What the F#@K is NMEA 0183 and what does it do for me?????

The NMEA, pronounced "KNEE-MA," (National Marine Electronics Association) 0183 Standard for Interfacing Marine Electronics Devices is a voluntary industry standard, first released in March of 1983. The NMEA 0183 Standard defines electrical signal requirements, data transmission protocol, timing and specific sentence formats for a 4800 baud serial data bus. There are three NMEA standards known as 0180, 0182, and 0183, the latter now being the most common and by far the most versatile. You must be sure that your equipment is compliant to the latest standard, 0183.

It's a lot like RS-232 communications and, in fact, can be interfaced to the serial port on your computer.

OK, so now that I've said *that*, what is RS-232??

Warning: **Yucky technical stuff:**

Short for recommended standard-232C, a standard interface approved by the Electronic Industries Association (EIA) for connecting serial devices. In 1987, the EIA released a new version of the standard and changed the name to EIA-232-D. And in 1991, the EIA teamed up with Telecommunications Industry association (TIA) and issued a new version of the standard called EIA/TIA-232-E. Many people, however, still refer to the standard as RS-232C, or just RS-232.

Almost all modems conform to the EIA-232 standard and most personal computers have an EIA-232 port for connecting a modem or other device. "Normal" people just call this a serial port. In addition to modems, many display screens, mice, and serial printers are designed to connect to a EIA-232 port.

Basically, a 232 interface consists of a transmit wire (Tx), a receive wire (Rx) and some control signal (handshaking) wires so each ends knows when to talk, etc. The data is transmitted down the wires as a series of 'binary coded' pulses. These have two electrical values. At least 4.0 volts represents a logical '0' and less than 0.5 volts, a '1'. Thus a string of' '1's and '0's are sent back and forth. It's slow because all of the communications has to go serially (one bit after another) down one wire, thus the term "serial port."

Like NMEA 0183, the communication is asynchronous (don't worry if you don't know what that means).

The EIA-232 standard supports two types of connectors -- a 25-pin D-type connector (DB-25) and a 9-pin D-type connector (DB-9), laptops will have DB9's to save space. You can buy adapters at Fry's and Radio Shack that convert size and sex (males pins/female receptacles).

If you're a real masochist, go here, http://www.optimized.com/COMPENDI/L1-R232.htm, it has a great discussion on RS-232.

The NMEA 0183 Standard is available from the National Marine Electronics Association, but they want $125 for non-members. The web site is http://www.nmea.org/0183.htm. I did find another web site that said it could be purchased for $35, plus $3 shipping/handling, from:

Robert Sassaman
NMEA Executive Director
P.O. Box 50040
Mobile, AL 36605
U.S.A. Telephone: (205) 473-1793
FAX: (205 473-1669

Wiring Convention

The normal interconnection, as specified by the NMEA, requires a two-core shielded cable. It must be shielded and contain two color-coded and stranded conductors.

The two-core shielded cable must be connected to the source of data or 'talker' using any plugs or terminals provided. Both cores are used as well as the shield. The shield will be grounded either to a specified point or via a metal-bodied plug. The shield itself may be plaited or consist of an overlapped spiral foil with a bare 'drain' wire trapped under it.

Always make sure that the shield cannot accidentally touch any other terminal or electronics.

Feed the cable to the listener, i.e. the autopilot, radar etc, protecting it from chafe if necessary and supporting it at regular intervals. While such data cables are relatively insensitive to picking up interference, avoid running it next to SSB radio antenna feeds, echo sounder transducer cables, engine ignition leads, AC mains cables or DC supplies carrying heavy currents and feeding electrically noisy devices such as motors and fluorescent lights.

At the listening end, the shielding is not connected (so as not to generate a ground loop), only the two core wires. Again a plug or terminals may be used.

More Yucky Technical Stuff

NMEA 0183 devices employ an asynchronous serial interface with the following parameters:

Baud Rate	4800
Data Bits	8(d7=0)
Parity	None
Stop Bits	One(or more)

Devices are designated as either talkers or listeners with some devices being both. A talker is any device which sends data to other NMEA 0183 devices. A listener is any device which receives data from other NMEA 0183 devices. All data either transmitted or received is interpreted as 8 bit ASCII (d7=0).

ELECTRICAL REQUIREMENTS

Talker:

Under the latest version of the standard, NMEA 0183 talkers are supposed to be differential drive compatible with EIA RS-422 (sort of like RS-232, but different, the differential drive signals have no reference to ground and are more immune to noise). Earlier versions of the NMEA 0183 standard allowed single-ended drive circuitry for talker(s) (i.e., 0 to +15VDC). Therefore, there are still instruments around which are not differential drive output. A single talker can drive multiple listeners within drive current limitations.

Listener:

NMEA 0183 listeners are supposed to have input isolation from the ships Ground. Opto-isolation (convert from electricity to light and back to electricity again, thus eliminating noise), which is generally used to meet this requirement, limits the input impedance. The standard specifies a minimum input resistance for listeners of 500 ohms and most devices will probably be close to this value.

Message Format

The general NMEA 0183 message format is shown below:

$aaaaa,df1,df2,....[CR][LF]

All NMEA 0183 messages start with a "$" and are terminated by a [**C**arriage **R**eturn][**L**ine **F**eed]. The five characters immediately after the "$" are the address field. The address field is interpreted based on the type of sentence (talker, query or proprietary). Characters within the address field are limited to digits and upper case letters. The address field may not be a null field. Multiple data fields follow the address field and are delimited by commas. The format of the Data Field is determined by the Field Identifier Sentence Formatter value.

There are three basic sentence structures defined by the standard;

talker sentence
query sentence
proprietary sentence

<u>*talker* Sentence</u>

The general format for a talker (instrument) message is:

$ttsss,df1,df2,....[CR][LF]

The address field of a talker sentence contains a five character string immediately following the "$" sign. The first two characters are the talker identifier while the next three are the sentence identifier. The sentence identifier defines the remaining data fields. Under the NMEA 0183 Standard, the data fields are uniquely defined for each sentence type.

Talker ID Table

Some examples of Talker Mnemonics:

EC Electronic Chart Display & Information System (ECDIS)
ER Engineroom Monitoring Systems
GP Global Positioning System (GPS)
HC Heading Sensors, Compass, Magnetic
HE Heading Sensors, Gyro, North Seeking
HN Heading Sensors, Gyro, Non-north Seeking
II Integrated Instrumentation
LA Loran A
LC Loran C
TR Transit Navigation System
VD Velocity Sensor, Doppler, other/general
VM Velocity Sensor, Speed Log, Water, Magnetic
VW Velocity Sensor, Speed Log, Water, Mechanical
ZA Timekeepers, Time/Date, Atomic Clock
ZC Timekeepers, Time/Date, Chronometer
ZQ Timekeepers, Time/Date, Quartz
ZV Timekeepers, Time/Date, Radio Update, WWV or WWVH
WI Weather Instruments

Sentence Formatters

Some examples of sentence formatters:

GGA - Global Positioning System Fix Data

Time, position and fix related data for a GPS receiver.

$--GGA,hhmmss.ss,llll.ll,a,yyyyy.yy,a,x,xx,x.x,x.x,M,x.x,M,x.x,xxxx

hhmmss.ss = UTC of position
llll.ll = latitude of position

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a = N or S
yyyyy.yy = Longitude of position
a = E or W
x = GPS Quality indicator (0=no fix, 1=GPS fix, 2=Dif. GPS fix)
xx = number of satellites in use
x.x = horizontal dilution of precision
x.x = Antenna altitude above mean-sea-level M = units of antenna altitude, meters
x.x = Geoidal separation M = units of geoidal separation, meters
x.x = Age of Differential GPS data (seconds)
xxxx = Differential reference station ID

GLL - Geographic Position, Latitude / Longitude

Latitude and Longitude of present vessel position, time of position fix and status.

$--GLL,lll.ll,a,yyyyy.yy,a,hhmmss.ss,A

llll.ll = Latitude of position
a = N or S
yyyyy.yy = Longitude of position
a = E or W
hhmmss.ss = UTC of position
A = status: A = valid data

HDT - Heading, True

I.M.O. Ref. A424 (XI). Actual vessel heading in degrees Ture produced by any device or system producing true heading.

$--HDG,x.x,T

x.x = Heading, degrees True

STN - Multiple Data ID

This sentence is transmitted before each individual sentence where there is a need for the Listener to determine the exact source of data in the system. Examples might include dual-frequency depth sounding equipment or equipment that integrates data from a number of sources and produces a single output.

$--STN,xx

xx = Talker ID number, 00 to 99

TRF - TRANSIT Fix Data

Time, date, position, and information related to a TRANSIT Fix.

$--TRF,hhmmss.ss,xxxxxx,llll.ll,a,yyyyy.yy,a,x.x,x.x,x.x,x.x,xxx

hhmmss.ss = UTC of position fix
xxxxxx = Date: dd/mm/yy
llll.ll,a = Latitude of position fix, N/S
yyyyy.yy,a = Longitude of position fix, E/W
x.x = Elevation angle
x.x = Number of iterations
x.x = Number of Doppler intervals
x.x = Update distance, nautical miles
x.x = Satellite ID

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VBW - Dual Ground/Water Speed

Water referenced and ground referenced speed data.

$--VBW,x.x,x.x,A,x.x,x.x,A

x.x = Longitudinal water speed, knots
x.x = Transverse water speed, knots
A = Status: Water speed, A = Data valid
x.x = Longitudinal ground speed, knots
x.x = Transverse ground speed, knots
A = Status: Ground speed, A = Data valid

VTG - Track Made Good and Ground Speed

The actual track made good and speed relative to the ground.

$--VTG,x.x,T,x.x,M,x.x,N,x.x,K

x.x,T = Track, degrees True
x.x,M = Track, degrees Magnetic
x.x,N = Speed, knots
x.x,K = Speed, Km/hr

ZDA - Time & Date

UTC, day, month, year, and local time zone.

$--ZDA,hhmmss.ss,xx,xx,xxxx,xx,xx

hhmmss.ss = UTC
xx = Day, 01 to 31
xx = Month, 01 to 12
xxxx = Year
xx = Local zone description, 00 to +/- 13 hours
xx = Local zone minutes description (same sign as hours)

An example talker sentence is:

$HCHDM,238,M[CR][LF]

where the "HC" specifies the talker as being a magnetic compass, the "HDM" specifies the magnetic heading message follows. The "238" is the heading value, and "M" designates the heading value as magnetic.

query Sentence

A query sentence is a means for a listener to request a particular sentence from a talker. For example, a query message might be sent to a GPS receiver to request "DISTANCE-TO-WAYPOINT" information be transmitted.

The general format of a query sentence is:

$ttllQ,sss,[CR][LF]

The first two characters of the address field are termed the talker identifier of the requester and the next two characters are the talker identifier of the device being queried (listener). The fifth character is always a "Q" defining the message as a query. The next field (sss) contains the three letter mnemonic of the sentence being requested. An example query sentence is:

$CCGPQ,GGA[CR][LF]

where the "CC" device (computer) is requesting from the "GP" device (GPS) the "GGA" sentence. The GPS will then transmit this sentence once per second until a different query is requested.

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Proprietary Sentence
The proprietary sentence is a means for manufacturers to use special sentences which are not pre-defined by the standard.

The general format of a proprietary message is

$PmmmA,df1,df2,...,[CR][LF]

Where the "P" indicates that it is a proprietary message and that the data fields which follow do not necessarily correspond to any approved sentence structure. The "mmm" is defined as the manufacturers message code. The fifth character of the address field is a letter (A-Z) which defines the specific message type.

Checksum
The NMEA 0183 Standard allows for an optional checksum. The checksum is preceded by the asterisk (*) character placed after the last data field. It is a two-character field equal to the hex value obtained by XOR'ing all the character bytes of the sentence.

NMEA 2000

The National Marine Electronics Association has announced an initiative to develop a new standard for data communications among shipboard electronic devices. NMEA 2000 will be a low-cost bi-directional, multi-transmitter, multi-receiver serial data network. The network design, which is based on the ISO Open Systems Interconnect (ISO/OSI) model, will operate in a "carrier sense, multiple access, collision arbitration" mode. It is multi-master and self-configuring, and there is no central controller. Equipment designed to the NMEA 2000 standard will have the ability to share data, including commands and status, with other compatible equipment over a single signaling channel. "NMEA 2000 is designed to support relatively brief data messages, which may be periodic, transmitted as needed or on-demand by use of query commands. It will have approximately 20 times the capacity of the existing NMEA 0183 standard, but is not necessarily intended to support high-bandwidth applications such as radar, electronic chart or other video data, or intensive database or file transfer applications.

NMEA 2000 Update: (For more information, see http://www.nmea.org/2000.htm)

–20X faster than 0183
–Multiple “talkers”
–Standardization of connectors
–5 wire “backbone” cable up to 200 meters
•25 meters - 1,000 Kbits/Sec
•75 meters – 500 Kbits/Sec
•200 meters - 250 Kbits/Sec

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Maritime Safety Information Broadcasts

The U.S. Coast Guard and other government agencies broadcast different kinds of maritime safety warnings, using a variety of different radio systems to ensure coverage of different ocean areas for which the United States has responsibility, and ensure all ships of every size and nationality can receive this safety information. All broadcasts except those over VHF and MF radiotelephone are made by computer.

