

## BENDIX / KING KHF-950/KFS-594 HF RADIO



### SET UP

- Set emission mode to USB, turn HF radio on, turn squelch to max sensitivity, select HF 1 on the audio control panel. Unit is warmed up when the display appears (approx. 2 minutes.)

### DIRECT TUNING

- Select “0” in the channel position. Tune in the desired frequency with the channel control knob, selecting each of the 6 digits separately. The first two digits are on top, the last four are on the bottom. The “0” in the channel position will change to a blank.
- For example, the frequency 5650 would be input as 05 on the top line and 6500 on the bottom line.
- Tune the antenna by keying the mic. “TX” flashes and the display blanks. When complete, “TX” stops flashing, and the display returns. (Takes 1 or 2 seconds.) Release mic key when tuning is complete.
- Retune antenna after every frequency change.
- Direct tuning allows simplex channels (i.e. transmit and receive on the same frequency) or duplex channels (transmit and receive on different frequencies)

### PROGRAMMING CHANNELS

- There are 19 programmable channels, simplex or duplex. Select the channel you wish to change.
- A dash appears after the channel number to show that the unit is in program mode. You cannot transmit or receive in program mode. Pressing the mic key in program mode returns to the previous frequency.
- Tune in the frequency you wish to receive on, and press the STO button.
- Tune in the frequency you wish to transmit on, and press the STO button again. If you wish to operate in simplex mode, press STO the second time.
- The dash and cursor will disappear. Key the mic to tune the antenna; you are now ready to transmit.

## COMMUNICATING WITH HF

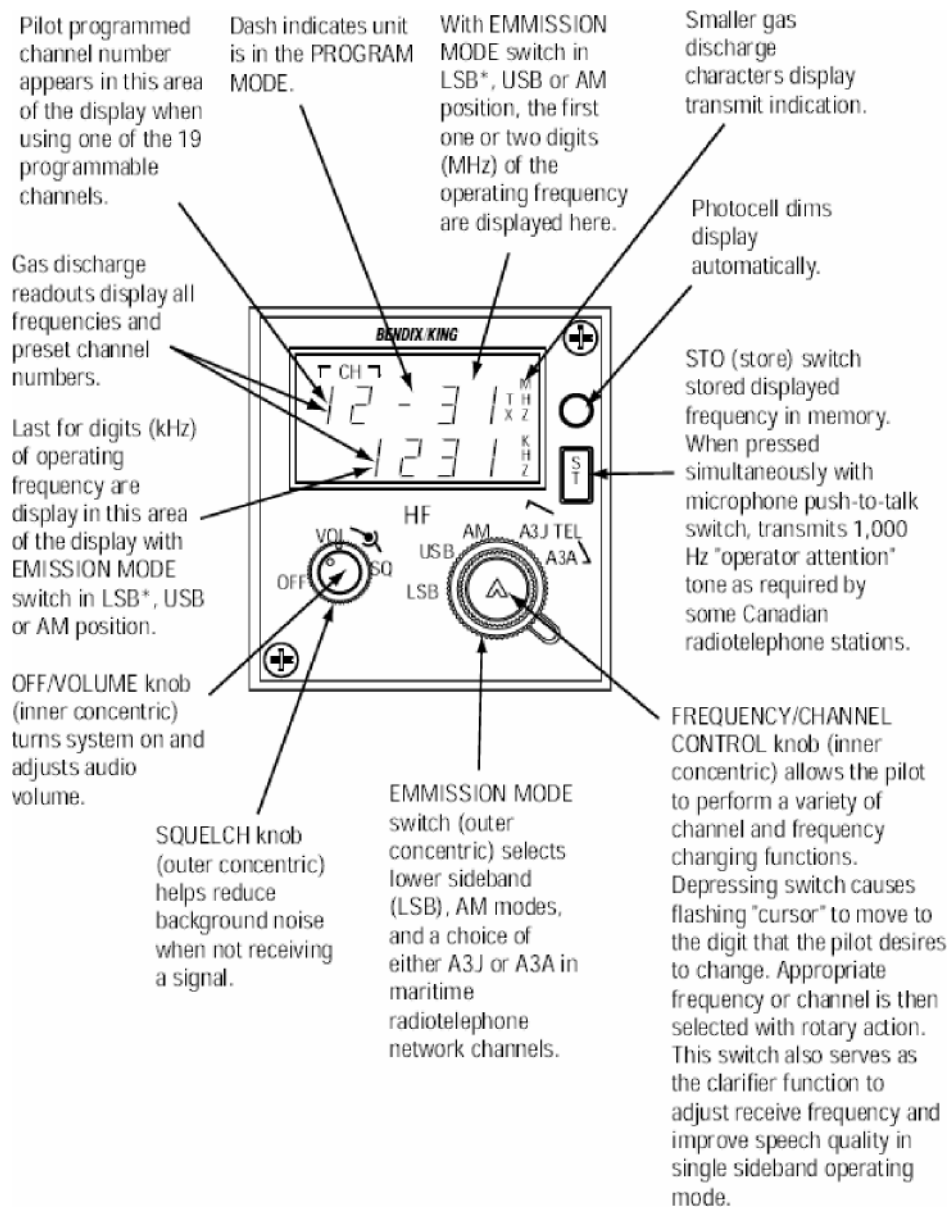
- Do a ground check prior to flight. This can also be done in flight, but a ground check is preferred.
  - 1) Call Arinc on a VHF radio using an appropriate air or ground frequency from Jeppesen Arinc pages 1 and 2 (Can be found at [www.arinc.com](http://www.arinc.com).) It may take up to 3 minutes for Arinc to answer. Do not change frequencies during this time
  - 2) Request a HF radio check. They will assign you a HF frequency for the check.
  - 3) Tune HF freq and request radio check on freq. For example, if given New York on 11390, say “New York, [callsign] radio check on 11390.” After they reply, respond that radio check was received.
- Communicating on HF in flight
  - 1) Your last VHF controller will give you a primary and 1 or 2 secondary HF frequencies. If you lose the primary due to deterioration of signal, try reestablishing contact on a secondary.
  - 2) It is helpful to program your assigned frequencies following steps above.
  - 3) Use standard ICAO terminology for RADAR and non-RADAR environment. Frequently when using HF you will be in a non-RADAR environment. Report over all mandatory reporting points (black triangle on en-route chart) and ATC requested points. Report time (in Zulu) over your present reporting point, flight level, time over next reporting point and name only of the following reporting point. Note these are not all the waypoints you are approaching, but the actual upcoming reporting points (black triangles, etc.). Use the FMS to determine times over approaching waypoints.
  - 4) Example:

