	157.000	Port Operations
1021	21A	157.050	157.050	U.S. Coast Guard only

1022	**22A**	**157.100**	**157.100**	**Coast Guard Liaison and Maritime Safety Information Broadcasts. Broadcasts announced on channel 16.**
1023	23A	157.150	157.150	U.S. Coast Guard only
24	24	157.200	161.800	Public Correspondence (Marine Operator). VDSMS
25	25	157.250	161.850	Public Correspondence (Marine Operator). VDSMS
26	26	157.300	161.900	Public Correspondence (Marine Operator). VDSMS
27	27	157.350	161.950	Public Correspondence (Marine Operator). VDSMS
28	28	157.400	162.000	Public Correspondence (Marine Operator). VDSMS
1063	63A	156.175	156.175	Port Operations and Commercial, VTS. Available only in New Orleans / Lower Mississippi area.
1065	65A	156.275	156.275	Port Operations
1066	66A	156.325	156.325	Port Operations
67	67	156.375	156.375	Commercial. Used for Bridge-to-bridge communications in lower Mississippi River. Inter-ship only.
68	**68**	**156.425**	**156.425**	**Non-Commercial. VDSMS**
69	**69**	**156.475**	**156.475**	**Non-Commercial. VDSMS**
70	70	156.525	156.525	Digital Selective Calling (voice communications not allowed)
71	**71**	**156.575**	**156.575**	**Non-Commercial. VDSMS**
72	**72**	**156.625**	**156.625**	**Non-Commercial (Inter-ship only). VDSMS**
73	73	156.675	156.675	Port Operations
74	74	156.725	156.725	Port Operations
77	77	156.875	156.875	Port Operations (Inter-ship only)
1078	**78A**	**156.925**	**156.925**	**Non-Commercial. VDSMS**
1079	79A	156.975	156.975	Commercial. Non-Commercial in Great Lakes only. VDSMS
1080	80A	157.025	157.025	Commercial. Non-Commercial in Great Lakes only. VDSMS

1081	81A	157.075	157.075	U.S. Government only – Environmental protection operations.
1082	82A	157.125	157.125	U.S. Government only
1083	83A	157.175	157.175	U.S. Coast Guard only
84	84	157.225	161.825	Public Correspondence (Marine Operator). VDSMS
85	85	157.275	161.875	Public Correspondence (Marine Operator). VDSMS
86	86	157.325	161.925	Public Correspondence (Marine Operator). VDSMS
87	87	157.375	157.375	Public Correspondence (Marine Operator). VDSMS
88	88	157.425	157.425	Commercial, Inter-ship only. VDSMS
AIS 1	AIS 1	161.975	161.975	Automatic Identification System (AIS)
AIS 2	AIS 2	162.025	162.025	Automatic Identification System (AIS)
	WX1		162.550	NOAA Weather
	WX2		162.400	
	WX3		162.475	
	WX4		162.425	
	WX5		162.450	
	WX6		162.500	
	WX7		162.525	

Appendix E – USCG HF Distress and Contact Frequencies

Portsmouth/NMN, Boston/NMF, Miami/NMA, New Orleans/NMG, Pt. Reyes/NMC, Honolulu HI/NMO, Kodiak AK/NOJ	
4207.5	DSC test calls on 4207.5 kHz will be automatically acknowledged from any of the US Coast Guard Communication Stations listed below EXCEPT USCG SECTOR Guam.
6312	
8414.5	
12577	
16804.5	
Note: For digital selective calling, frequencies listed are assigned. Carrier frequency is located 1700Hz below the assigned frequency.	