Coastal Maritime Safety Broadcasts

VHF Marine Radio Broadcasts. Urgent marine navigational and weather information is broadcast over VHF channel 22A (157.1 MHZ) from over 200 sites covering the coastal areas of the U.S., including the Great Lakes, major inland waterways, Puerto Rico, Alaska, Hawaii and Guam. Broadcasts are first announced over the distress, safety and calling channel 16 before they are made. All ships in U.S. waters over 20m in length are required to monitor VHF channel 16, and must have radios capable of tuning to the VHF simplex channel 22A.

NOAA Weather Radio. The U.S. National Oceanic and Atmospheric Administration continually broadcasts weather information on frequencies near 162 MHZ. www.nws.noaa.gov/nwr/index.html

Medium Frequency Radiotelephone. Urgent marine information broadcasts are made over the single sideband frequency 2670 kHz, after first being announced on the distress, safety and calling frequency 2182 kHz. www.navcen.uscg.mil/marcomms/cgcomms/voice.htm

Navtex. Navtex text broadcasts on 518 kHz, recognized by the GMDSS, cover most coastal areas of the U.S. The International Maritime Organization has designated NAVTEX as the primary means for transmitting coastal urgent marine safety information to ships worldwide. In the United States, NAVTEX is broadcast from Coast Guard facilities in Boston, Portsmouth VA, Miami FL, New Orleans LA, San Juan PR, Cambria CA, San Francisco CA, Astoria OR, Kodiak AK, Honolulu HI, and Guam. The Coast Guard began operating NAVTEX from Boston in 1983, and completed its last installation in Adak Alaska, on the Aleutian Islands, just in time to meet IMO's August 1993 requirement that ships carry NAVTEX receivers. www.navcen.uscg.mil/marcomms/gmdss/navtex.htm

High Seas Broadcasts

HF Radiotelephone (SSB) Weather forecasts and warnings are broadcast over scheduled HF radiotelephone channels from Coast Guard Communication Stations using a very distinctive and recognizable computer-synthesized voice dubbed "Perfect Paul".

- Listen to "Perfect Paul": www.navcen.uscg.mil/marcomms/cgcomms/vobra.wav

HF Radiofacsimile (SSB Weather Fax) Weather charts and ice charts are broadcast from Coast Guard Communications Stations. National Weather Service weather charts are also available from the World Wide Web at http://weather.noaa.gov/fax/marine.shtml.

Radiofacsimile product and schedule information

- Boston/NMF http://weather.noaa.gov/pub/fax/hfmarsh.txt
- Pt Reyes/NMC http://weather.noaa.gov/pub/fax/hfreyes.txt
- New Orleans LA/NMG http://weather.noaa.gov/pub/fax/hfgulf.txt
- Hawaii KVM-70 http://weather.noaa.gov/pub/fax/hfhi.txt
- Kodiak AK/NOJ http://weather.noaa.gov/pub/fax/hfak.txt

For information concerning other U.S. and international marine radiofacsimile broadcasts, see The Radiofacsimile WWW Page at http://ourworld.compuserve.com/homepages/hffax/hf-fax.htm

Marine Radiofacsimile Policy

The Coast Guard, which broadcasts radiofacsimile information from five Communications Stations, will continue these broadcasts to meet the needs of its cutters, and to meet public safety needs as described in Chapter V of the Safety of Life at Sea Convention, unless otherwise directed.

HF Radiotelex (HF SITOR) Weather, NAVAREA, HydroLant, HydroPac and other navigational safety text information, recognized by the GMDSS, are broadcast over scheduled GMDSS HF narrow-band direct printing channels from Coast Guard Communications Stations. www.navcen.uscg.mil/marcomms/cgcomms/sitor.htm

Inmarsat-C SafetyNET. Worldwide weather, navigational, ice and search and rescue text information, recognized by GMDSS, are broadcast over the Inmarsat satellite system. www.navcen.uscg.mil/marcomms/gmdss/snet.htm and www.inmarsat.org.

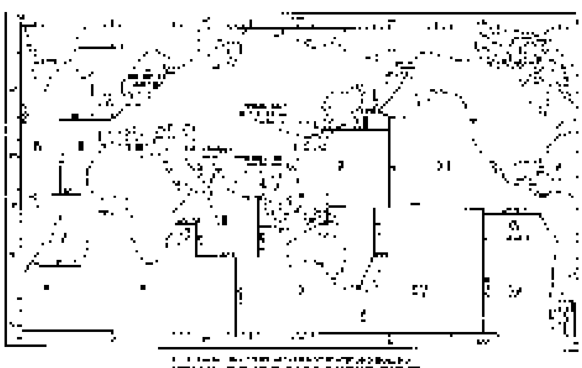
Marine Product Dissemination Information

The U.S. National Weather Service has a new World Wide Web page listing sources and schedules for receiving marine meteorological information by a variety of means, including Internet, radio, satellite, computer bulletin board, and others. It's address is www.nws.noaa.gov/om/marine/home.htm.

Meteorological Observations

Even with satellites, meteorologists cannot accurately prepare marine weather forecasts without accurate ship weather reports. For this reason, the National Weather Service sponsors the United States Voluntary Observing Ship Program (VOS). Ships participating in the VOS program provide meteorological and oceanographic reports while at sea. These observations form the basis of marine weather forecasts in coastal and high seas areas. For more information, see the NWS Port Meteorological Officers and Voluntary Observing Ship Program Page at www.vos.noaa.gov.

Geographical areas for coordination and promulgation of navigational and meteorological warnings



Last Revised: 21 August 1998

Commandant (G-SCT-2)
U.S. Coast Guard
Washington DC 20593

www.navcen.uscg.mil/marcomms/gmdss/msi.htm

Wireless Telecommunications Bureau

GLOBAL MARITIME DISTRESS AND SAFETY SYSTEM (GMDSS)

What is the GMDSS?
The GMDSS is an internationally recognized distress and radio communication safety system for ships replacing the previous ship to ship safety system, which relied on a manual Morse code system on 500 kHz and voice radiotelephony on Channel 16 and 2182 kHz. The GMDSS is an automated ship to shore system using satellites and digital selective calling technology. The GMDSS is mandated for ships internationally by the International Maritime Organization (IMO) Safety of Life at Sea Convention (SOLAS), 1974, as amended in 1988, and carries the force of an international treaty. The procedures governing use are contained in the International Telecommunications Union recommendations and in the International Radio Regulations, and also carry the force of an International Treaty. The GMDSS regulations are contained in 47 C.F.R Part 80, Subpart W.

What ships are affected by the GMDSS rules?
The international GMDSS regulations apply to "compulsory" ships including:

- cargo ships of 300 gross tons and over when traveling on international voyages or in the open sea
- all passenger ships carrying more than twelve passengers when traveling on international voyages or in the open sea

These are the same ships currently covered by the SOLAS Convention and Title III, Part II of the Communications Act of 1934, as amended.

- Fishing vessels (to which it applied) – The full implementation of GMDSS was temporarily waived for fishing vessels, to which it applied until a date to be announced in the future. See Waiver of Certain Global Maritime Distress and Safety System (GMDSS) Rules Applicable to Fishing Vessels and Small Passenger Vessels, Order, FCC 98-296 (rel. November 20, 1998) (Fishing Vessel Order). The waiver is conditioned on the requirement that, during the duration of the waiver, fishing vessels of 300 gross tons or greater, shall continue to carry a 406 MHz EPIRB, a NAVTEX receiver, and survival craft equipment including at least three portable VHF radiotelephones and two 9 GHz radar transponders (SARTs). See Fishing Vessel Order cited above.
- Vessels on the Great Lakes - The GMDSS regulations do not apply to vessels operating exclusively on the Great Lakes.

Why were the changes necessary?
The changes were mandated by international treaty obligations. In 1988, the International Maritime Organization (IMO), an organization of the United Nations, amended the Safety of Life at Sea (SOLAS) Convention to implement the GMDSS worldwide. The United States has been a strong advocate of the GMDSS internationally. On January 16, 1992, the FCC adopted the GMDSS regulations for U.S. compulsory vessels. Report and Order, PR Docket No. 90-480, FCC 92-19 (rel. February 7, 1992), 7 FCC Rcd 951 (1992), 57 Fed. Reg. 903 (March 16, 1992).

What are the advantages of the GMDSS over the current system?

provides worldwide ship to shore alerting, it is not dependent upon passing ships

simplifies radio operations, alerts may be sent by "two simple actions"

ensures redundancy of communications, it requires two separate systems for alerting

enhances search and rescue, operations are coordinated from shore centers minimizes unanticipated emergencies at sea, maritime safety broadcasts are included

eliminates reliance on a single person for communications, it requires at least two licensed GMDSS radio operators and typically two maintenance methods to ensure distress communications capability at all times

Are radio officers still required?
Radio officers (trained in manual Morse code) are not part of the GMDSS regulations or system. In lieu of a single radio officer, the GMDSS regulations require at least two GMDSS radio operators and a GMDSS maintainer if the ship elects at sea repair as one of its maintenance options.

What are the requirements regarding communications personnel aboard GMDSS ships?
The FCC requires two licensed radio operators to be aboard all GMDSS certified ships, one of whom must be dedicated to communications during a distress situation. The radio operators must be holders of a GMDSS Radio Operator's License. The GMDSS radio operator is an individual licensed to handle radio communications aboard ships in compliance with the GMDSS regulations, including basic equipment and antenna adjustments. The GMDSS radio operator need not be a radio officer.

Another IMO Convention requires all masters and mates to hold the GMDSS Radio Operator's License and attend a two week training course and demonstrate competency with operation of the GMDSS equipment. These requirements would also carry to any person employed specifically to act as a dedicated radio operator if the ship elected to carry such a position.

Can I use my current FCC operator license aboard GMDSS ships?
No. Any person who wants to become a GMDSS radio operator must pass a new examination to receive the GMDSS license.

What about radio equipment maintenance aboard GMDSS ships?
Identical to the international GMDSS regulations, the FCC regulations provide three methods to ensure that radio equipment is functionally capable of providing communications. The three methods approved for GMDSS ships are (two of the three methods are required for most ocean voyages):

shore based maintenance

at sea maintenance

duplication of equipment

Does duplication of equipment mean that GMDSS ships must carry "two sets of everything?"
No. Duplication of equipment is not equivalent to complete redundancy. Only that equipment critical to radio communications during an emergency is required. The GMDSS regulations specify the particular radio equipment that is required under the duplication of equipment option. See the FCC's GMDSS regulations, 47 CFR Section 80.1105, for exact details.

Who can make repairs or adjustments to GMDSS radio equipment?
The GMDSS regulations require that GMDSS ships that choose at sea maintenance carry a licensed GMDSS radio maintainer. In addition to those individuals holding a GMDSS Radio Maintainer's License, the First or Second Class Radiotelegraph Operator's Certificate (T-1 or T-2) and the General Radiotelephone Operator License (G) are acceptable. Land maintenance must be performed by qualified individuals or companies.

Do the GMDSS radio operator, the GMDSS radio maintainer, and the current radio officer need to be separate individuals?
The GMDSS ship must have two licensed GMDSS radio operators. One of the GMDSS licensed radio operators can be the current radio officer or any other qualified member of the crew holding the appropriate FCC license. If the GMDSS ship chooses at sea maintenance, then it must have a person holding a T-1, T-2, G, or GMDSS Radio Maintainer's License, who could be one of the GMDSS radio operators, the radio officers, or any other qualified member of the crew.

What equipment is necessary under the GMDSS rules?
The exact suite of equipment depends upon the intended routes of your ship. A careful review of the new regulations is needed to determine the requirements applicable to each ship. A ship can sail in any of four sea areas, as defined below:

Sea area A1. An area within the radiotelephone coverage of at least one VHF coast station in which continuous DSC alerting is available as defined by the International Maritime Organization.

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Sea Area A2. An area, excluding sea area A1, within the radiotelephone coverage of at least one MF coast station in which continuous DSC alerting is available as defined by the International Maritime Organization.

Sea Area A3. An area, excluding sea areas A1 and A2, within the coverage of an INMARSAT geostationary satellite in which continuous alerting is available.

Sea Area A4. An area outside sea areas A1, A2, and A3.

How do I determine what sea area my ship will traverse?
Contact the US Coast Guard for the latest information on GMDSS sea areas in US waters.

Is there any equipment that is common to all GMDSS ships?
Generally, all GMDSS ships carry a 406 MHz EPIRB, a VHF radio capable of transmitting and receiving DSC and radiotelephony, a NAVTEX receiver, a SART, and two-way VHF portable radios. See the FCC's GMDSS regulations, 47 CFR Sections 80.1085 through 80.1093 for exact details.

