

Pilot's Guide

KHF 1050

HF Communications System
(with PS440 Control Display Unit)



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KHF 1050 (PRIMUS HF 1050) SYSTEM DESCRIPTION

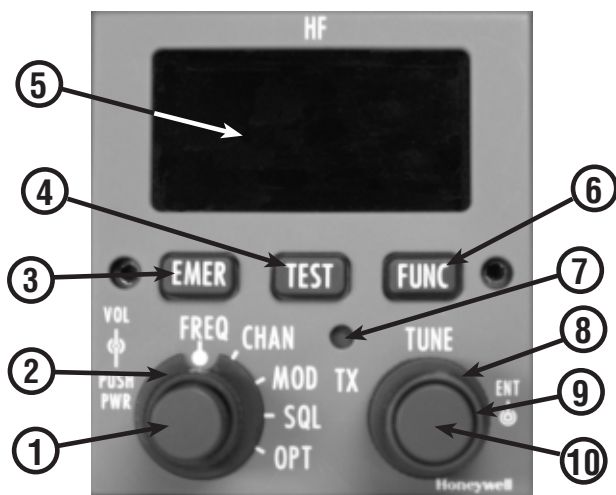
The KHF 1050 System (also known as the Primus HF 1050 System) is a solid-state high frequency single sideband transceiver system providing voice and data communication. Data communication is through an external modem.

This publication describes the operation of the KHF 1050 HF Communication System using the PS440 Control Display Unit.

SYSTEM OPERATION

PS440 CONTROL DISPLAY UNIT

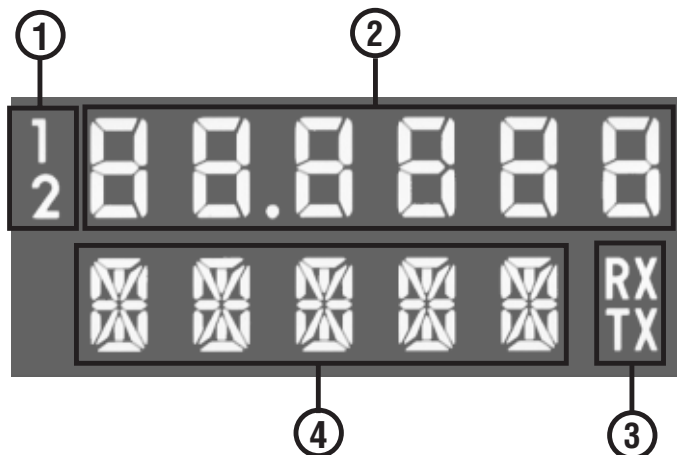
CONTROLS



- 1 **ON/OFF/Volume** - Inner concentric knob. Press ON and press OFF. Rotate to adjust volume.
- 2 **Function Selector** - Outer concentric knob. Rotate to select FREQ, CHAN, MOD, SQL or OPT.
- 3 **Emergency Channel Access Button** - Press to gain access to selection of emergency channels.
- 4 **Functional Test Button** - Press to initiate the built-in functional test.
- 5 **Display Area** - Digital display of frequencies, modes, channel numbers, etc.
- 6 **Sub-Function Select Button** - Press to enter and select sub-functions.
- 7 **Transmit Lamp** - Illuminates when the system is transmitting.
- 8 **Outer Selector Knob** - Right outer concentric knob. Rotate to select frequency, channel numbers, etc.
- 9 **Inner Selector Knob** - Right inner concentric knob. Rotate to select frequency, channel numbers, etc.
- 10 **Enter Button** - Press to store data entries.

Figure 1 - PS440 Controls

The control functions of the PS440 are described in the following sections. Refer to Figure 1 for control locations.



- 1 Controller Number** - Identifies the designation of the Control Display Unit. Pilot's side would normally be #1 and co-pilot #2.
- 2 Frequency Display** - Indicates transmit or receive frequency.
- 3 Transmit or Receive** - RX indicates displayed data pertains to receive state. TX indicates data pertains to transmit state.
- 4 Information Display** - Alpha-numeric characters conveying information such as selected mode, channel number, squelch type/value, power setting, clarifier setting, etc.

Figure 2 - PS440 Display

DISPLAY

Figure 2 defines the display areas.

PS440 OPERATION

ON/OFF/VOLUME

This smaller inner concentric knob (lower left) turns the system off and on and controls volume. Pressing the inner knob turns the system on. Pressing and holding the inner knob for 3 seconds turns the system off. Rotating the inner knob clockwise increases volume. Counterclockwise rotation decreases volume.

A built-in functional test is performed at power-up. The test should take no longer than 30 seconds. If any problems are found, the system will enter a Fail Mode.

The functional test may also be initiated by pressing and holding the **TEST** button for three seconds. After three seconds, all display segments will be lit and the **TX** lamp will be illuminated. Allow at least 30 seconds for the test to complete. Press the **TEST** button again to exit the test mode.

FAIL MODE

If there is a failure in the PS440 the bottom row on the display will show **PANEL**.

A failure elsewhere in the system will display **FAIL** (**ACP** in the case of an Antenna Coupler pressure warning or failure) on the top row of the display.

Depending on the nature of the failure, the system will display the following on bottom row of the display:

RXEX Receiver/Exciter Failure

PA Power Amplifier Failure

CPLR Antenna Coupler Failure

PRS W Antenna Coupler Pressure Warning (service will be required soon)

PRS F Antenna Coupler Pressure Failure (transmitter power has been reduced to 50 Watts. The antenna coupler requires service.)

SQUELCH

The KHF 1050 system offers four types of squelch with corresponding values as follows:

SBH - (Syllabic Squelch High). This is the default squelch and is usually best for normal voice communications. A syllabic squelch opens upon receiving a signal with voice-like characteristics while ignoring other signals. With syllabic squelch, there is the possibility that the first syllable of a voice reception may be partially squelched. The possible adjustment levels are open, meaning no squelch action (**OPN**), minimum (**MIN**), medium (**MED**) and maximum (**MAX**).

SBL - (Syllabic Squelch Low). This squelch is also a syllabic squelch and is intended for voice communications where the desired signal is very weak and noisy. This squelch is more prone to opening on noise than the SBH squelch. The possible adjustment levels are open (**OPN**), minimum (**MIN**), medium (**MED**) and maximum (**MAX**).