HF DIGITAL SELECTIVE CALLING

Station	**MARITIME MOBILE SERVICE IDENTITY**
Universal US Coast Guard shore-based identity	003669999
USCG Communications Command, Chesapeake VA/NMN	003669995
USCG Communications Command, remotely keying transmitters at Boston/NMF	003669991
USCG Communications Command, remotely keying transmitters at Miami/NMA	003669997
USCG Communications Command, remotely keying transmitters at New Orleans/NMG	003669998
USCG Communications Command, remotely keying transmitters at Pt. Reyes CA/NMC	003669990
USCG Communications Command, remotely keying transmitters at Honolulu HI/NMO	003669993
USCG Communications Command, remotely keying transmitters at Kodiak AK/NOJ	003669899
USCG Sector Guam/NRV	003669994

HF RADIOTELEPHONE (SINGLE SIDEBAND) – DISTRESS AND INITIAL CONTACT			
KHz SHIP STATION	**KHz COAST STATION**	**Station and Schedule (UTC)**	
		NRV (Guam)	**NOJ (Kodiak AK)**
4125	4125		24 HRS
6215	6215	0900-2100Z	24 HRS
8291	8291		24 HRS
12290	12290	2100-0900Z	

HF RADIOTELEPHONE (SINGLE SIDEBAND) - WORKING CHANNELS		
These channels are available at all Coast Guard Long Range Communication Facilities for traffic handling purposes after initial contact is established on the HF Radiotelephone (Single Sideband) - Distress and Initial Contact frequencies. These coast station frequencies are also used for scheduled broadcasts of marine weather forecasts.		
ITU CHANNEL	**KHz SHIP STATION**	**KHz COAST STATION**
424	4134	4426
601	6200	6501
816	8240	8764
1205	12242	13089
1625	16432	17314

Appendix F – Feedback from sailors and updates

This appendix is updated periodically with feedback from sailors and with other updates such as changes in pricing, changes in technology, etc. Updates are put here when they are of high interest but we do not yet have enough experience reported by sailors to merit updating the appropriate chapter of the guide.

Update: December 2024

Starlink update

Starlink maritime offerings have advanced rapidly and matured in 2024. At this point we think Starlink can be said to be the satellite communication of choice for cruising sailors based on the cost of the equipment and airtime plans, as well as the flexibility and ease of use of the airtime plans.

The CCA has received considerable feedback on Starlink equipment and performance. The CCA completed a controlled test of the Starlink mini system with a boat on an offshore passage. This update reflects the most current feedback from our sailors and the results of our own testing.. It discusses the Starlink equipment and offerings as of December 2024. We acknowledge that many of our early adopters have legacy equipment and systems/air time plans that are no longer available are not addressed..

In our opinion, there are two important decisions an offshore sailor needs to make when selecting a Starlink system: The equipment model and the airtime plan. We will examine these in turn:

Equipment models::

There are currently 6 antennas offered:

1. Mini
2. Standard
3. Standard actuated
4. High performance
5. Flat high performance
6. Enterprise

We advise that two of these antennas are most appropriate for offshore sailors. The primary or default choice should be the “flat high performance” system.. Boats that are constrained on electrical power (e.g no genset) might consider the “mini”.

Yes, the other equipment will also work on a boat. However the flat high performance antenna is specifically designed for mobile use, particularly on boats. So unless size, power, cost, or other

constraints restrict your choice for your boat, the flat high performance antenna is the preferred choice at this time for an offshore boat.

The flat high performance antenna is approximately 20 X 22 inches which is 30% larger compared to the standard antenna which is 15 X 23 inches. The additional antenna area allows a wider “look angle” covering 140 degrees of sky compared to 100 degrees of the standard antenna. The larger look angle tracks satellites significantly better when the boat is moving such as swinging at anchor or underway heeling and rocking/rolling compared to the standard antenna.

The drawback of the flat high performance antenna is that it uses AC power and the system including the modem consumes 240 watts (2 amps for 120V AC and at least 20 amps DC when supplying power through an inverter).

Sailors that are constrained by electrical power ***may*** want to consider the new “mini” antenna. The mini antenna is a flat, stationary array that is 10 X 10 inches. It uses 12 - 48 VDC power and consumes only 78 watts (1/3 of the power used by the flat high performance antenna and system). The modem is built into the antenna so there is only one piece of equipment plus the power supply. It is designed to fit in a backpack. The modem is built into the antenna unit.