Can I continue to use my current equipment; for example, is my INMARSAT-A terminal acceptable under the new regulations?
It depends. INMARSAT approves equipment to work on its satellite system. Some of the INMARSAT approved equipment meets GMDSS standards and some does not. Even some of the equipment that does not meet GMDSS standards may be capable of sending a distress signal. The only way to ensure compliance with GMDSS requirements is to use equipment that has been approved by the FCC for GMDSS use. Also, you may need to add an INMARSAT unit capable of receiving enhanced group calling (EGC) SafetyNet messages and you will have to ensure that the system, which may include the gyro or other systems providing vital input to the system, meets GMDSS emergency power requirements.

How can I check to see if my radio equipment is authorized for GMDSS use?
Any equipment that meets the GMDSS requirements will have a FCC ID# and appear on the "FCC Radio Equipment List" with a notation that it is authorized for GMDSS use. Further, GMDSS equipment (excluding 406 MHz EPIRBS), must have a label stating:
This device complies with the GMDSS provisions of Part 80 of the FCC Rules.
Only the manufacturer or an authorized representative may add these labels. In all cases, you can verify the status of equipment by asking the manufacturer or the FCC. FCC information is available at the Office of Engineering and Technology home page.

How do I get copies of the FCC's GMDSS regulations, the IMO Master Plan, and all of the reference documents?
Copies of any FCC document can be purchased through the FCC's copy contractor, ITS at (202)857-3800.

Reference documents, such as the Master Plan and ITU-R (formerly CCIR) recommendations, may be purchased directly from the following organizations:

Master Plan of Shore-Based Facilities for the Global Maritime Distress and Safety System -- International Maritime Organization (IMO), Publications, 4 Albert Embankment, LonSEE SE1 7 SR, United Kingdom; telephone 011 44 71 735 7611.

ITU Radio Regulations, CCIR and CCITT publications -- International Telecommunication Union (ITU), Place des Nations, CH-1211 Geneva 20, Switzerland; telephone 011 41 22 730 5111.

IEC and ISO publications -- American National Standards Institute (ANSI), 11 West 42nd Street, New York, NY 10036; telephone (212) 642-4900.

Who can I contact for further information about the GMDSS?

Questions concerning vessel or radio operator licensing -- FCC National Call Center at 888-225-5322 (888)CALLFCC.

US Coast Guard at: Commandant (G-SCT), US Coast Guard, Washington, DC 20593, (202) 267-2860; or cgcomms@comdt.uscg.mil.

If you have any comments or questions about this information, please contact the Public Safety and Private Wireless Division at (202)418-0680 or E-mail at mayday@fcc.gov
Last reviewed/updated: August 9, 1999

www.fcc.gov/wtb/marine/gmdss.html

VHF Frequencies

U.S. VHF Marine Radio Channels and Frequencies

This information can also be found in the back of your tides & currents tables book. (***Look in the back of your book – it's good reading!!***)

Channel Number	Ship Transmit MHz	Ship Receive MHz	Use
01A	156.050	156.050	Port Operations and Commercial, VTS*. Available only in New Orleans / Lower Mississippi area.
05A	156.250	156.250	Port Operations or VTS in the Houston, New Orleans and Seattle areas.
06	**156.300**	**156.300**	**Intership Safety**
07A	156.350	156.350	Commercial
08	156.400	156.400	Commercial (Intership only)
09	**156.450**	**156.450**	**Boater Calling. Commercial and Non-Commercial.**
10	156.500	156.500	Commercial
11	156.550	156.550	Commercial. VTS in selected areas.
12	**156.600**	**156.600**	**Port Operations. VTS in selected areas.**
13	**156.650**	**156.650**	**Intership Navigation Safety (Bridge-to-bridge). Ships >20m length maintain a listening watch on this channel in US waters.**
14	**156.700**	**156.700**	**Port Operations. VTS in selected areas.**
15	--	156.750	Environmental (Receive only). Used by Class C EPIRBs.
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.**
17	156.850	156.850	State Control
18A	156.900	156.900	Commercial
19A	156.950	156.950	Commercial
20	157.000	161.600	Port Operations (duplex)
20A	157.000	157.000	Port Operations
21A	157.050	157.050	U.S. Coast Guard only
22A	**157.100**	**157.100**	**Coast Guard Liaison and Maritime Safety Information Broadcasts. Broadcasts announced on channel 16.**
23A	157.150	157.150	U.S. Coast Guard only
24	**157.200**	**161.800**	**Public Correspondence (Marine Operator)**
25	**157.250**	**161.850**	**Public Correspondence (Marine Operator) San Francisco, North – Bodega Bay to Fort Bragg & 50 miles out**
26	**157.300**	**161.900**	**Public Correspondence (Marine Operator) , North – Bodega Bay to Fort Bragg & 50 miles out**
27	**157.350**	**161.950**	**Public Correspondence (Marine Operator) Sacramento, Stockton, Delta, North – Bodega Bay to Fort Bragg & 50 miles out**
28	**157.400**	**162.000**	**Public Correspondence (Marine Operator) Sacramento, Stockton, Delta, North – Bodega Bay to Fort Bragg & 50 miles out, South – Santa Cruz to Pt. Sur & 50 miles out**

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63A	156.175	156.175	Port Operations and Commercial, VTS. Available only in New Orleans / Lower Mississippi area.
65A	156.275	156.275	Port Operations
66A	156.325	156.325	Port Operations
67	156.375	156.375	Commercial. Used for Bridge-to-bridge communications in lower Mississippi River. Intership only.
68	**156.425**	**156.425**	**Non-Commercial**
69	**156.475**	**156.475**	**Non-Commercial**
70	156.525	156.525	Digital Selective Calling (voice communications not allowed)
71	**156.575**	**156.575**	**Non-Commercial**
72	**156.625**	**156.625**	**Non-Commercial (Intership only)**
73	156.675	156.675	Port Operations
74	156.725	156.725	Port Operations
77	156.875	156.875	Port Operations (Intership only)
78A	**156.925**	**156.925**	**Non-Commercial**
79A	156.975	156.975	Commercial. Non-Commercial in Great Lakes only
80A	157.025	157.025	Commercial. Non-Commercial in Great Lakes only
81A	157.075	157.075	U.S. Government only - Environmental protection operations.
82A	157.125	157.125	U.S. Government only
83A	157.175	157.175	U.S. Coast Guard only
84	**157.225**	**161.825**	**Public Correspondence (Marine Operator)** **San Francisco**
85	**157.275**	**161.875**	**Public Correspondence (Marine Operator)**
86	**157.325**	**161.925**	**Public Correspondence (Marine Operator)** **Sacramento, Stockton, Delta**
87	**157.375**	**161.975**	**Public Correspondence (Marine Operator)** **San Francisco**
88	157.425	162.025	Public Correspondence only near Canadian border.
88A	157.425	157.425	Commercial, Intership only.

VTS – Vessel Traffic Service

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NOAA Weather Radio Frequencies, in MHz

WX1	--	**162.550**
WX2	--	**162.400**
WX3	--	**162.475**
WX4	--	162.425
WX5	--	162.450
WX6	--	162.500
WX7	--	162.525

Glossary of Instrumentation Terms

Reprinted from the KiwiTech help file.

Apparent Wind Angle (AWA)

The Apparent Wind Angle is the angle as actually measured by the masthead wind instruments. When the boat is stationary, the Apparent Wind Angle is the same as True Wind Angle. As the boat starts moving, Apparent Wind Angle is always less then True Wind Angle.

Apparent Wind Speed (AWS)

The Apparent Wind Speed is the speed as actually measured by the masthead wind instruments. Upwind, Apparent Wind Speed will be greater than the True Wind Speed, because the Boat Speed is adding to the Wind a sailor on the yacht feels. Downwind, Apparent Wind Speed will be less, because the boat is moving in the same direction as the wind.

Boat Speed (BSP)

Boat Speed is the speed of the boat through the water.

True Wind Angle (TWA)

True Wind Angle is the angle between the True Wind Direction and the centerline of the boat.

True Wind Direction (TWD)

True Wind Direction is the magnetic bearing that the wind is coming from, as if measured by a stationary boat. As with TWS, it is calculated by removing the effects of the boat's motion.

This is the most important number for the tactician in identifying useful wind shifts.

True Wind Speed (TWS)

True Wind Speed is calculated by removing the effect of the boat's motion on the wind Instruments. This gives the wind speed we would measure if we were sitting in a stationary boat.

Velocity Made good on Course (VMC)

VMC is the VMG towards a mark or destination. The only time VMC is the same as VMG is when the bearing to the mark and the wind direction are identical.

The main use of VMC is when you can expect the wind to change between your present position and the mark (mainly long course racing). In this instance you are better to sail a course which will reduce your distance to the mark as fast as possible, even if it is not heading directly to the mark.

Velocity Made Good (VMG)

Velocity Made Good (VMG) is your velocity directly towards or way from the True Wind Direction. VMG is the ultimate measure of your performance when sailing upwind or downwind. However it is not possible to sail off the VMG number because of the momentum of the boat. When you sail closer to the wind the VMG will initially increase because the boat will maintain its speed due to its momentum. If the helmsman reacted to this by steering even higher, you would eventually end up head to wind!

For this reason VMG is of little value in the short term. This is basically why yachtsmen now identify the True Wind Angle and BSP that will produce the best VMG at different wind speeds and sail to these numbers.

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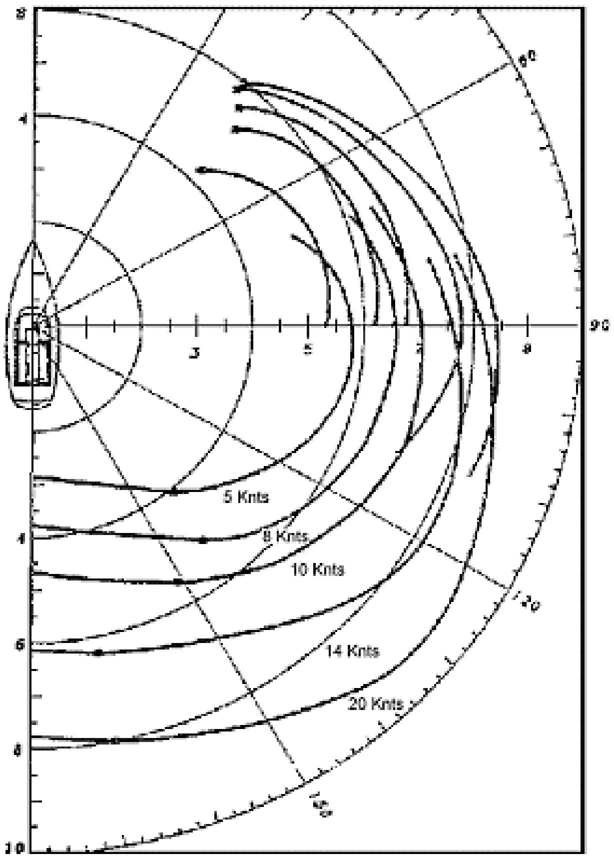
Polars aren't Bears

So what are polars anyway and what good are they?



Technically speaking, polars are graphs. The name polar is a type of graph just as is bar, pie, line and logarithmic They're called polars because the scale is angular, the grid lines are circles, or in the case of graphing boat performance data, semi-circles.

The boat's speed is graphed as a function of wind direction from 0 to 180 for a given wind speed. The other axis is wind speed.

The benefit of looking at the data in this way is that for each wind speed, the optimum angle to the wind is determined to get the boat up or downwind with the maximum VMG (Velocity Made Good), i.e., it spells out the trade off between 'reaching off and adding both boat speed and distance' to pointing higher and slowing the boat speed but also traveling fewer miles.

For example, the polar data will tell you that, for a wind speed of 10 knots, you should sail a wind angle of 40 degrees and the target boat speed through the water should be 6 knots to achieve maximum VMG.

The data is developed by professionals for each boat type based on the boat's performance data. US Sailing's Performance Package has information on over 700 boats. The cost is $170 for members and $195 for non-members. www.ussailing.org/merchandise/performance.asp. Data can also be obtained from yacht designers and VPP Services.

Some instrumentation systems and software packages support the displaying and updating of polar data.

Reprinted from the KiwiTech help file:

A polar graph is a graph of the maximum sustainable boat speed at different wind angles, for a given wind speed. The boat speed is given by the distance from the center.

Several polar curves are drawn on a polar plot to represent the boat's performance in different true wind speeds.

To understand what the graph is showing us, look at the outer circle, which describes the yachts performance in 30 knots of True Wind Speed. At 0° (head to wind) the boat will make no speed, hence the line starts here at the center. As we bear off to close hauled the graph is increasing in speed (the radius is getting longer). The peak of the graph in the close hauled area (around 40°) is a special point called the upwind Target. Sailing the boat at this angle and at that speed will give you the best VMG in 30 knots True Wind Speed.

From the Upwind target point you will see the speed increase (radius increase more) as you bear off to reaching and then broad reaching (around 140°) before it starts to actually come back up to the 180° (flat off) point. Once again the lowest point of the curve shows the Downwind Target point for 30 knots True Wind Speed. Sailing the boat at this angle and at that speed will give you the best VMG downwind in 30 knots True Wind Speed.

The left side of the polar graph is not normally shown because it is the mirror image of the right side.