SQH - (Signal Strength Squelch High). This is a traditional signal-to-noise squelch best suited for listening to non-voice signals, or voice signals that do not respond well to one of the syllabic squelches. The possible adjustment levels are **1-32**, where **1** is open squelch.

SQL - (Signal Strength Squelch Low). This is a signal strength squelch which opens on any strong input signal. This squelch opens quickly on strong signals, but also opens on strong noise or static. This squelch is recommended for use only on desired signals that are strong and under low noise conditions. This squelch is well suited for music broadcasts. The possible adjustment levels are **1-32**, where **1** is open squelch.

Perform the following steps to set the squelch:

1. Rotate the left outer concentric knob to the **SQL** position. See Figure 3. The value of the active squelch is displayed on the right bottom row of the display. At system power-up the last selected squelch will be active.
2. Press the **FUNC** button to cycle through the four types of squelch. Turn the right inner knob to select the desired value for the selected squelch type. See Figure 4.

NOTE: It is important to know that squelch operation in HF is not as predictable as in conventional VHF communications. **It is not unusual for conditions to make it necessary to make squelch inactive (open) to maintain satisfactory reception.** Otherwise the signal may fade below the threshold you have set on the squelch, and you may miss an important message from a ground station. This is unlike VHF receiver squelch where you are normally dealing with a strong, non-fading signal. For this reason SELCAL may be a desirable option.



Figure 3



Figure 4

DIRECT TUNING A FREQUENCY

SELECTING THE PROPER OPERATING FREQUENCY

Long range communications are possible due to the signals being reflected back to earth by the ionosphere. The ionosphere's ability to propagate HF radio signals is dependent on many factors. These include time of day, season of the year, solar activity and latitude. Various frequencies propagate differently as they travel through the ionosphere. See Appendix A for more information.

It is important that the selected operating frequencies be appropriate for the distance between the aircraft and the ground station or other aircraft. If communications cannot be established on a particular frequency, attempt to establish communications on other appropriate frequencies. Table 1 summarizes the typical propagation distances of various frequencies.

In direct tune operation, the pilot may select directly any of 280,000 frequencies in the range of 2.0 to 29.999 or 29.9999 MHz depending on installation configuration.

Frequency Band (MHz)	Daytime Distance (Miles)	Nighttime Distance (Miles)
2.8	Up to 100; Often unusable	Up to 400
4.4	Up to 200	Up to 1000
5.5	Up to 300	100 to 1200
6.5	100 to 600	200 to 1500
8.8	200 to 800	400 to 1500 or greater
10.0	300 to 1000	500 to 1800 or greater*
11.1	400 to 1200	600 to 1800 or greater*
13.3	600 to 1500 or greater	Often unusable
17.9	700 to 1800 or greater*	Often unusable
21.9	900 to 1800 or greater*	Often unusable

The transition between daytime and nighttime distances may occur gradually over a several hour period. During this transition, communication distances between the daytime and nighttime distances listed will generally be realized.

* At times, communication may not be possible on this band during this time-frame. However, during periods of good propagation, worldwide communications may be realized.

Table 1 - Typical HF Signal Propagation Distance for Common Aviation Bands

There are two types of frequency operation. “Simplex” is tuning the same frequency for receive and transmit. “Semi-duplex” (sometimes called “split”) is tuning two different frequencies, one for receive and one for transmit. It is important to know the requirements of the desired ground station when tuning these frequencies. Virtually all aviation services operate on simplex.

SIMPLEX DIRECT TUNING

1. Turn the left outer knob to **FREQ**. See Figure 5. The frequency shown in the upper row of the display is the receive frequency indicated by the **RX** on right of the display.
2. Select the desired frequency using the right inner and outer concentric knobs. The outer knob changes the frequency in .1 MHz increments. The inner knob changes the frequency in .001 MHz (1 KHz) increments or .0001 MHz (100 Hz) increments, depending on the configuration selected when the system was installed.



Figure 5

The transmit frequency will automatically track the receive frequency when tuning, providing for simplex operation. To verify the transmit frequency, press and hold the **ENT** button located on the end of the right knobs. **RX** and **TX** will be illuminated on the display and the transmit frequency will be displayed in the upper row.

3. Tune the antenna coupler. Momentarily press the push-to-talk button to initiate antenna tuning. During the tuning process the **TX** lamp (just below the **TEST** button) will flash and the frequency numbers will blank. A tune tone will be heard, if enabled during system installation. When the **TX** lamp stops flashing and the frequency reappears, the antenna tuning cycle is complete and you are ready to transmit on the selected frequency.

In the event the antenna coupler is unable to tune to the selected frequency, the frequency digits and the **TX** lamp will flash. If enabled, a tune tone will sound intermittently. Press push-to-talk once or twice to clear the fault or initiate another tune cycle attempt. The fault may also be cleared by selecting a different frequency. After the new frequency is selected, press the push-to-talk to tune the antenna coupler.

NOTE: The KHF 1050 stores the antenna coupler tune information for previously tuned frequencies. If the antenna coupler was previously tuned for the current frequency (or nearby frequency) the antenna coupler may not need to be tuned and transmission may begin immediately. It is advisable to always press the push-to-talk button after selecting a new frequency to initiate antenna tuning. Otherwise poor reception may be experienced or it may not be possible to hear a ground station which is calling.

SEMI-DUPLEX DIRECT TUNING

If operating in a situation that requires a transmit frequency that is different than the receive frequency (semi-duplex) a different transmit frequency may be tuned.

1. Turn the left outer knob to **FREQ.** See Figure 5. The frequency shown in the upper row of the display is the receive frequency indicated by the **RX** on right of the display.

2. Press and hold the **ENT** button.

3. Momentarily press the **FUNC** button, then release the **ENT** button. The transmit frequency can now be tuned independent of the receive frequency. Note that **TX** is now illuminated on the display indicating that the displayed frequency is the transmit frequency. See Figure 6.



Figure 6

4. Select the desired frequency using the right inner and outer concentric knobs. The outer knob changes the frequency in .1 MHz increments. The inner knob changes the frequency in .001 MHz (1 KHz) increments or .0001 MHz (100 Hz) increments, depending on the configuration selected when the system was installed.