The CCA conducted a test with a boat making a 5 day passage off the US east coast. This boat was equipped with the mini system. Our observations are:

- The mini system worked superbly and reliably in a variety of typical sea conditions including in significant rolls.
- The system was supplied with a 12V DC adapter (from 120 VAC). The system was sensitive to power at 12 VDC. The long power cable from the adapter to the unit had too much voltage drop and the unit did not work. The issue was solved by using a 120 VAC to 48V DC power supply. We conclude that boats that choose to use the mini to conserve power should plan on using a higher DC voltage than 12V DC off of the house battery bank.
- Voice calls using VoIP (wireless calling mode of a cell phone) worked flawlessly. We called from shore to the boat twice a day and every call went through immediately. Audio quality was excellent. There was no noticeable latency (time delay).

Power considerations - Flat high performance system versus the mini system: We suggest that the choice depends largely on how you plan to use the system and your boat's ability to charge the house batteries. If you plan to have the system on 24 X 7 or for an extended period each day, the power savings with the mini will be considerable. This would amount to a small amount of additional generator run time for boats equipped with a generator.

If you plan to turn the system on only once or twice a day for a short period, it would seem that the additional power consumption of the flat high performance system would not have a significant impact on power use and battery charging when compared to the mini system.

Thus each boat should look at how they intend to operate a Starlink system and physical size constraints (if any) deciding whether to go with the flat high performance or the mini system.

Airtime plan choice:

The term “airtime plan” is used to be consistent with other satellite communications providers. Starlink does not use this term. As of September 2024, Starlink offers 3 airtime plans they recommend for boaters:

1. Roam Unlimited: $165/month Unlimited data. Best for inland and coastal cruising.

2. Mobile Priority 50 GB: $250/month 50 GB/month data offshore, unlimited data inland. For offshore cruising.

3. Mobile Priority 1 TB: $1,000/month 1 TB/month data offshore, unlimited data inland. For offshore cruising

The download speed, upload speed, and latency are the same for all plans.

IMPORTANT NOTE about offshore coverage: Starlink uses a “geo-fence” for these plans. Our test boat was on the basic ROAM plan at the start of the test. We have heard that some users switch to the basic ROAM plan ($50/month) instead of the unlimited ROAM plan ($165/month) to save money when they are in port for extended periods or operating inland (e.g. Great Lakes). When our test boat was approximately 12 NM offshore, the service stopped completely for the basic ROAM plan. The boat switched to the unlimited ROAM plan to restore service.

Starlink users have reported that they typically use the Roam Unlimited plan for coastal cruising and switch to the Mobile Priority 50 GB plan when going offshore. Starlink does not charge a fee to change plans. Changing to a more expensive plan (e.g. from ROAM to ROAM unlimited takes effect almost immediately and the fees are prorated for that billing cycle. Changing from a higher cost to a lower cost plan takes effect at the end of the billing cycle and thus does not need to be prorated.

Voice service choice:

Starlink provides an internet connection. It does NOT provide voice service. Phone calls are made and received using your personal cell phone in the “wireless calling” mode. (Voice over IP – VoIP) as you would on land. The boat does not have its own phone number.

Tips from our sailors for using Starlink:

<u>Minimizing data usage:</u> Make sure your cell phone and any crew members’ cell phones that are allowed to use Starlink are set to minimize data usage by preventing the many app’s on the phone from updating and getting data in the background. The setting on iPhones is called “low data mode”. The setting on Android phones is the connection settings and is called “data saver”. Similarly other devices such as PC’s should be set in the appropriate mode to minimize data usage. For example, on a Windows PC set the Starlink connection to be a “metered connection” and pause Window’s Updates.

Looking to the near future:

We think one of the most interesting near-term capabilities being developed by Starlink is “Direct to Cell”. This term refers to the capability for unmodified cell phones to connect directly to Starlink satellites. Starlink’s vision is to provide ubiquitous connectivity for text, voice and data for LTE phones across the globe. Essentially this service is cell phone towers in space.

Starlink says that “the launch” of Direct to Cell service is underway. Text service is supposed to be available now, followed by voice and data in 2025. The equipment for Direct to Cell is designed to ride the standard Starlink satellite. The first satellites with this capability were launched in January 2024 and are operational. The low transmit power of an unmodified cell phone presents a great challenge. In addition to the antenna and modem on the satellites, the satellites need to hand off to each other and the ground seamlessly and then connect to partner operated networks.

Starlink has not yet announced what the pricing will be, or the initial coverage areas.

Stay tuned as this exciting capability starts to be rolled out.