The polar plot represents a sustainable condition. It tells us the boat speed we can sustain at a specific true wind angle in that amount of breeze. By looking at the polar plot you can see that if you steer higher than the upwind target point the boat speed decreases so much that even though you are sailing more directly into the wind, the VMG is less. Similarly when sailing downwind sailing too flat also decreases boat speed so much that VMG decreases.

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Upwind Targets

If you graph the highest points (upwind target points) from each of the polar plots you get an Upwind Target curve:

These upwind target points give you a both a true wind angle and a unique boat speed value which produce the best average VMG for that curve's particular true wind speed.

This boat speed value is called Target Boat Speed and is the ideal value to use to optimize VMG upwind. The best crews use Target Boat Speed as their primary tool for steering the boat and adjusting the sails. If you are sailing too slow then you must be pinching- bearing off and accelerating to Target Boat Speed will give you your best VMG. Conversely if you are sailing too fast then you must be sailing too low- pinching up and slowing down to Target Boat Speed will give you your best VMG.

Keeping the boat speed close to Target Boat Speed gives the sail trimmers and the helmsman a common goal to work towards, this requires good communication and teamwork between them.

For example if you hit a rough patch of water, and the boat speed slows the conversation could go something like this:

Genoa trimmer calls out 'Below target- head down as we ease sheets'.

The helmsman bears off a touch to accelerate whilst the sheets are being eased.

As the boat speed builds towards target the trimmers start to trim back in and the helmsman gently heads the boat back up to a close hauled course

When the boat speed reaches the Target speed the helmsman settles in again and the trimmers are at full upwind trim.

RaceTech can display the actual and target boat speed numbers back to many instrument systems, and display them on the computer screen.

Velocity Shifts upwind

A velocity shift is a change in the Apparent Wind Angle caused by a change in True Wind Speed. Significant gains can be made if you can identify and react correctly to velocity shifts.

A velocity header is caused by a sudden lull or decrease in True Wind Speed which will cause the Genoa luff to back. The normal reaction is to bear off, however if you are sailing to Target Boat Speed you will react in the opposite manner:

You apparently get a big header- the Genoa backwinds. A quick check of True Wind Direction on RaceTech identifies that the True Wind Direction has remained constant and you have just had a velocity header (decrease in True Wind Speed)

RaceTech calculates and displays new lower Target boat speed

Now you are sailing too fast for the new wind strength so you can obtain a nice VMG gain by taking a bite to windward- head up slightly and trim in at the same time

As the boat speed drops towards the new target the helmsman bears off and the trimmers ease the sails. It is important to bear away to your correct sailing angle before your boat speed drops below your new target than to have to bear off more to get back up to target later. Note that you can still make a gain by simply holding your existing course (compared to bearing off) if it has only been a slight change or you are unsure.

You can see from the Target graph that this is mainly applicable in under 8 knots of True Wind Speed where the Target speed varies a lot with changes to True Wind Speed.

A velocity lift requires the opposite response. When sailing upwind a sudden gust produces a velocity lift. As the Apparent Wind Angle increases the normal reaction is to head up and point higher. However if you are sailing to Target Boat Speed you will react in the opposite manner:

You apparently get a big lift. A quick check of True Wind Direction on RaceTech identifies that the True Wind Direction has remained constant and you have just had a velocity lift (increase in True Wind Speed and Apparent Wind Angle)

RaceTech calculates and displays new higher Target boat speed

Now you are sailing too slow for the new wind strength. You will obtain the best overall VMG by accelerating to your Target Boat Speed a quickly as possible. If necessary bear off slightly and ease sheets at the same time

Polars Insert

As the boat speed increases towards the new target the helmsman heads up and the trimmers trim the sails back in. It is important to head up to your correct sailing angle and trim as soon as possible. Don't waste VMG by sailing at or above Target Boat Speed whilst you are pointing too low. Note that you can still make a gain by simply holding your existing course (compared to rounding up) if it has only been a slight change or you are unsure. Once again the main conditions when this will apply is the below 8 knots when the Target speed varies significantly with True Wind Speed. In the higher wind speeds simply easing sheets slightly will get you up to the new Target Boat Speed quickly.

Note that the current wind strength and the shape of your Upwind Target graph influences how you should respond to changes in True Wind Speed.

Normally a Upwind Target graph shows a fairly linear increase in the 0 to 8 knot True Wind Speed range, that is Target boat speed increases quickly in proportion to the increasing True Wind Speed. This is where using the techniques described above can make the biggest gains.

Then there is often a transition zone around the 8 to 14 knot True Wind Speed range where the curve flattens off as the boat reaches hull speed. This area, often called the 'upwind hump', requires a combination of boat speed and angle change in response to velocity changes.

Over 14 knots True Wind Speed the curve will generally flatten off- increasing True Wind Speed hardly increases Target Speed at all, although Target angle may continue to decrease. In these conditions your natural reaction- to sail slightly higher in the puffs and lower in the lulls will be correct for optimum VMG.

Downwind Targets

Applying Target Boat Speed concepts to downwind sailing is just as important. However when sailing offwind the Target Angle information is very valuable as well in helping you to sail the best gybing angles.

Autopilots - Definitions

Control Head – Device in cockpit or and/or nav station used to program & drive the autopilot. Should be easy to use.

Junction Box – The brains or computer & S/W used to produce the signals to drive the motor or drive unit steering the boat.

Rudder Feedback – A device that senses and transmits rudder angle to the junction box. Information is used to calculate response time and desired rudder angle as the boat swings and yaws.

Drive Unit – The machinery that actually moves the rudder.

Feedback control - Prevents the pilot from constantly steering the boat back and forth across the course line.

Deadband - An area around the set course within which deviations are tolerated and do not produce any steering response. Often can be varied for different conditions. Allows the boat to come back to course by itself and so to conserve power and prevent over steering.

Gain - The amount and speed of the rudder movements induced by the pilot, can also be adjusted to fit the existing conditions.

Rate of Turn - Speed of rudder movement in degrees/second, should be based on boat speed.

Rate Gyro - Accelerometer, tells autopilot how fast boat is slewing off course.

Flux Gate Compass - Directly senses the horizontal component of the earth's magnetic field with a field sensor, usually an inductor, mounted to a gimbaled platform.

More on Flux Gate Compasses and Rate Gyros

The earth's field has two components: the horizontal field, which gives directional information, and the vertical field, which provides no useful heading information.

If flux gate sensor moves from its horizontal position due to roll or pitch, the sensor will pick up some of the vertical field, mixing it with the horizontal field and causing an error.

At mid latitudes in the U.S., one degree of sensor tilt equals an apparent two-degree shift in indicated heading.

In higher latitudes, one degree of tilt can cause over 10 degrees compass error.

Some manufacturers compensate for this effect with damping by utilizing oil or additional electronics.

A rate gyro is a solid-state vibrating crystal that experiences lateral forces when rotated. These forces are detected by electrodes connected to the crystal surface which produce signals proportional to the rate of turn.

The information from the fluxgate compass and the rate gyro are combined to produce accurate heading information free of drift and acceleration effects.

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Autopilots –Steering Force and Sizing

Warning: These numbers should be used only as a starting point and guidance. (I ran out of time while trying to collect all of the data, but this is a start anyway.) Manufacturers tend to state the performance of their systems in the best possible light and performance in actual conditions is based on many factors, such as the physical properties of the boat, how the autopilot is set up, the ocean conditions and the desired performance under those conditions. The only way to get reasonable comparisons is to have a detailed conversation with each manufacturer with respect to a particular boat and desired performance.

Another consideration is efficiency, how much power is consumed to get the job done. Alpha Marine claims that their systems are 80% efficient, while the others operate at 30%. You can try to check this out for yourself.

Brand	Type	Max Torque	Peak Thrust	Max Stroke	Coupling Radius	Power Consumption	Peak Current	Rate of Turn
B&G Size 1 & 2	Hydraulic/ linear	7867 lb.ins – 23780lb.ins	935 – 2342 lbs	12"	8.4" +/- 35 deg	2 – 4 A (Cruising)	14 A	
B&G Size 3	Hydraulic/ linear	867 lb.ins – 23780lb.ins	935 – 2342 lbs	12"	10.16" +/- 35 deg	2 – 4 A (Cruising)	14 A	
B&G	Rotary Sprocket							
Course-master	Rotary Sprocket	120kg/cm			Up to +/-35 deg	3 - 7.2 A	15 - 22 A	4 – 7 deg/sec*
Course-master	Hydraulic/ linear							Up to 20 deg/sec*
Autohelm	Mechanical/ linear							
Alpha Marine	Mechanical/ linear	1,200 ft/lbs			+/- 20 deg			Up to 40 deg/sec
W-H	Hydraulic/ Linear		1,500 – 4000 lbs	7", 9" & 12"		1 – 3 A (Calm Sea)	20 A	10 deg/sec
Robertson								

*Rate of turn, based on boat speed, 8, 3/sec (20 knots), 6/sec (up to 20 knots), 9/sec (10 knots)

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Radio Definitions

Amplitude: The signal level and the amount of negative and positive voltage.

Bandwidth: The width of the spectrum of the signal.

Duplex: A mode of communication where a person can talk and listen at the same time. When operating a duplex radio, the transmitter and receiver operate on different frequencies and do so at the same time.

Frequency: Number of complete oscillations of the wave form in a given time, usually in oscillations per second. 1 hertz (Hz) is equivalent to one oscillation per second. Frequency is also the rate of signal oscillation. (A complete oscillation is one cycle)

Half Duplex: A mode of radio operation where the transmitter and receiver operate on different frequencies, but cannot operate simultaneously (cannot talk and listen at the same time).

Period: Amount of time for a cycle duration.

Period = 1/Frequency = 1/(osc/sec) = sec/osc

Phase: The point to which the signal has advanced in its cycle.

Simplex: A mode of communication where a person either talks or listens, but not both at a time. When operating a two way radio on a simplex radio channel, the transmitter and receiver operate on the same frequency, and the operator cannot listen while he is talking

Spectrum: Range of frequencies contained in the signal bandwidth.

Wave length: the length of the distance between two peaks or troughs of the signals sine wave

Wave length = S/Frequency
where S = speed of signal propagation

To Learn More:

Cruiser's Radio Guide, An Operating Guide for the Maritime Radio Service, Amateur Radio Service – Maritime Mobile Operations by Roger Krautkremer

More on Propagation

Software

FREE RF Propagation Program, RFProp (100K): http://sss-mag.com/toptensw.html#new:

RFProp is a utility for calculating signal characteristics of radio propagation paths. It runs on Windows 3.x, and Windows 95, and includes algorithms for line-of-sight, free space, through-building and obstructed (diffracting) paths.

Range and path budget margin can be rapidly calculated and viewed while modifying the model parameters conveniently using the graphic mode main window.

Propagation Reports on the Web

Space Environment Center Radio User's Page: www.sec.noaa.gov/radio/radio.html

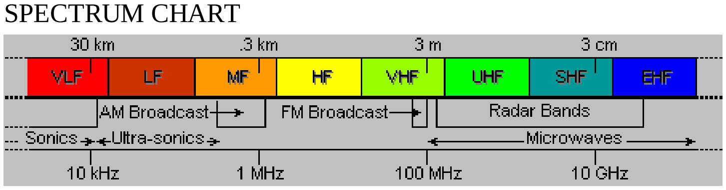
DX.QSL.NET: http://dx.qsl.net/propagation/

The electromagnetic spectrum:

BANDWIDTH DESCRIPTION	FREQUENCY RANGE				
Extremely Low Frequency (ELF)	0		to	3	kHz
Very Low Frequency (VLF)	3	kHz	to	30	kHz
Radio Navigation & maritime/aeronautical mobile	9	kHz	to	540	kHz
Low Frequency (LF)	30	kHz	to	300	kHz
Medium Frequency (MF)	300	kHz	to	3000	kHz
AM Radio Broadcast	540	kHz	to	1630	kHz
Travelers Information Service	1610	kHz			
High Frequency (HF) **SSB Range**	3	MHz	to	30	MHz
Shortwave Broadcast Radio	5.95	MHz	to	26.1	MHz
Very High Frequency (VHF)	30	MHz	to	300	MHz
Low Band: TV Band 1 - Channels 2-6	54	MHz	to	88	MHz
Mid Band: FM Radio Broadcast **VHF Radio Range**	88	MHz	to	174	MHz
High Band: TV Band 2 - Channels 7-13	174	MHz	to	216	MHz
Super Band (mobile/fixed radio & TV)	216	MHz	to	600	MHz
Ultra-High Frequency (UHF)	300	MHz	to	3000	MHz
Channels 14-70	470	MHz	to	806	MHz
L-band:	500	MHz	to	1500	MHz
Personal Communications Services (PCS)	1850	MHz	to	1990	MHz
Unlicensed PCS Devices	1910	MHz	to	1930	MHz
Superhigh Frequencies (SHF) (Microwave)	3	GHz	to	30.0	GHz
C-band	3600	MHz	to	7025	MHz
X-band:	7.25	GHz	to	8.4	GHz
Ku-band	10.7	GHz	to	14.5	GHz
Ka-band	17.3	GHz	to	31.0	GHz
Extremely High Frequencies (EHF) (Millimeter Wave Signals)	30.0	GHz	to	300	GHz
Additional Fixed Satellite	38.6	GHz	to	275	GHz
Infrared Radiation	300	GHz	to	810	THz
Visible Light	810	THz	to	1620	THz
Ultraviolet Radiation	1.62	PHz	to	30	PHz
X-Rays	30	PHz	to	30	EHz
Gamma Rays	30	EHz	to	3000	EHz

http://www.qsl.net/kb2vgh/bandplan.html

SPECTRUM CHART



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SSB Basics

See handout.