5. Press the **ENT** button again to accept the new transmit frequency. If the **ENT** button is not pressed and the system detects no further activity, the system will revert to the previous transmit frequency.

6. Momentarily press push-to-talk to tune the antenna to the new channel frequency.

NOTE: Always press the push-to-talk button after selecting a new frequency to initiate antenna tuning. Otherwise poor reception may be experienced or it may not be possible to hear a ground station which is calling.

MODE SELECTION

Emission Mode selection options include Upper Sideband Voice (**USB V**), Lower Sideband Voice (**LSB V**), Upper Sideband Data (**USB D**), Lower Sideband Data (**LSB D**), AM Voice (**AM**) and Reduced Carrier (**RC**). Upper Sideband Voice will always be available, but availability of the other choices depends upon options selected when the system was installed.

It is important to know the correct Mode that matches the requirements of the ground station. Upper Sideband Voice and Data are considered the standard and most commonly used. Some older stations may still use AM Voice. Also, AM Voice is best for listening to voice broadcast stations. Some stations have the ability to lock on to a transmitted carrier to avoid frequency errors. When communicating with one of these stations, Reduced Carrier may be used.

To select the desired mode turn the left outer knob to **MOD**. See Figure 7. Pressing the **FUNC** button will toggle between modes. Also, turning the right inner or outer knob will advance through the modes. See Figure 8.



Figure 7



Figure 8

CHANNEL OPERATION AND PROGRAMMING

The 100 programmable channels available with the PS440 Control Display Unit are easily programmed on the ground or in the air. Channels are 00-99. Channel 00 is always turned to 2.182 MHz. In addition, there are six emergency channels, five of which can be programmed. Channels are EMR 2 - EMR 6. EMR 1 is tuned to 2.182 MHz. It is the default channel and cannot be changed.

Simplex and semi-duplex frequency tuning also applies when programming channels. It is important to know the requirements of the desired ground station when programming frequencies.

In addition to assigning frequencies to a channel, a mode is also assigned.

Channel Operation

The following steps illustrate how to select already programmed channels.

1. Turn the left outer knob to **CHAN** as shown in Figure 9. The last selected channel will be displayed.
2. Turn the right inner or outer knob to select the desired channel number.
3. Momentarily press push-to-talk to tune the antenna to the new channel frequency.



Figure 9

Emergency Channel Operation

Emergency channels typically use simplex operation. However channels 2 - 6 can be programmed for semi-duplex operation.

The emergency channels are programmed at the factory according to Table 2. Only channels 2 - 6 may be changed.

	Frequency (kHz)		ITU Channel	Assignment
Channel	Simplex Tune (Default)	Semi-Duplex (also called Split)		
EMR 1	2182	Simplex Only	----	International Distress and Calling.
EMR 2	4125	Rx: 4417 Tx: 4125	421	International Distress and Calling.
EMR 3	6215	Rx: 6516 Tx: 6215	606	Maritime Distress and Calling.
EMR 4	8291	Simplex Only	833	Maritime Distress and Calling.
EMR 5	12290	Rx: 13137 Tx: 12290	1221	Maritime Distress and Calling.
EMR 6	16420	Rx: 17302 Tx: 16420	1621	Maritime Distress and Calling.
Simplex operation is typically used for communicating with other aircraft, ships or emergency ground stations.				
Semi-Duplex operation may be used for communications with Maritime Radiotelephone Network ground stations.				
Upper Sideband Voice is the only emission mode available when using emergency channels.				

Table 2 - PS440 Emergency Channels (Factory Default Programming

The following steps illustrate how to select already programmed emergency channels.

1. Press and hold the **EMER** button for approximately 2 seconds. The display will appear as shown in Figure 10 with EMR 1 as the default channel.

2. If other than EMR 1 is desired turn the right inner or outer knob to select the desired emergency channel number.

Even if the selected channel has previously been programmed for semi-duplex operation, simplex operation will initially be selected. If desired, press the **ENT** button to select semi-duplex operation. **SPLT** will be displayed for two seconds in the lower part of the display. Press the **ENT** button again to return to simplex operation. **SIMP** will now be displayed for two seconds in the lower part of the display. Repeated pressing of the **ENT** button will toggle between simplex and semi-duplex operation.



Figure 10

3. Momentarily press push-to-talk to tune the antenna to the new channel frequency.

4. Press the **EMER** button to exit the emergency channels.

Channel Programming

The following steps show how to program channels into memory.

1. Turn the left outer knob to **CHAN**. The last selected channel will be displayed. Refer to Figure 9.
2. Press and hold the **FUNC** button for approximately 3 seconds. The channel window will start flashing indicating entering programming mode.
3. Turn the right inner or outer knob to select the desired channel number.
4. Press the **ENT** button on the end of the right knob. The selected channel is stored and the receive frequency will begin flashing.
5. Use the right inner and outer knobs to select the desired receive frequency. Remember to check ground station requirements as to the need for simplex or semi-duplex operation.
6. Press the **ENT** button. The selected receive frequency is stored and the Mode will begin flashing.
7. Turn the right inner or outer knob to select the desired emission mode.
8. Press the **ENT** button. The selected Mode is stored and the transmit frequency will now begin flashing.
9. If the channel requires simplex operation, again press the **ENT** button to store the automatically displayed transmit frequency. The channel window now displays the next available channel number.
10. If the channel requires semi-duplex operation, use the right inner and outer knobs to select the desired transmit frequency. Press the **ENT** button. The transmit frequency is stored and the channel window now displays the next available channel number. Again, check the ground station requirements as to the need for simplex or semi-duplex operation.
11. Press and hold the **FUNC** button for approximately 3 seconds to exit programming. The display reverts to the last channel programmed.

Emergency Channel Programming

Following steps show how to program emergency channels into memory.

1. Press and hold the **EMER** button for approximately 2 seconds. The display will appear as shown in Figure 10 with EMR 1 as the default channel.
2. Press and hold the **FUNC** button for approximately 3 seconds. The channel window will start flashing indicating entering programming mode.
3. Turn the right inner or outer knob to select the desired channel number.

4. Press the **ENT** button on the end of the right knob. The selected channel is stored and the receive frequency will begin flashing.
 5. Use the right inner and outer knobs to select the desired receive frequency. Remember to check ground station requirements as to the need for simplex or semi-duplex operation.
 6. Press the **ENT** button. The selected receive frequency is stored and the Mode will begin flashing. Only USB V is available when programming an emergency channel.
 7. Press the **ENT** button. The selected Mode is stored and the transmit frequency will now begin flashing.
 8. If the emergency channel requires simplex operation, again press the **ENT** button to store the automatically displayed transmit frequency. The channel window now displays the next available emergency channel number.
 9. If the channel requires semi-duplex operation, use the right inner and outer knobs to select the desired transmit frequency. Press the **ENT** button. The transmit frequency is stored and the channel window now displays the next available emergency channel number. Again, check the ground station requirements as to the need for simplex or semi-duplex operation.
- NOTE: On any Emergency Channel with separate receive and transmit frequencies, simplex operation will occur on the programmed channel's transmit frequency when the channel is first selected.*
10. Press the **EMER** button to exit.

CLARIFIER

The purpose of the Clarifier is to help eliminate the unnatural “tinny sound” found at times with SSB audio voice quality as a result of off-frequency ground station transmissions. The Clarifier works by allowing frequency adjustment of ± 250 Hz whether the channel involved is semi-duplex or simplex tuned. It is not normally used in the AM mode.

Long range HF signals received under less than optimum propagation conditions may still vary in quality and volume.

To use clarifier, perform the following steps:

1. Turn the left outer knob to **OPT**. The Clarifier will be displayed first, denoted by the **C** as shown in Figure 11.



Figure 11

2. Turn the right inner knob to adjust the Clarifier frequency up or down for reception.
3. Select any other function to exit the Clarifier. When another frequency or channel is selected the Clarifier value will return to 000.

MARITIME RADIOTELEPHONE NETWORK (PUBLIC CORRESPONDENCE) CHANNEL OPERATION

All 246 ITU public correspondence channels in the maritime radiotelephone network are programmed permanently in the electronic memory of the KHF 1050 System. These channels may be used by aircraft to make telephone calls through the High-Seas-Operator Network. Refer to Appendix B for channels and frequencies.

To use the ITU channels perform the following steps:

1. Turn the left outer knob to **OPT**. The Clarifier will be displayed first, denoted by the **C** as shown in Figure 11.
2. Press the **FUNC** button until the last tuned ITU channel appears in the lower right of the display as shown in Figure 12. The lower left will be blank.
3. Turn the right inner or outer knob to select the desired ITU channel.
4. Momentarily press push-to-talk to tune the antenna to the new channel frequency.
5. Select any other function to exit.



Figure 12

TRANSMIT POWER SELECTION

The KHF 1050 System transmit power can be adjusted for optimum communication quality dictated by conditions such as ionospheric conditions and distance to station. Available settings are Minimum (**MIN**), Medium (**MED**) and Maximum (**MAX**).

MIN = 50 Watts

MED = 100 Watts

MAX = 200 Watts

To change the transmit power, perform the following steps:

1. Turn the left outer knob to **OPT**. The Clarifier will be displayed first, denoted by the **C** as shown in Figure 11.

2. Press the **FUNC** button until transmit power is selected, denoted by the **P** and a value in the lower part of the display as shown in Figure 13.

3. Turn the right inner or outer knob to select the desired transmitter power output.

4. Select any other function to exit.



Figure 13

DATA COMMUNICATIONS

The KHF 1050 System will transmit and receive data, such as fax transmissions, etc. Data communication requires an external modem be installed with the system.

Before transmitting or receiving data, select the appropriate Mode (**USB D**, **LSB D** or possibly **AM**) as previously discussed in Mode Selection. Check the requirements of the desired station.

AVIATION SERVICES AVAILABLE TO HF USERS

In addition to using the KHF 1050 for air traffic control functions, HF users can also take advantage of other HF services.

ARINC AIR/GROUND INTERNATIONAL RADIO SERVICES

This service can be used to coordinate flight and ground activities, advise dispatch of events, provide radio checks and a variety of other related services.

Arrangements can be made with ARINC by calling 1-800-633-6882 in the United States. Internationally, use the AT&T Access Code + 1-800-633-6882. Or visit www.arinc.com/products/voice_data_comm/.

UNIVERSAL WEATHER AND AVIATION INC/HOUSTON RADIO

This service can be used to forward messages, perform phone patches, provide flight following, give weather updates, provide radio and SELCAL checks and forward ETAs to appropriate government agencies.

To make arrangements with Universal/Houston Radio, call 1-800-231-5600 extension 8311 in the United States. Internationally, call 713-944-1622 extension 8311. Or visit www.univ-wea.com.

WLO MARINE RADIO

This service in Mobile Alabama allows aircraft equipped with the KHF 1050 system to make telephone calls through the Maritime Radiotelephone Network (High-Seas Operator). Information about High-Seas Operator stations in other parts of the world can also be obtained from WLO.

Contact by calling 251-666-5110 or visit www.wloradio.com

APPENDIX A

CHARACTERISTICS OF HF SINGLE SIDEBAND COMMUNICATIONS

HF SSB COMMUNICATIONS

High frequency single side band communications achieve reliable long range transmission and reception over distances of thousands of miles. The primary reason is due to skywave propagation which allows HF radio waves which are beamed toward outer space to be reflected back toward the earth's surface by the ionosphere. Another reason is because of a transmission process known as single sideband which puts all the transmitter's power into sending just a radio wave containing the intelligence to be communicated. Both of these make HF radio highly useful to aircraft flying over water or desolate land areas when they are out of reach of VHF communications which are limited to line of sight transmissions.

FREQUENCY

The frequency of a radio wave is the number of cycles of that radio wave which pass a given point within one second. The longer the wavelength, the lower the frequency. The frequency is often expressed as cycles per second, with one complete wave representing a cycle. The term **hertz** (Hz) is more commonly used today to represent one cycle per second. Expression of the measurement Hz has a shorthand of its own. When thousands of Hz are expressed, they are designated **kilohertz** (kHz), and millions of Hz as **megahertz** (MHz). Thus, the notation 29.9999 MHz represents a signal which is passing a given point at 29,999, 900 cycles per second. Expressed in kHz, the same figure would read 29,999.9 kHz representing 29,999.9 thousand cycles per second. In using HF, you will encounter both MHz and kHz notations for frequencies.