Modulation (This is WAY More than You Want to Know):

Modulation is the process of combining a information bearing signal (voice, music or other data) and superimposing it upon a carrier signal for transmission. A carrier wave provides the time baseline for the imposition of a modulated signal. When you hear "dead air" between songs or announcements on a radio station, you're "hearing" the carrier. The different methods of modulating a radio signal are called modes.

Carrier signals are generally high frequency for several reasons:

- For low loss, low dispersion propagation as electromagnetic waves
- May be simultaneously transmitted without interference from other signals
- Requires small antennas (a fraction, usually a quarter of the wavelength)
- To multiplex (combine) multiple signals for transmission at the same time.

The different modes of modulation have their advantages and disadvantages. Here is a summary:

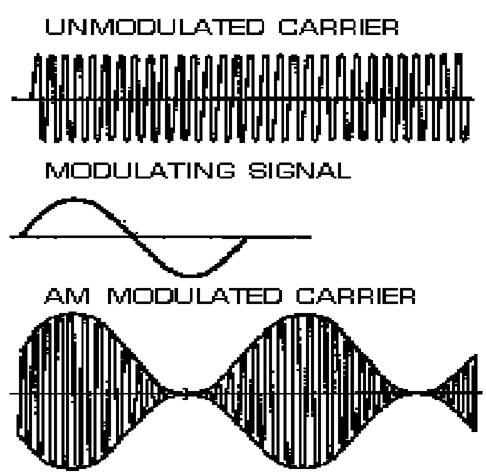
Continuous Wave (CW)

CW is the simplest form of modulation. The output of the transmitter is switched on and off, typically to form the characters of the Morse code.

CW transmitters are simple and inexpensive, and the transmitted CW signal doesn't occupy much frequency space (bandwidth), usually less than 500 Hz. However, the CW signals will be difficult to hear on a normal receiver; you'll just hear the faint quieting of the background noise as the CW signals are transmitted. To overcome this problem, shortwave and ham radio receivers include a beat frequency oscillator (BFO) circuit. The BFO circuit produces an internally-generated second carrier that "beats" against the received CW signal, producing a tone that turns on and off in step with the received CW signal. This is how Morse code signals are received on shortwave.

Amplitude Modulation (AM)

Amplitude modulation varies the height (amplitude) of a carrier wave while the frequency remains fixed to create an analog of the original signal; that is, changing the heights of the signal in relation to the time baseline.



When you speak into the microphone of an AM transmitter, the microphone converts your voice into a varying voltage. This voltage is amplified and then used to vary the strength of the transmitter's output. Amplitude modulation adds power to the carrier, with the amount added depending on the strength of the modulating voltage.

From the diagram on the right, it can be seen that when the carrier is modulated, its amplitude goes above and below its unmodulated amplitude.

The maximum percentage modulation possible is 100%. Going above this causes distortion. Most broadcasters limit modulation to 80%

Amplitude modulation results in three separate frequencies being transmitted: the original carrier frequency, a lower sideband (LSB) below the carrier frequency, and an upper sideband (USB) above the carrier frequency. The upper sideband is the carrier frequency plus the audio frequency. The lower side band is the carrier frequency minus the audio frequency.

The sidebands are "mirror images" of each other and contain the same broadcast information. When an AM signal is received, these frequencies are combined to produce the sounds you hear.

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Since the audio signal is not a single frequency but a range of signals (usually 20 Hz to 20 kHz) the sidebands are each 20 Hz to 20 kHz wide.

Each sideband occupies as much bandwidth as the highest audio frequency being transmitted. If the highest audio frequency being transmitted is 5 kHz, then the total bandwidth occupied by an AM signal will be 10 kHz (the carrier occupies negligible bandwidth).

AM has the advantages of being easy to produce in a transmitter and AM receivers are simple in design. Its main disadvantage is its inefficiency. About two-thirds of an AM signal's power is concentrated in the carrier, which contains no information. One-third of the power is in the sidebands, which contain the signal's information. Since the sidebands contain the same information, however, one is essentially "wasted." Of the total power output of an AM transmitter, only about one-sixth is actually productive, useful output!

Other disadvantages of AM include the relatively wide amount of bandwidth an AM signal occupies and its susceptibility to static and other forms of electrical noise. Despite this, AM is simple to tune on ordinary receivers, and that is why it is used for almost all shortwave broadcasting.

Single Sideband (SSB)

Since so much power is wasted in AM, radio engineers devised a method to transmit just one sideband and put all of the transmitter's power into sending useful information. This method is known as single sideband (SSB). In SSB transmitters, the carrier and one sideband are removed before the signal is amplified. Either the upper sideband (USB) or lower sideband (LSB) of the original AM signal can be transmitted.

SSB is a much more efficient mode than AM since all of the transmitter's power goes into transmitting useful information. A SSB signal also occupies only about half the bandwidth of a comparable AM signal, however, SSB transmitters and receivers are far more complicated than those for AM. An SSB signal cannot be received intelligibly on an AM receiver; the SSB signal will have a badly distorted "Donald Duck" sound. This is because the carrier of an AM signal does play a major role in demodulating (recovering the transmitted audio) the sidebands of an AM signal. To demodulate an SSB signal, you need a "substitute carrier."

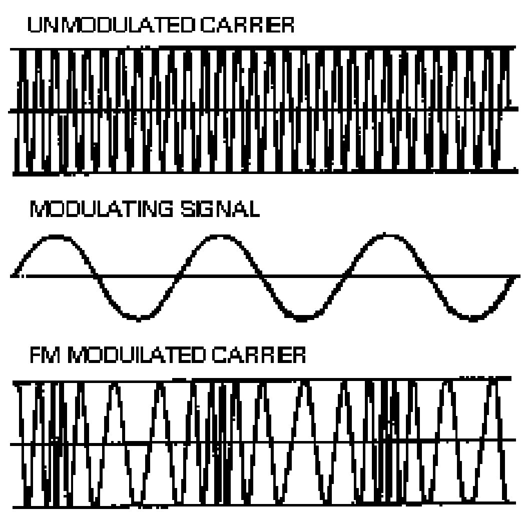
A substitute carrier can be supplied by the beat frequency oscillator (BFO) circuit used when receiving CW signals, however, this means that a SSB signal must be carefully tuned to precisely "beat" it against the replacement carrier from the BFO. For best performance, a SSB receiver needs more precise tuning and stability than an AM receiver, and it must be tuned more carefully than an AM receiver. Even when precisely tuned, the audio quality of a SSB signal is less than that of an AM signal.

SSB is used mainly by ham radio operators, military services, maritime and aeronautical radio services, and other situations where skilled operators and quality receiving equipment are common. There have been a few experiments in using SSB for shortwave broadcasting, but AM remains the preferred mode for broadcasting because of its simplicity.

Frequency Modulation (FM)

Frequency modulation varies the frequency of a signal so that the frequency changes create an analog of the original signal while keeping the amplitude is fixed.

The unmodulated frequency of a FM signal is called its center frequency. When a modulating signal is applied, the FM transmitter's frequency will swing above and below the center frequency according to the modulating signal. The amount of "swing" in the transmitter's frequency in any direction above or below the center frequency is called its deviation. The total bandwidth occupied by a FM signal is twice its deviation.



FM signals occupy a great deal of bandwidth. The deviation of a FM broadcast station is 75 kHz, for a total bandwidth of 150 kHz. Most other users of FM (police and fire departments, business radio services, etc.) use a deviation of 5 kHz, for a total bandwidth occupied of 10 kHz. For these reasons, FM is mainly

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used on frequency above 30 MHz, where adequate bandwidth is available. This is why most scanner radios can only receive FM signals, since most signals found above 30 MHz are FM.

The big advantage of FM is its audio quality and immunity to noise. Most forms of static and electrical noise are naturally AM, and a FM receiver will not respond to AM signals. FM receivers also exhibit a characteristic known as the capture effect. If two or more FM signals are on the same frequency, the FM receiver will respond to the strongest of the signals and ignore the rest. The audio quality of a FM signal increases as its deviation increases, which is why FM broadcast stations use such large deviation. The main disadvantage of FM is the amount of bandwidth a signal requires.

Channels and classifications

AM has 117 channels from 535 kHz to 1705 kHz, each 10 kHz wide (1705-535=1170 divided by 10=117 channels). For example, a station at 760 kHz transmits a signal from 755 kHz to 765 kHz with the carrier at 760.

FM has 100 channels from 88 MHz to 108 MHz, each 200 kHz wide, which is why there are no even FM stations. For example, if a station transmits at 91.5 MHz its signal stretches from 91.4 to 91.6 MHz.

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For fun: Amateur Radio on the International Space Station (ARISS)

With the help of Amateur Radio clubs and ham radio operators, space shuttle astronauts have been speaking over the ham airwaves while in orbit. They are talking directly with large groups of the general public, showing teachers, students, parents and communities how Amateur Radio energizes youngsters about science, technology, and learning. The program was called *SAREX*, the *S*pace *A*mateur *R*adio *Ex*periment and is now called ARISS, Amateur Radio on the International Space Station.

ARISS is sponsored by the American Radio Relay League (ARRL), the Radio Amateur Satellite Corporation (AMSAT), and the National Aeronautics and Space Administration (NASA).

For more information on ARISS: http://ariss.gsfc.nasa.gov/

http://www.arrl.org/ARISS/

Radiofax Schedule (DOS Text Format)

Updated: Sun Jul 1 15:33:46 2001 UTC

PT. REYES, CALIFORNIA, U.S.A.

CALL SIGN	FREQUENCIES	TIMES	EMISSION	POWER
NMC	4346 kHz	NIGHT	F3C	10 KW
	8682 kHz	CONTINUOUS	F3C	10 KW
	12730 kHz	CONTINUOUS	F3C	10 KW
	17151.2 kHz	CONTINUOUS	F3C	10 KW
	22527 kHz	DAY	F3C	10 KW

TRANS TIME	CONTENTS OF TRANSMISSION	RPM/IOC	VALID TIME	MAP AREA
0230/1430	TEST PATTERN	120/576		
0235/----	TROPICAL 0/24HR WIND/WAVE FORECAST	120/576	00&00	4
0248/1438	GOES IR SATELLITE IMAGE	120/576	LATEST	7/5
0259/1449	GOES IR SATELLITE IMAGE	120/576	LATEST	5/6
0310/1500	SEA STATE ANALYSIS	120/576	00/12	1/8
----/1510	TROPICAL 0/24HR WIND/WAVE FORECAST	120/576	12&12	4
0320/1520	SURFACE ANALYSIS (PART 1 NE PACIFIC)	120/576	00/12	2
0333/1533	SURFACE ANALYSIS (PART 2 NW PACIFIC)	120/576	00/12	3
0345/1545	500MB ANALYSIS	120/576	00/12	1
0355/1555	TROPICAL CYCLONE DANGER AREA	120/576	03/15	10
0408/----	TROPICAL 48HR WIND/WAVE FORECAST	120/576	0000	4
0750/----	TEST PATTERN	120/576		
0755/1608	TROPICAL SURFACE ANALYSIS	120/576	00/12	4
----/1930	TEST PATTERN	120/576		
0808/1933	24HR SURFACE FORECAST	120/576	00/12	8
0818/1943	24 HR WIND/WAVE FORECAST	120/576	00/12	8
0828/1953	48HR 500MB FORECAST	120/576	00/12	1
0838/2003	48HR SURFACE FORECAST	120/576	00/12	1
0848/2013	48HR WIND/WAVE FORECAST	120/576	00/12	1
0858/2023	48 HR WAVE PERIOD/SWELL DIRECTION	120/576	00/12	1
----/2033	96HR 500MB FORECAST	120/576	0000	1
----/2043	96HR SURFACE FORECAST	120/576	0000	1
----/2053	96HR WIND/WAVE FORECAST	120/576	0000	1
----/2103	96HR WAVE PERIOD/SWELL DIRECTION	120/576	0000	1
0908/2113	GOES IR SATELLITE IMAGE	120/576	06/18	7/5
0919/2124	SURFACE ANALYSIS (PART 1 NE PACIFIC)	120/576	06/18	2
0932/2137	SURFACE ANALYSIS (PART 2 NW PACIFIC)	120/576	06/18	3
0944/----	GOES IR SATELLITE IMAGE	120/576	0600	5
----/2149	TROPICAL 0/24HR WIND/WAVE FORECAST	120/576	18&18	4
0955/----	TROPICAL 0/24HR WIND/WAVE FORECAST	120/576	06&06	4
1008/----	TROPICAL 48HR WAVE PERIOD/SWELL DIR	120/576	1200	4
----/2159	TROPICAL 48/72HR WAVE PERIOD/SWELL DIR	120/576	00&00	4
----/2212	TROPICAL SURFACE ANALYSIS	120/576	1800	4
1100/2300	TEST PATTERN	120/576		
----/2304	SST ANALYSIS	120/576	LATEST	9
----/2314	SST ANALYSIS	120/576	LATEST	6
1104/2324	BROADCAST SCHEDULE (PART 1)	120/576		
1115/2335	BROADCAST SCHEDULE (PART 2)	120/576		
1126/----	REQUEST FOR COMMENTS	120/576		
1137/----	PRODUCT NOTICE BULLETIN	120/576		
1148/----	TROPICAL SURFACE ANALYSIS	120/576	0600	4
1158/----	TROPICAL 48/72HR WIND/WAVE FORECAST	120/576	12&12	4