The **high frequency** (HF) band covers from 2.0 MHz to 30 MHz (2,000 kHz to 30,000 kHz). The HF band lies between the medium frequency (MF) band and the very high frequency (VHF) band. Pilots are familiar with the characteristics of MF frequencies through the use of ADF equipment and know that these signals hug the ground and are sensitive to variations in terrain and to atmospheric disturbances. On the other hand, pilots know that VHF frequencies such as are used in VOR navigation and normal communications with Air Traffic Control facilities generally travel line-of-sight range and are not greatly affected by atmospheric disturbances. As will be discussed next, HF has its own characteristics which allow long range communications to take place.

SKYWAVE PROPAGATION - WHICH FREQUENCY TO USE?

As mentioned earlier, HF's primary method of travel or propagation is via skywaves which are radio waves that start out radiating into space and are reflected off the ionosphere back to the earth's surface. This reflecting of signals makes communications possible over very long distances—under ideal conditions, more than 4,000 miles and typically in excess of 2,000 miles—possible. Because of variations in the ionosphere, HF communications require more analysis of conditions and operational decisions (such as frequency selection) than VHF communications.

The ionosphere is a multi-layered band of electrically charged particles surrounding the earth. It varies in height above the surface of the earth from approximately 30 to over 400 miles. The height and intensity varies from one location to the next and according to the season of the year and the time of day.

Because HF radio waves depend upon the ionosphere for reflection, their propagation is affected by changes in the ionosphere. It is changes in the density of the electrically charged particles in the ionosphere which cause propagation to improve or deteriorate. Since the ionosphere is formed primarily by the action of the sun's ultraviolet radiation, its thickness changes in relation to the amount of sunlight passing through it. Sunlight-induced ionization increases the particle density during the day and the absence of it reduces the particle density at night. At midday, when the sun's radiation is at its highest, the ionosphere's thickness may expand into four layers of ionized gas. During the nighttime hours, the ionosphere diminishes, normally merging into just one layer.

Solar disturbances including solar flares and magnetic storms can cause propagation of HF radio waves to deteriorate rapidly. HF signals can also suffer interference from such atmospheric disturbances as precipitation and thunderstorms.

The net result of all these factors is that because the ionospheric and atmospheric conditions are constantly changing, HF communications can vary in quality and strength. The signal received on the KHF 1050 may be accompanied by a considerable amount of static from atmospheric disturbances, or it may fade in and out at times because each radio wave which hits the changing ionosphere may be reflected differently. Your reception and transmission success may vary from loud and clear to nonexistent depending on your selection of frequency and the conditions in the atmosphere and the ionosphere. One of the best things the pilot can do to assure the best possible HF communications, based on existing HF propagation conditions, is to select the proper frequency. A good rule of thumb for the time of day is that the higher frequencies are best during daylight (10 to 29.9999 MHz) and lower frequencies work best at night (2 to 10 Mhz).

This rule of thumb can be explained by a mirror analogy. It is the electrically charged particles in the ionosphere which reflect or bend radio waves back toward earth like a mirror reflects light. Sunlight induces ionization and increases the density of these particles in the ionosphere during the day. The mirror becomes thicker and it reflects higher frequencies better. When the sun goes down the density of charged particles decreases and the ionosphere becomes a mirror that can only reflect lower frequencies in the HF band.

For any one particular frequency, as the angle at which an HF radio wave hits a layer of the ionosphere is increased, a **critical angle** will be reached from which the wave will just barely manage to be reflected back to earth (Figure 1A). Waves entering at sharper angles than this will pass through this layer of the ionosphere and be lost in space (or may reflect off another layer of the ionosphere).

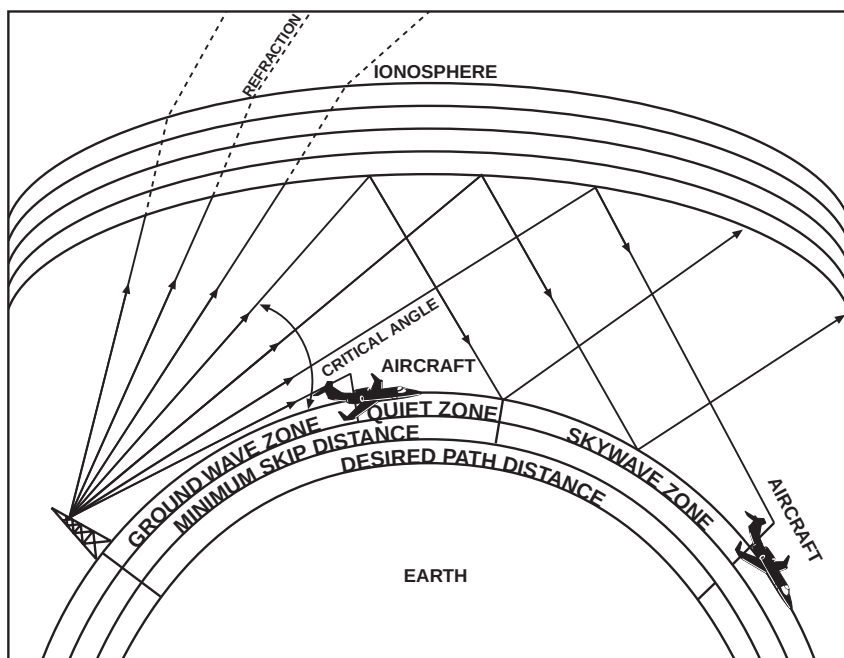


Figure 1A - Effects Of Different Skywave Paths

Changing the frequency under the same conditions will change the critical angle at which the HF radio waves will be reflected back to earth. The highest frequency which is reflected back to the earth is called the maximum useable frequency (MUF). The best HF communications are usually obtained using a frequency as close to the MUF as possible since radio waves higher than this frequency are not reflected and radio waves lower than this frequency will be partially absorbed by the ionosphere.