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```
MAP AREAS:   1.  20N - 70N,   115W - 135E        2.  20N - 70N,   115W - 175W
             3.  20N - 70N,   175W - 135E        4.  20S - 30N,  EAST OF 145W
             5.  05N - 60N,  WEST OF 100W        6.  23N - 42N,  EAST OF 136W
             7.  05N - 55N,  EAST OF 130W        8.  25N - 60N,  EAST OF 155W
             9.  40N - 53N,  EAST OF 136W       10.   0N - 40N,    80W - 180W
```

(INFORMATION DATED 09/24/01)tdr
(EFFECTIVE DATE 30 JUL 2001)

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Weather Fax Insert

Updated: Tue Dec 18 13:10:54 2001 UTC
HONOLULU, HAWAII, U.S.A.

CALL SIGN	FREQUENCIES	TIMES	EMISSION	POWER
KVM70	9982.5 kHz	1150-1522	F3C	5 KW
	11090 kHz	EXCEPT 2350-0336	F3C	5 KW
	16135 kHz	EXCEPT 1150-1522	F3C	5 KW
	23331.5 kHz	2350-0336	F3C	5 KW

TRANS TIME	CONTENTS OF TRANSMISSION	RPM/IOC	VALID TIME	MAP AREA
2350/1150	TEST-ID-SCHEDULE-GENERAL NOTICE	120/576		
0005/1205	PACIFIC SURFACE ANALYSIS	120/576	18/06	B
0030/1230	GOES IR SATELLITE IMAGE	120/576	LATEST	EP
0045/1245	GOES IR SATELLITE IMAGE	120/576	LATEST	SP
0103/1304	TROPICAL SURFACE ANALYSIS	120/576	18/06	H
0128/1328	48HR SURFACE FORECAST	120/576	18/06	C
0148/1350	48HR 500MB/VORTICITY FORECAST	120/576	12/00	F
0209/----	24HR WIND/STREAM FORECAST	120/576	0000	D
0234/----	48HR WIND/STREAM FORECAST	120/576	0000	D
----/1412	24HR WIND/WAVE FORECAST	120/576	0000	E
----/1428	48HR WIND/WAVE FORECAST	120/576	0000	E
0258/1444	0/24 HR WIND/SEAS FORECAST (2 CHARTS)	120/576	00&00/12&12	G
0317/1503	48HR,48/72HR(2) WIND/WAVE FORECAST	120/576	00/12&12	G
0336/1522	48/72HR(2),48HR WAVE PERIOD/SWELL DIR	120/576	00&00/12	G
0355/1541	TROPICAL STREAMLINE ANALYSIS	120/576	18/06	K
0418/1604	NORTH PACIFIC SURFACE PRESSURE ANALYSIS	120/576	18/06	J
0533/1733	TEST-ID-SYMBOLS-GENERAL NOTICE	120/576		
0545/1745	SIGNIFICANT CLOUD FEATURES	120/576	00/12	A
0605/1804	PACIFIC SURFACE ANALYSIS	120/576	00/12	B
0630/1827	GOES IR SATELLITE IMAGE	120/576	LATEST	EP
0645/1842	GOES IR SATELLITE IMAGE	120/576	LATEST	SP
0656/1853	TROPICAL SURFACE ANALYSIS	120/576	00/12	H
0721/1918	PACIFIC OCEAN SEA SURFACE TEMPS	120/576	LATEST	NPA
0741/1937	0/24 HR WIND/WAVE FORECAST (2 CHARTS)	120/576	06&06/18&18	G
0800/1956	TROPICAL STREAMLINE ANALYSIS	120/576	00/12	K
0823/2019	NORTH PACIFIC SURFACE PRESSURE ANALYSIS	120/576	18/06	J

MAP AREAS:						
	A	-	50N-30S, 110W-160E	H	-	40N-40S, 105W-120E
	B	-	50N-30S, 110W-130E	J	-	50N-EQ , 110W-130E
	C	-	60N-55S, 055W-070E	K	-	30N-30S, 110W-130E
	D	-	50N-30S, 100W-120E	EP	-	55N-40S, 105W-155E
	E	-	60N-35S, 110W-130E	SP	-	05N-40S, 130W-165E
	F	-	50N-25S, 120W-120E	NPA	-	55N-EQ , 010W-160E
	G	-	30N-20S, 145W-080W			

(1)TROPICAL STREAM-FUNCTION ANALYSIS AND THE WIND/STREAM-FUNCTION FORECAST CHARTS DISPLAY 1000 MILLIBAR STREAM FUNCTION LINES. FOR SPEEDS IN KNOTS FOR ALL LATITUDES DIVIDE 50 BY THE SPACING BETWEEN THE STREAM FUNCTION LINES EXPRESSED IN DEGREES OF LATITUDE. THESE CHARTS, COMPUTER-GENERATED, ARE PARTICULARLY USEFUL IN THE TROPICS, WHERE THE ISOBARIC SPACING AND WIND-SPEED RELATIONSHIPS BECOME LESS MEANINGFUL. ARROWS ON THE STREAM-FUNCTION ANALYSIS CHARTS DEPICT VELOCITIES IN KNOTS OF THE TOPS OF LOWER CLOUDS DERIVED FROM SUCCESSIVE OBSERVATIONS BY SATELLITE. CAUTION - THESE CHARTS, BEING COMPUTER GENERATED, MAY NOT PROPERLY DELINEATE SMALL, THOUGH INTENSE, SYSTEMS IN DATA-SPARSE AREAS. NOTES ARE MANUALLY ADDED TO DIRECT ATTENTION TO SUCH SYSTEMS WHEN PRESENT.

(2)PACIFIC SURFACE ISOBARIC ANALYSIS CHARTS, MANUALLY ANALYZED AT THE WEATHER SERVICE FORECAST OFFICE/CENTRAL PACIFIC HURRICANE CENTER, HONOLULU DEPICT THE ISOBARIC (PRESSURE) FIELD NORTH OF 15 NORTH AND STREAM LINES SOUTH OF 15 NORTH; SPACING BETWEEN STREAM LINES IS NOT INDICATIVE OF WIND SPEEDS.

(3)THE 48-HOUR ISOBARIC SURFACE/THICKNESS FORECAST CHARTS DEPICT LINES OF EQUAL EQUAL PRESSURE IN MILLIBARS (SOLID LINES) AND, CHIEFLY OF INTEREST TO METEOROLOGISTS, 1000-TO-500 MILLIBAR THICKNESSES (DASHED LINES).

(4)THE SIGNIFICANT CLOUD FEATURES CHARTS DEPICT CLOUD FEATURES BASED UPON IMAGES FROM THE VARIOUS GEOSTATIONARY AND POLAR ORBITING SATELLITES OVER THE PACIFIC. ABBREVIATIONS ON THESE CHARTS INCLUDE: AC - ALTOCUMULUS; AS - ALTOSTRATUS; BKN - BROKEN; CB - CUMULONIMBUS; CC - CIRROCUMULUS; CI - CIRRUS; CS - CIRROSTRATUS; CU - CUMULUS; FEW - FEW; ISOL - ISOLATED; LYRS - LAYERS; NS - NIMBOSTRATUS; OVC - OVERCAST; SC - STRATO-CUMULUS; SCT - SCATTERED; TCU - TOWERING CUMULUS; TSTM - THUNDERSTORM

(5) THE 48-HOUR 500 MILLIBAR CHARTS DISPLAY 500 MILLIBAR HEIGHTS (SOLID LINES) AND VORTICITY LINES (DASHED LINES.)

(6) THE SATELLITE IMAGES ARE INFRARED CLOUD PICTURES TRANSMITTED IN REAL TIME AS THEY ARE BEING SCANNED BY SATELLITE.

(7) RADIOFAX FREQUENCIES ARE ASSIGNED FREQUENCIES. TO CONVERT TO CARRIER FREQUENCIES, SUBTRACT 1.9 KHZ FROM THE ASSIGNED FREQUENCIES.

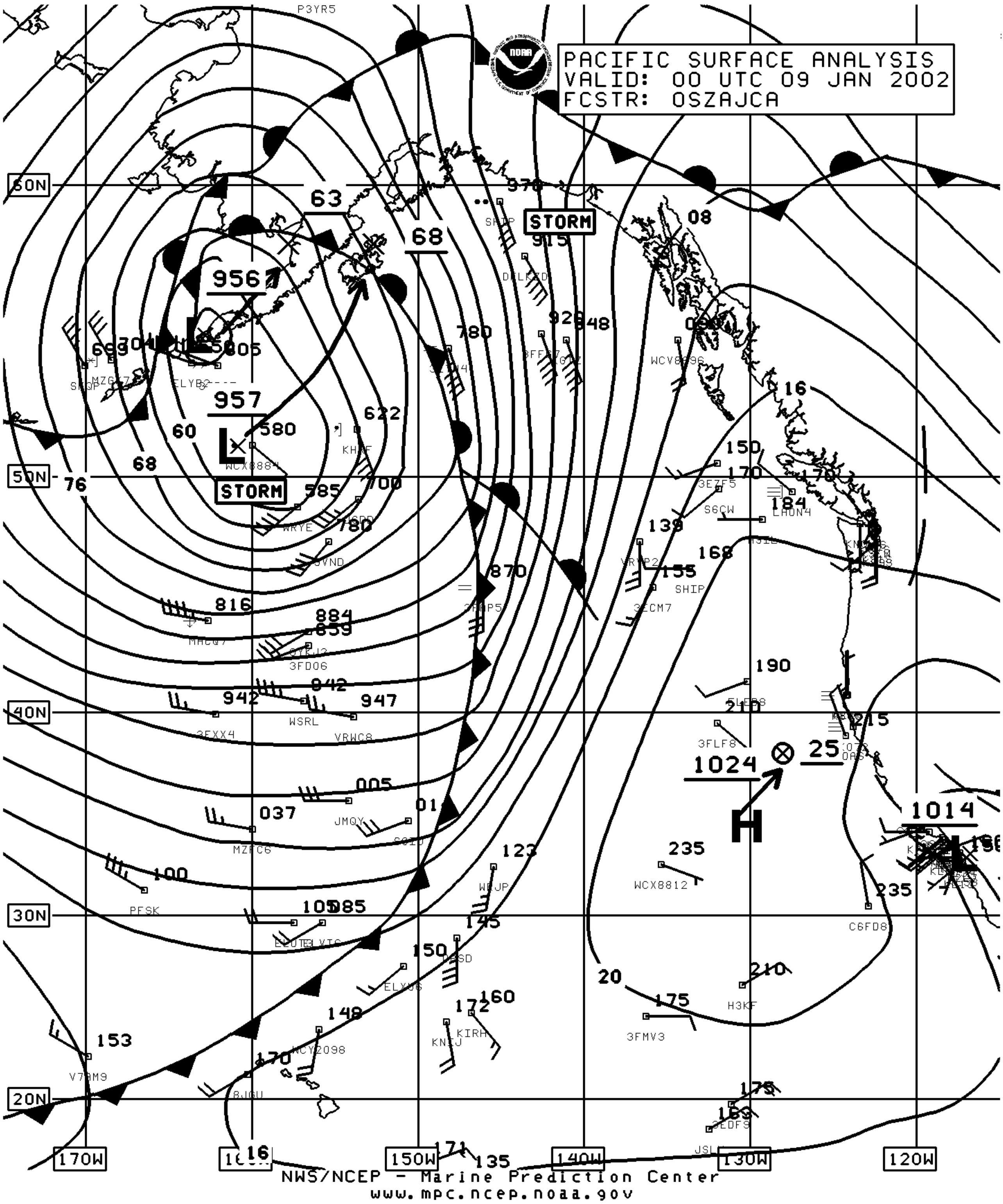
(8) BROADCAST MAY BE PERFORMED CONTINUOUSLY ON FOUR LISTED FREQUENCIES WHEN RESOURSES ARE AVAILABLE.

(9) TRANSMITTERS MAY BROADCAST AT 10KW AT TIMES.

(10) YOU MAY ADDRESS COMMENTS ABOUT THIS BROADCAST TO:

Meteorologist In Charge
National Weather Service
2525 Correa Rd.
Honolulu, HI 96822
PHONE: (808) 973-5286/FAX: (808) 973-5271
E-Mail david.meek@noaa.gov

(INFORMATION DATED 12/17/01)tdr
(INFORMATION DATED 08/17/99)tdr



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Radars

How Far Can You See?

Line of sight

Atmospheric refraction bends the beam slightly. As a rule of thumb, radar can "see" about 15 percent farther than a human observer located at the same height. When the antenna is mounted fairly low (say 10 feet above the surface), the visual horizon will only be three or four miles away.

The height of targets located beyond the visual horizon determines the actual radar range.

Distance (nautical miles) = 1.144 x (sq. root of h1 + sq. root of h2)

h1 equals the height of the antenna

h2 equals the height of the object. (Increase this distance by 15 percent for absolute maximum radar range.)

Output power

The amount of energy, in kilowatts, transmitted by the antenna

3,000 watts is usually considered about minimum for a long-range cruising boat (though a 2,000-watt unit is better than no radar at all).

Output power ultimately determines the amount of power reflected from a target, and this, coupled with receiver sensitivity, defines how small a target can be seen and at what range.

The line-of-sight rule still limits the ultimate range.

Beam Width

The horizontal beam width of a radar determines the bearing resolution (the radar's ability to discriminate between multiple targets that are close together). If the beam is wide enough to strike both objects at the same time, they will be displayed as a single target on the screen.

Beam width also affects the bearing accuracy by elongating a target's displayed image as the wider beam sweeps across it; this must be taken into account when taking bearings with radar. A narrow-beam antenna does a better job of focusing the available power and the result is more effective radiated power aimed at the target.

Choosing A Display

The amount of reflected energy or echo returned by the target determines the intensity of the displayed target image. Weak echoes provide dimmer images than strong echoes. The ability to display the strength of an echo at various levels of image intensity is called multilevel quantization.

A typical CRT display might offer as many as eight levels of quantization (though you may be hard-pressed actually to see that many). An LCD display with multi-level capability will define the strength of the echo by using more than one level of gray on the display. Four levels of quantization are typical in better LCD displays.

Cockpit-mounted displays are increasingly popular; some LCD displays can even be mounted on the pedestal. While the ability to view the radar from the helm is highly desirable, be careful of their definition of "waterproof." Often, a display can be mounted the display below decks but in a spot where it is visible from the cockpit. If you go this route, consider the brighter CRT display that's a little easier to read from a distance.

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Glossary of Radar Terms

A/C Rain Control: Anti-clutter control suppresses the reflected radar energy (clutter) from rain, snow and other forms of precipitation to prevent masking objects that might otherwise be lost in the clutter on the display. See FTC.

A/C Sea Control: Anti-clutter control suppresses display clutter caused by the reflection of echoes from waves in a seaway. Sea clutter on the display could obscure the return from other objects in the area preventing detection. See STC.

Beam Width: The horizontal and vertical angle of the path taken by the transmitted radar pulse. For small boat radars, the horizontal width of the beam is typically four to five degrees and the vertical beam width is 20 to 25 degrees.

Brilliance Control: Adjusts the brightness of the display.

EBL Control: Activates and deactivates the Electronic Bearing Line used to display the relative or true bearing to a target on the display. The EBL is moved with the cursor, and the bearing is usually read at the bottom of the screen in degrees relative to the vessel's track or heading if compass information is available to the radar.

Gain Control: Adjusts the sensitivity of the receiver to compensate for variations in the strength of the reflected radar pulse.

Guard Zone: An adjustable zone around your vessel set by the Guard Control. Once activated, any target that enters the guard zone will trigger an alarm. On some radars, the alarm will also be triggered when a target leaves the guard zone.

Maximum Detectable Range: The maximum range at which a target can be detected as determined by output power and antenna height. Doubling the output power increases the maximum detectable range by 19 percent. Doubling the height of the antenna increases the detectable range by approximately 43 percent assuming that power output is adequate for the range.

Minimum Detectable Range: Determined by the antenna height, vertical beam width and transmitted pulse length, this is the minimum range at which an object can be detected.

Off Center Control: Shifts the display center to a location (usually selected by the cursor) to permit better viewing of a specific area without changing range selections.

Offset EBL: An electronic bearing line that can be shifted to any position on the display. Regular EBLs always have one end anchored at the center of the screen.

Pulse Repetition Rate: The number of radar pulses transmitted each second. The pulse transmission rate is lengthened for longer ranges.

Plot Control: Plots the movements of objects relative to your own position by marking the positions of all targets on the display at the end of a preset time.

Range Control: Selects the scale used by the display and sets the distance between the range rings to correspond with the range selected. Internally, pulse rate and length are adjusted automatically when the range setting is changed.