You should also be aware of the possibility that you or the ground station you are calling may be in a quiet zone. The linear distance from the point of transmission to the point where the skywave returns to earth is called the skip distance. There may be a quiet zone between the end of the ground wave and the return of the skywave. No communication can take place in this area. At any time, day or night, there is a “window” of useable frequencies created by the reflecting properties of the ionosphere. At night this “window” will normally be in the lower range of HF frequencies, and during the day it will be in the higher range of frequencies.

Normally you will not know what the MUF is at any particular time and location unless you have a table of propagation forecasts. Just remember that the higher frequencies in the “window” of useable frequencies are likely to be the most effective. The closer a frequency is to the MUF, the better it is likely to be.

The effect of solar disturbances including solar flares and magnetic storms is to change the particle density in the ionosphere. Therefore, the “window” of useable frequencies may begin to close, with radio waves of frequencies in the lower range dropping out first as they are absorbed by the ionosphere.

Next, the radio waves of upper frequencies in the useable “window” may start to penetrate the ionosphere and go into outer space. It is even possible for the entire “window” to close, particularly if you are flying in a polar region in latitudes above 60 degrees north or 60 degrees south. Solar disturbances have the most negative effects on HF communications in these regions.

If you are flying in polar regions and are having difficulty raising any ground station located in the same region, remember this: even though the “window” of useable frequencies may have closed in the polar regions, another “window” may be open in regions closer to the equator which are less affected by solar disturbances. Try calling a station closer to the equator in latitudes lower than 60 degrees north or 60 degrees south, and use a higher frequency. If you can raise a station in these areas, that station may be able to relay your message.

There are even times when solar disturbances improve the usability of higher frequencies in the HF band, particularly in equatorial regions. Another phenomenon which occurs during solar disturbances may allow you to communicate with a station even though the “window” is closed. This is known as scatter propagation, in which a radio wave is broken up in the ionosphere and scatters in various directions.

Because frequency propagation cannot be predicted with total accuracy, ground stations responsible for aircraft HF communications will typically operate on several different frequencies within the HF band. The pilot is then able to choose the optimum communication frequency for the existing ionospheric conditions.

One feature that will be particularly useful when a trial and error method is used to find an HF frequency which is working well. This is the system's capability to be programmed by the pilot with 100 channels using the PS440 Control Display Unit. Rather than having to select the four to six digits each time you want to try another frequency, you can preprogram the frequencies you need to contact a particular ground station. Then if you call and fail to get through, you just change to another channel.

NOTE: It is advisable to program at least three frequencies for each station you plan to contact, in case one frequency suddenly becomes unusable. During times of solar disturbances, a useable frequency can fade out in less than a minute. And the "window" of useable frequencies can shift rapidly during solar disturbances or during sunset and sunrise when the level of ionization in the ionosphere is changing rapidly.

Tables 1A and 2A show typical propagation distances due to reflection from the ionosphere for various frequencies during different hours of the day and for different seasons of the year. It may prove helpful in selecting the optimum HF frequency for the communications distance your operation requires.

Frequency (kHz)								
4000			8000		12000		16000	
Propagation (Miles)								
	Min	Max	Min	Max	Min	Max	Min	Max
Hours After Sunset								
1	50	250	200	1000	500	3500	750	6000
2	100	600	250	1500	500	3500	750	6000
3	100	600	250	2000	500	3500		
4	100	800	250	2500				
5	100	1000	250	2500				
6	100	1500	400	3000				
7	100	1500	500	3500				
8	250	2000	750	4000				
9	250	2500	750	4000				
10	250	2500	750	4000				
11	100	1000	500	2500				
Hours After Sunrise								
1	100	500	400	2000				
2	0	100	400	2000				
3	0	100	250	1500				
4	0	100	250	1500	500	1000		
5	0	100	250	1500	500	1500		
6	0	100	250	1500	500	2500	750	4000
7	0	100	250	1500	500	3500	750	4000
8	0	100	250	1500	500	3500	750	4000
9	0	100	250	1500	500	3500	750	4000
10	0	100	250	1500	500	3500	750	4000
11	0	100	150	500	500	3500	750	6000
12	0	200	150	500	500	3500	750	6000
13	50	250	150	750	500	3500	750	6000

Table 1A - Typical Frequency Propagation Spring And Summer

Frequency (kHz)								
4000			8000		12000		16000	
Propagation (Miles)								
	Min	Max	Min	Max	Min	Max	Min	Max
Hours After Sunset								
1	100	600	400	2000	500	3500	750	6000
2	100	800	400	2000	500	4000	750	6000
3	100	1000	400	2000	500	4000		
4	100	1000	400	2500	500	4000		
5	100	1000	400	3000	500	4000		
6	100	1500	400	3500				
7	250	2000	400	4000				
8	250	2500	500	4000				
9	500	3000	500	4000				
10	500	4000	500	4000				
11	500	3000	750	5000				
12	250	2500	750	5000				
13	250	1500	500	2500				
Hours After Sunrise								
1	100	1000	400	2000				
2	100	500	400	2000				
3	0	100	400	2000		3500	750	4000
4	0	100	400	2000	500	3500	750	4000
5	0	100	250	1500	500	3500	750	4000
6	0	100	250	1500	500	3500	750	4000
7	0	100	250	1500	500	4000	750	5000
8	0	100	250	1500	500	4000	750	5000
9	0	100	250	1500	500	4000	750	6000
10	0	100	250	1000	500	3500	750	6000
11	0	250	250	1500	500	3500	750	6000

Table 2A - Typical Frequency Propagation For Fall And Winter

WHY SINGLE SIDEBAND IS IMPORTANT IN HF COMMUNICATIONS

As mentioned earlier, there are two characteristics of HF SSB communications which allow long range capability. Skywave propagation has been discussed in detail. The other characteristic is a transmission process known as single sideband. Single sideband (SSB) high frequency (HF) communications was developed in the early 1950's as a means of increasing the effective range of HF signals. The KHF 1050 is capable of both amplitude modulation (AM) operation, such as is used in conventional VHF aircraft communications, and of SSB operation.

AMPLITUDE MODULATION (AM)

In order to understand SSB operation, a discussion of AM operation is helpful. Amplitude Modulation (AM) is a transmission process in which the selected frequency (called the carrier frequency) and two sidebands (which are frequencies above and below the carrier frequency) are generated and transmitted. (Figure 2A.) It takes about two-thirds of the transmitter's power just to transmit the carrier frequency, yet the carrier does not contain any of the intelligence to be communicated. Each of these sidebands contains all the intelligence to be communicated. Standard broadcast stations (550-1600 kHz) and short-wave broadcasts use AM since it allows simpler receivers.

NOTE: The use of lower sideband isn't normally authorized for airborne HF use. It is normally used in the KHF 1050, but can be selected for those who are authorized to use it.

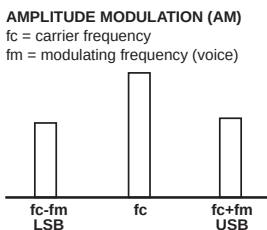


Figure 2A - Amplitude Modulation

SINGLE SIDEBAND OPERATION

By electronically eliminating the carrier wave and one sideband, a single sideband transmitter manages to pack all of its power in transmitting the remaining single sideband. (Figure 3A). Either the upper sideband (USB) or the lower sideband (LSB) can be used since each sideband contains all the required intelligence. However, from a practical standpoint the USB is used almost exclusively in airborne HF SSB operations and the LSB may be disabled. Upon receiving this SSB signal, the receiver then generates the carrier frequency internally and combines it with the one sideband in such a way that the intelligence (voice) can be heard and understood by the pilot.

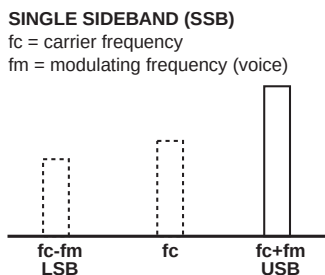


Figure 3A - Single Sideband

The result is that an SSB system has the effective transmit power of AM units having many more times the transmitter power. Also, SSB communications allow the frequency band to be utilized more efficiently since the space or “bandwidth” of only one sideband rather than two sidebands is required to transmit the message.

SUPPRESSED CARRIER VS. REDUCED CARRIER

The single sideband (SSB) operation just described with the carrier frequency virtually eliminated is actually referred to as single sideband suppressed carrier. If just a small portion of the carrier is transmitted along with the sideband, the operation is referred to as single sideband reduced carrier.

SIMPLEX AND SEMI-DUPLEX OPERATION

The KHF 1050 is capable of both simplex and semi-duplex operation.

Simplex operation means that communication signals are transmitted and received on the same frequency. Simplex operations are used when communicating with Air Traffic Control (ATC), for example. Semi-duplex operation means that messages are transmitted on one frequency and received on another. The HF operator selects separate transmit and receive frequencies, then keys the microphone to transmit and releases the push-to-talk switch to receive. Semi-duplex operation is usually used for maritime radiotelephone (public correspondence) communications.

APPENDIX B

MARITIME RADIOTELEPHONE CHANNEL DESIGNATIONS

Channel (400s)	Aircraft Receive (kHz)	Aircraft Transmit (kHz)
401	4357.0	4065.0
402	4360.0	4068.0
403	4363.0	4071.0
404	4366.0	4074.0
405	4369.0	4077.0
406	4372.0	4080.0
407	4375.0	4083.0
408	4378.0	4086.0
409	4381.0	4089.0
410	4384.0	4092.0
411	4387.0	4095.0
412	4390.0	4098.0
413	4393.0	4101.0
414	4396.0	4104.0
415	4399.0	4107.0
416	4402.0	4110.0
417	4405.0	4113.0
418	4408.0	4116.0
419	4411.0	4119.0
420	4414.0	4122.0
421	4417.0	4125.0
422	4420.0	4128.0
423	4423.0	4131.0
424	4426.0	4134.0
425	4429.0	4137.0
426	4432.0	4140.0
427	4435.0	4143.0
428*	4351.0	4160.0

Table 1B - Maritime Radiotelephone Channel Designations (400s)

Channel (600s)	Aircraft Receive (kHz)	Aircraft Transmit (kHz)
601	6501.0	6200.0
602	6504.0	6203.0
603	6507.0	6206.0
604	6510.0	6209.0
605	6513.0	6212.0
606	6516.0	6215.0
607	6519.0	6218.0
608	6522.0	6221.0

Table 2B - Maritime Radiotelephone Channel Designations (600s)

Channel (800s)	Aircraft Receive (kHz)	Aircraft Transmit (kHz)
801	8719.0	8195.0
802	8722.0	8198.0
803	8725.0	8201.0
804	8728.0	8204.0
805	8731.0	8207.0
806	8734.0	8210.0
807	8737.0	8213.0
808	8740.0	8216.0
809	8743.0	8219.0
810	8746.0	8222.0
811	8749.0	8225.0
812	8752.0	8228.0
813	8755.0	8231.0
814	8758.0	8234.0
815	8761.0	8237.0
816	8764.0	8240.0
817	8767.0	8243.0
818	8770.0	8246.0
819	8773.0	8249.0
820	8776.0	8252.0
821	8779.0	8255.0
822	8782.0	8258.0
823	8285.0	8261.0
824	8788.0	8264.0
825	8791.0	8267.0
826	8794.0	8270.0
827	8797.0	8273.0
828	8800.0	8276.0
829	8803.0	8279.0
830	8806.0	8282.0
831	8809.0	8285.0
832	8812.0	8288.0
833	8291.0	8291.0
836*	8713.0	8113.0
837*	8716.0	8128.0

Table 3B - Maritime Radiotelephone Channel Designations (800s)

*THE AIRCRAFT/SHIP TRANSMIT FREQUENCIES FOR CHANNELS 428, 836 and 837 MAY VARY WORLDWIDE. The frequencies programmed into Honeywell products are those assigned by the FCC (Federal Communication Commission, U.S.A.) for stations operating under FCC authorization. Contact appropriate authorities for frequencies authorized in other countries.