Rings Control: Range rings are displayed on the screen when selected by this control and provide a rough estimate of the distance to a target displayed on the screen. The distance between the range rings is usually displayed in nautical miles in the corner of the screen along with the scale selected by the Range Control.

Radar Range: A measurement of the distance an object can be seen by radar based on the height of the antenna, the height of the object and atmospheric bending of the radar beam.

Resolution: Radar's ability to display individually two objects that are close together. Bearing resolution refers to closely spaced targets at the same range while range resolution is a measure of a radar's ability to display two targets that are on the same bearing and close together.

STC: Sensitivity Time Control circuits that can be adjusted with the STC control to change the gain characteristics of the receiver at close ranges. This helps to reduce display clutter caused by returns from the vertical portion of nearby waves.

Tune Control: Tunes the receiver frequency to the same frequency used by the transmitter. Not used on radars that incorporate automatic tuning.

VRM Control: Activates and deactivates the Variable Range Marker used to measure the distance to a target. An additional ring on the display is adjusted over the target with the cursor control and the distance to the object is usually displayed on the bottom of the screen.

Zoom Control: Zooms display in on the area around the cursor or between the cursor and the display center to enhance the view of a target of specific interest.

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Computer Insert

Raymarine RayTech Navigator™

PC based Navigation

RayTech Navigator is a unique PC navigation software solution designed to integrate multiple sources of data and on board information. RayTech combines state of the art chartplotting with advanced tools for accessing weather forecasts, tidal currents, live instrument displays and much, much more. Drawing on over 75 years of experience in building electronic navigation products Raymarine has designed RayTech to integrate easily with Raymarine's SeaTalk bus products and other NMEA 0183 compatible devices.

Features:

• View Maptech ®, C- Map ® Or SoftCharts ® On Your PC
• Plot A Route Using Point 'n Click Waypoints
• Get Instant Course And Distance Readings To Your Cursor
• Track Your Boat's Position (GPS Required)
• View Tides And Currents In Real Time And Plan Voyages Using Predicted Data
• Download Weather Files From this Web Site And Overlay Them On Your Charts
• 3- day Forecasts Are FREE!
• View MapTech Aerial Photo Chart and track your vessel position
• Split Screen Views of Aerial and Raster charts
• View Multiple Chart Types Simultaneously
• View 3D Bathymetric Contour charts and track your position
• Display Radar Targets(MARPA Radar w/NMEA required) and Radar EBL,VRM and Cursor
• Interface Raymarine SeaTalk instruments
• Optional SeaTalk interface box allows one simple point of connection to Raymarine's family of instruments, GPS, radars, autopilots, and fishfinders
• NMEA 0183 Compliant for connection to other brands of marine electronics

Raymarine Sail Racer™

Tactical Racing Suite

The ultimate sailing software integrates RayTech Navigator 3.0 chart plotting and weather monitoring capabilities with high performance modules designed for the club racer, offshore racer and serious cruiser. This is the same technology used by America's Cup,Whitbread and Around Alone crews. Includes RayTech Navigator 3.0 Plus:

•Race Analysis Tools for precise Instrument Calibration,Start, Wind Trends, Performance Monitoring, Layline and Navigation analysis

•Data Track Time Based Graphs for monitoring Wind Trends,Comparing Instruments and Vessel Performance.

•Polar Data Collection and Analysis application for identifying optimum speed and heading for varying conditions

•Route Optimization identifies your ideal route based on ocean current, wind speed and direction as well as your vessel's polar characteristics

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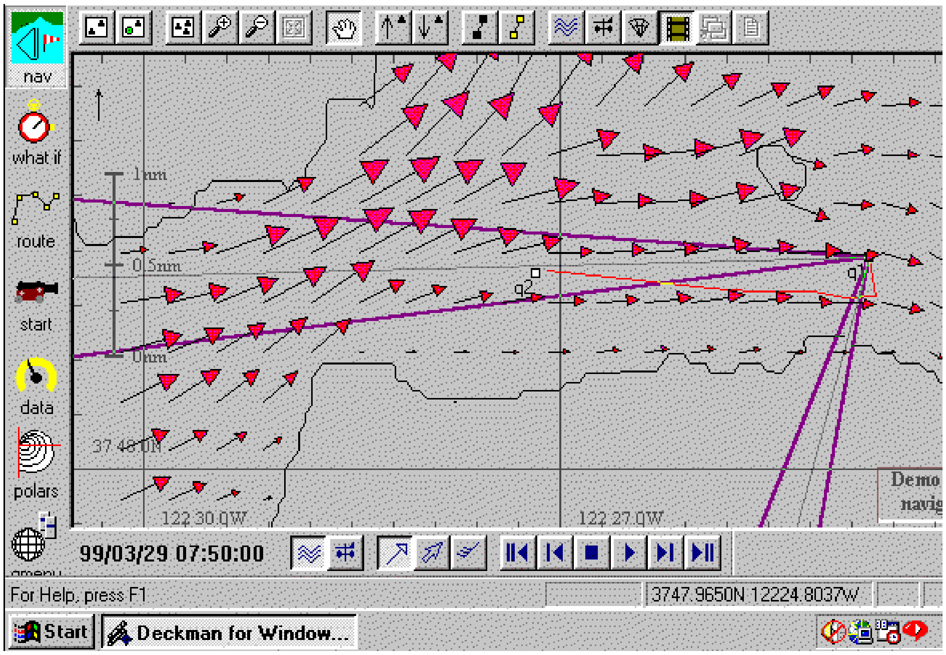
Computer Insert

Local Knowledge Marine Software

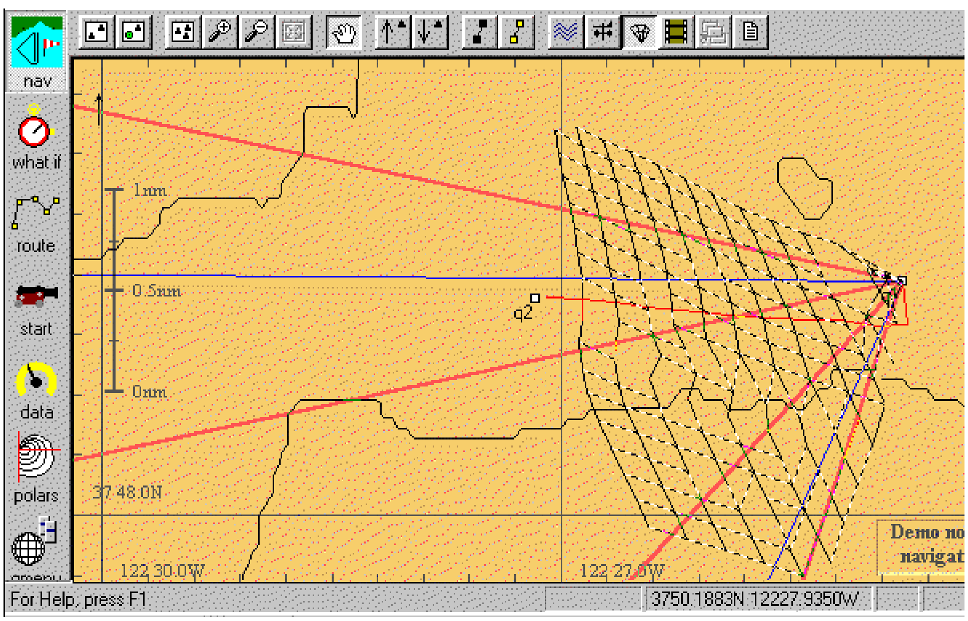
Local Knowledge has released a new product, a "current server," which will enable other popular tactical and navigational software to draw on our current models. If you are using Ockamsoft, Sailmath/Deckman or MaxSea, you can now purchase our "current server" as an "add-on" module. This will enable your program to use our method to compute currents, and thereby to produce much more accurate courses, laylines, etc.

The examples below were generated with Deckman, modified to draw on our San Francisco Bay current model:

Example 1: Deckman for Windows Using Local Knowledge Currents (SF Bay)



Example 2: Deckman for Windows: Isochrones in "Planning" Calculation



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Email Services for Yachts via Marine HF SSB Radio

See also Icom Material.

SailMail

Note: The following text is reprinted with permission directly from the SailMail website and references hyperlinks, depicted as underlined text, on that website. http://www.sailmail.com/

Background of SailMail

Stan Honey WA6IVA organized the SailMail Association, obtained the necessary FCC licenses, begged, borrowed, and bought the necessary equipment, wrote the internet gateway/multiple-station synchronization software, and assembled and installed the initial SailMail radio stations. Jim Corenman KE6RK wrote the AirMail program that serves as the email client running on PC's aboard member vessels and also is used at the SailMail stations to control the radios and HF-modems. Jim and Sue Corenman installed the Rockhill and Honolulu stations. Steve Chamberlin was the first member and user of the SailMail system and helped finance the original station. Sally Lindsay Honey manages membership registrations and helps run the network. The current directors of the SailMail Association are Stan Honey, Jim Corenman, Sally Lindsay Honey, and Steve Chamberlin.

All users of the SailMail service must join the SailMail Association in order to access the stations. The SailMail Association pro-rates the expenses for station operation among the members of the Association. The membership assessment is $200 per vessel, per year. This assessment is subject to change in the future as the number of members, the cost of station operation, and the cost of setting up additional stations vary. Any membership assessments received by the Association in excess of the funds required will be refunded to the members, pro-rata to each member's paid-in fee's.

The SailMail Stations could not be operating now without support from Chuck Hawley and the Rockhill, Palo Alto, Honolulu, and Corpus Christi staff of West Marine, Richard Spindler of Latitude 38, Don Melcher of HF Radio On Board, ICOM, Sally Lindsay Honey of Spinnaker Shop, and Martin (DL1ZAM) of SCS Inc. Please take lots of business to these companies in thanks for their support of SailMail.

We also want to thank the operators of overseas stations that handle SailMail traffic: Derek and Jeanine Barnard of Penta Comstat in Firefly NSW Australia, Justice Malanot of Bushmail in South Africa, William Latter of LMR Communications in Lunenburg Nova Scotia, Allan Riches of Brunei Bay Radio in Brunei Darussalam, and Philip Cazaerck in Belgium. We are looking for additional affiliates in South America; if there is interest contact sysop@sailmail.com.

In addition, a number of other individuals contributed to the effort: Jim Corenman KE6RK, developed the AirMail software. Jim Jennings W5EUT and Hans Kessler N8PGR were extremely supportive and their work on Netlink and Winlink, respectively, paved the way for HF email systems such as that of the SailMail Association.

What kind of email services does SailMail provide?

Depending on propagation, the quality of your radio (especially grounding system) installation, the type of equipment used, and the distance from the station, members are able to send and receive internet email at a rate varying between 10 characters per second to a maximum of 140 characters per second. These rates approximately compare to sending and receiving text on a PC using a modem of between 110 and 1200 baud. (remember those days?)

Clearly this does not allow "browsing the Internet." The objective of the SailMail station is not to provide "Internet Access" in any general sense but instead to allow sailors to send and receive plain-text Internet email from the high seas. These transfer rates, while stunningly slow by modern standards, are sufficient for sending and receiving plain-text email messages. For example an email message that could fit on one half of a type-written page would comprise about 1000 characters, and would take 10 to 90 seconds to transfer.

A half-page email is plenty long enough to send an update to family and friends, to order parts, to arrange travel, or to handle other logistical issues. A half-page email is a typical example, but the station will allow email messages that are up to 5 kBytes in length (about 2 type-written pages). There is no additional cost beyond the membership fee; i.e. there are no per-message fees. Members are requested, however, to limit their use of the SailMail stations to ten minutes per day. Members can send email to any Internet email address, and can receive email from anyone, addressed to:
CALLSIGN@SailMail.com (where CALLSIGN is your boat's marine callsign which should look something like WXY1234)

For example a typical email address for a SailMail member vessel could be:
WXY1234@sailmail.com

The SailMail Association has frequency allocations from 2 to 22 MHz at the stations. These frequencies provide communications at distances up to about 5000 miles from each station. SailMail has worldwide coverage and a number of members of the SailMail Association have circumnavigated and have used SailMail throughout their circumnavigation.

What does it cost to join the SailMail Association and use the station?

All users of the SailMail service must join the SailMail Association in order to access the station. The SailMail Association pro-rates the expenses for station operation among the members of the Association. The membership assessment is $200 per vessel, per year. This assessment is subject to change in the future as the number of members, the cost of station operation, and the cost of setting up additional stations vary. Any membership assessments received by the Association in excess of the funds required will be refunded to the members, pro-rata to each member's paid-in fee's.

Membership assessments pay for membership for one year from the date that the assessment is received.

Memberships are only available for one year periods, and are not refundable for any reason, including changes in a members cruising plans, or difficulties in using SailMail.

How do I sign up or renew my membership?

1. Read the Terms and Conditions of the SailMail Association.

2. Download and print copies of the FCC Licenses for the US SailMail stations, and keep the copies aboard. While you are at it download and print a copy of the SailMail Primer and any relevant Application Notes from the Primer and keep them aboard for reference.

3. Send a snailmail (old-fashioned letter) to the SailMail Association (at the address below) that includes your membership assessment ($200 check, cash, or credit card authorization), your vessel name, your marine callsign, your internet email address, and your signed confirmation that you have read and agreed with the Terms and Conditions. For your convenience (and ours) please print out and fill out the Application Form. If you are paying your membership assessment via a credit card, you can fax the completed and signed Application Form, including your credit card information, to the fax number listed below.

4. When your account is set up or renewed, you will receive a confirming email to your internet email address and to your SailMail address. This often takes up to a week; sometimes shorter when things work out conveniently, and sometimes longer when the sysops are out of town on their day jobs or off sailing themselves (it is only fair). Do not leave registration or renewal until the last minute. It is easier to do your installation when your registration is already complete and you can immediately test your system.

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5. If you are renewing, there is no advantage in waiting until the last minute. Your membership will be extended for one year from the time that it would have otherwise expired.

   (send membership assessment and membership information to:)
   SailMail Association
   921 E. Charleston Rd.
   Palo Alto, CA 94303

   fax: (650) 856-1638

How do I contact the SailMail Association?

The only way to contact the SailMail Association is by email to sysop@sailmail.com

There is no office, no full-time staff, and no phone number. Membership assessments are instead spent on operating expenses, improving the technology/service, and adding new stations.

RTFM (read the "fine" manual). Please carefully read this page as well as the SailMail Primer before emailing questions to the sysop. Pay particular attention to the "Frequently Asked Questions, Tips, and Trivia" section of the SailMail Primer.

Wait until you have diligently read the SailMail Primer and until you are in good humor before emailing messages asking for help or advice to the sysops; remember, we do this to support fellow cruisers, and not for a living. Be sure to include your radio callsign and vessel name in any email to the sysops.

How do I set up the gear?

You need to acquire an HF-modem, which is basically a special modem available from Ham Radio dealers that is designed to transfer data over radio. The SailMail system works best with the SCS PTC-IIpro or SCS PTC-IIe. The SCS PTC-IIe costs $649. SCS also makes a more expensive unit, the SCS PTC-IIpro that costs $985. The difference is the PTC-IIpro has a radio control output which enables it to remotely tune certain radios (i.e. Icom 700Pro, Icom710, Sea235, SGC2000). If you have one of these radios and want your laptop to tune it (which is handy) you need to either buy the PTC-IIpro, or if you get a PTC-IIe you will need to go through the hassle of adding a second serial port to your laptop (the first serial port is used by the SCS PTC-IIe). Both modems transfer data at up to 140 characters per second, and are available from SCS or the dealers listed below. There are no other differences between the two modems and elsewhere in this documentation the terminology PTC-II will be used to refer to both modems. Note that SCS used to build a modem with the model designation SCS PTC-II. For the purposes of SailMail this unit is equivalent to the SCS PTC-IIpro, and has a built in radio interface.

You might notice that SCS sells a special purpose commercial version of firmware that they confusingly have named "Marine Firmware." This firmware incorporates Selcall, WRU, and Free Signals. It turns out that the FCC prohibits these techniques to be used by Private Coast Stations (like SailMail) or by hams. If, for whatever reason, you have ended up with a SCS PTC-II with that firmware, it will work with SailMail, but it costs more and offers no advantages.

The SailMail system will also work but at substantially reduced performance with Pactor-1 modems, including the Kam+, Kam98, PK232, MFJ1276, or MFJ1278B. Unfortunately, these modems can only transfer data at rates up to 18 characters per second. The SG-7200 HF modem does not work on Pactor with the AirMail software and therefore does not work on SailMail.

Members should limit their use of the SailMail stations to 10 minutes per day, so if you intend to send or receive more than one or two short emails per day, or cruise beyond US coastal waters, you will need a PTC-II modem. The PTC-II modems send messages five times faster than Pactor-1 modems, and work much better with weak signals. Additionally, the PTC-II modems use your radio in a way that draws less battery power and is easier on your radio.

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Finally, the SCS PTC-II modems make terrific DSP-based weatherfax demodulators, using software that is available off of the internet (see the downloads page on the SailMail Website).

Whichever HF-modem that you buy, there is still much to do: you will need hook up the HF-modem with your radio and laptop, download the AirMail software, set it up, and learn how to operate the system. This can be tricky unless you get help.

You have two choices:

1. You can buy the HF-modem yourself, figure out and make the interface cables, download the software, read the documentation, and sort it all out. If you want to take this approach, there are instructions on this website in the SailMail Primer and in application notes referenced from the SailMail Primer. Alternatively...

2. you can get help from your marine/ham radio dealer who will sell you the HF-modem, make the special cables to connect it to your radio, hook it up, load the AirMail software in your laptop, and show you how to operate it. The radio-specific cables with ferrites etc. and installation will typically cost about $200-300 for a PTC-II. Even if you take this approach, you should print out the SailMail Primer, and keep it aboard as a reference.

Unless you either like sorting out details of interfacing laptops and radios, or you are unemployed, bored to tears, and looking for a challenge, we suggest that you contact your marine/ham radio dealer. It may turn out that you will need changes made in the configuration of your marine SSB in any event. If this is the case, then you will need the help of a licensed marine radio technician to make these changes.

There are many radio dealers who can sell and install an HF-modem for you. They will obviously charge you for their services to do the installation, but they are earning their money; the installation requires skill.

If you do use a dealer and arrange for a professional installation, you may want to refer to the Installation Checklist that is posted on this website. Discuss with your dealer in advance the cost, and which steps on the checklist he or she intends to complete. Be sure to watch the installation and checkout to gain familiarity with the system and installation.

How does SailMail compare to Ham Radio?

SailMail is not a Ham Radio system. You do not need a Ham license. All you need is to have a properly licensed marine SSB and join the SailMail Association (see the Terms and Conditions for eligibility).

The HF-modem that you purchase, however, is designed to be used on digital networks run by Ham Radio operators. Thus if you are a Ham, or if you become one, you can use your HF-modem on the Ham networks as well. Many SailMail members have developed an interest in radio from their use of SailMail and have subsequently become licensed Hams, and use the Ham WinLink system as well as SailMail. Conversely, many Hams who generally use the Ham WinLink system have joined SailMail in order to use SailMail for business-related communications that cannot be handled via Ham radio.

The Ham networks offer greater geographic coverage and contain more stations than SailMail or any other HF network. Further, the ham networks do not have any limits on connect-time, and permit users to send and receive file attachments like images and executables. By comparison, SailMail has usage guidelines of 10 minutes a day and only handles plain text email with limited attachments (weather data). Note, however, that while it is appropriate to send business-related messages over the SailMail system, business messages are not permitted on the Ham networks.

The SailMail system does not incorporate either a Ham Radio style bulletin board system or a land-line bulletin board system. Instead, the SailMail system only forwards plain-text internet email messages via SSB radio.

 anna@gofastmarine.com

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The SailMail stations are set up in the same configuration as that used on the Ham Radio digital networks for many years; each transceiver is hooked through an automatic antenna tuner to a single antenna. Each transceiver scans a dedicated set of frequencies and can connect to only one user at a time.

Can I use my HF-modem on other commercial marine email systems?

Yes, either the SCS PTC-II or the KAM+ can be used for Globe Wireless or other commercial radio networks in addition to the Ham networks.

The SCS PTC-II can possibly be used on PinOak, if PinOak is willing to modify it for you. Once modified, however, it cannot be used on any other network, including SailMail or the ham networks.

I want to run my business from my cruising boat and need absolutely reliable communications, several times a day; is SailMail (or any HF system) the solution?

No. Get a KVH Tracphone 25 and sign up for Inmarsat Mini-M service. Phone calls (and 2400 baud data calls) will cost about $2.80 per minute. Inmarsat Mini-M has worldwide coverage with the exception of polar regions.

If you only want email but it has to be absolutely reliable, get an Inmarsat C system. Email will cost about 1 cent per character (e.g. a two page text newsletter would cost $40 to send). Inmarsat C additionally offers good weather and notice-to-mariners information worldwide, and is part of the worldwide GMDSS system and so can be used for distress communications (in addition to your 406 epirb).

Globalstar has terrestrial coverage in many countries and complete coverage for the North Atlantic, including 9600 baud internet (and email) access. Unfortunately, beyond the North Atlantic, Globalstar only covers the ocean within two hundred miles of land. Proceed with caution, however, because Globalstar has recently suspended payments on their debt and one of their major investors, Qualcomm, has written off their investment.

Orbcomm is another possibility for pure email, but does not appear to have any advantages over Inmarsat-C. Orbcomm filed for Chapter 11 in September 2000, so one might check on the health of Orbcomm before investing in a unit.

Iridium is recently back on the scene, after their last brush with Chapter 11. They have announced a 10 kbps data service, which isn't available just yet. In their previous incarnation Iridium worked well, and so might be a reasonable alternative to Inmarsat.