Channel (1200)	Aircraft Receive (kHz)	Aircraft Transmit (kHz)
1201	13077.0	12230.0
1202	13080.0	12233.0
1203	13083.0	12236.0
1204	13086.0	12239.0
1205	13089.0	12242.0
1206	13092.0	12245.0
1207	13095.0	12248.0
1208	13098.0	12251.0
1209	13101.0	12254.0
1210	13103.0	12257.0
1211	13107.0	12260.0
1212	13110.0	12263.0
1213	13113.0	12266.0
1214	13116.0	12269.0
1215	13119.0	12272.0
1216	13122.0	12275.0
1217	13125.0	12278.0
1218	13128.0	12281.0
1219	13131.0	12284.0
1220	13134.0	12287.0
1221	13137.0	12290.0
1222	13140.0	12293.0
1223	13143.0	12296.0
1224	13146.0	12299.0
1225	13149.0	12302.0
1226	13152.0	12305.0
1227	13155.0	12308.0
1228	13158.0	12311.0
1229	13161.0	12314.0
1230	13164.0	12317.0
1231	13167.0	12320.0
1232	13170.0	12323.0
1233	13173.0	12326.0
1234	13176.0	12329.0
1235	13179.0	12332.0
1236	13282.0	12335.0
1237	13185.0	12338.0
1238	13188.0	12341.0
1239	13191.0	12344.0
1240	13194.0	12347.0
1241	13197.0	12350.0

Table 4B - Maritime Radiotelephone Channel Designations (1200s)

Channel (1600)	Aircraft Receive (kHz)	Aircraft Transmit (kHz)
1601	17242.0	16360.0
1602	17245.0	16363.0
1603	17248.0	16366.0
1604	17251.0	16369.0
1605	17254.0	16372.0
1606	17257.0	16375.0
1607	17260.0	16378.0
1608	17263.0	16381.0
1609	17266.0	16384.0
1610	17269.0	16387.0
1611	17272.0	16390.0
1612	17275.0	16393.0
1613	17278.0	16396.0
1614	17281.0	16399.0
1615	17284.0	16402.0
1616	17287.0	16405.0
1617	17290.0	16408.0
1618	17293.0	16411.0
1619	17296.0	16414.0
1620	17299.0	16417.0
1621	17302.0	16420.0
1622	17305.0	16423.0
1623	17308.0	16426.0
1624	17311.0	16429.0
1625	17314.0	16432.0
1626	17314.0	16435.0
1627	17320.0	16438.0
1628	17323.0	16441.0
1629	17326.0	16444.0
1630	17329.0	16447.0
1631	17332.0	16450.0
1632	17335.0	16453.0
1633	17338.0	16456.0
1634	17341.0	16459.0
1635	17344.0	16462.0
1636	17347.0	16465.0
1637	17350.0	16468.0
1638	17353.0	16471.0
1639	17356.0	16474.0
1640	17359.0	16477.0
1641	17362.0	16480.0
1642	17365.0	16483.0
1643	17368.0	16486.0
1644	17371.0	16489.0
1645	17374.0	16492.0
1646	17377.0	16495.0
1647	17380.0	16498.0
1648	17383.0	16501.0
1649	17386.0	16504.0
1650	17389.0	16507.0
1651	17392.0	16510.0
1652	17395.0	16513.0
1653	17398.0	16516.0
1654	17401.0	16519.0
1655	17404.0	16522.0
1656	17407.0	16525.0

Table 5B - Maritime Radiotelephone Channel Designations (1600s)

Channel (1800)	Aircraft Receive (kHz)	Aircraft Transmit (kHz)
1801	19755.0	18780.0
1802	19758.0	18783.0
1803	19761.0	18786.0
1804	19764.0	18789.0
1805	19767.0	18792.0
1806	19770.0	18795.0
1807	19773.0	18798.0
1808	19776.0	18801.0
1809	19779.0	18804.0
1810	19782.0	18807.0
1811	19785.0	18810.0
1812	19788.0	18813.0
1813	19791.0	18816.0
1814	19794.0	18819.0
1815	19797.0	18822.0

*Table 6B. Maritime Radiotelephone
Channel Designations (1800s)*

Channel (2200)	Aircraft Receive (kHz)	Aircraft Transmit (kHz)
2201	22696.0	22000.0
2202	22699.0	22003.0
2203	22702.0	22006.0
2204	22705.0	22009.0
2205	22708.0	22012.0
2206	22711.0	22015.0
2207	22714.0	22018.0
2208	22717.0	22021.0
2209	22720.0	22024.0
2210	22723.0	22027.0
2211	22726.0	22030.0
2212	22729.0	22033.0
2213	22732.0	22036.0
2214	22735.0	22039.0
2215	22738.0	22042.0
2216	22741.0	22045.0
2217	22744.0	22048.0
2218	22747.0	22051.0
2219	22750.0	22054.0
2220	22753.0	22057.0
2221	22756.0	22060.0
2222	22759.0	22063.0
2223	22762.0	22066.0
2224	22765.0	22069.0
2225	22768.0	22072.0
2226	22771.0	22075.0
2227	22774.0	22078.0

2228	22777.0	22081.0
2229	22780.0	22084.0
2230	22783.0	22087.0
2231	22786.0	22090.0
2232	22789.0	22093.0
2233	22792.0	22096.0
2234	22795.0	22099.0
2235	22798.0	22102.0
2236	22801.0	22105.0
2237	22804.0	22108.0
2238	22807.0	22111.0
2239	22810.0	22114.0
2240	22813.0	22117.0
2241	22816.0	22120.0
2242	22819.0	22123.0
2243	22822.0	22126.0
2244	22825.0	22129.0
2245	22828.0	22132.0
2246	22831.0	22135.0
2247	22834.0	22138.0
2248	22837.0	22141.0
2249	22840.0	22144.0
2250	22843.0	22147.0
2251	22846.0	22150.0
2252	22849.0	22153.0
2253	22852.0	22156.0

*Figure 7B - Maritime Radiotelephone
Channel Designations (2200s)*

Channel (2500)	Aircraft Receiver (kHz)	Aircraft Transmit (kHz)
2501	26145.0	25070.0
2502	26148.0	25073.0
2503	26151.0	25076.0
2504	26154.0	25079.0
2505	26157.0	25082.0
2506	26160.0	25085.0
2507	26163.0	25088.0
2508	26166.0	25091.0
2509	26169.0	25094.0
2510	26172.0	25097.0

*Figure 8B - Maritime Radiotelephone
Channel Designations (2500s)*

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006-18289-0000
Revision 0 Mar/2003

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