[callsign]: “New York, Position [callsign], on 6586”  
New York: “[callsign], go ahead with position”  
[callsign]: “New York, [callsign], position ALPHA 1346, flight level 390, estimating CHRLE 1421, next FXTRT, negative SELCAL.” 5)

## TIPS FOR PROPER OPERATION

- Use higher HF frequencies during daylight (10-30 MHz). Use lower HF frequencies during nighttime. (2-10 MHz)
- The Excel HF radio is not equipped with SELCAL, so you will need to maintain a listening watch on HF at all times.
- You should hear some static while monitoring HF. Adjust the squelch if needed. If you don't hear static, you probably won't hear ATC either.
- Remember to retune the antenna after every frequency change.

- Frequencies on the KFS 594 are displayed and input in KHz. MHz frequencies will have to be converted. 1MHz = 1000KHz
- Frequencies range is from 2000KHz to 29999.9KHz. 280,000 unique frequencies.
- Atomic clock and other information is available on 2.5, 5.0, 10.0, 15.0, 20.0 MHz Frequencies. Alerts concerning solar activity are broadcast at 18min past the hour or call 303-497-3235. (Solar activity affects HF communications.) GPS status at 14 and 15 past the hour. Marine storm info at 8,9,10 past the hour.
- HF Emergency frequency is 2182KHz.
- It is recommended while in HF, that you set \THF 1 to 121.5 and \THF 2 to 123.45 (Air to Air.)
- The KFS 594 has a clarifier function, which allows you to change the last frequency digit with the cursor to tune out unnatural “tinny” sounds if needed. Use the channel control knob.



## **SKYWAVE PROPAGATION WHICH FREQUENCY TO USE?**

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 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.

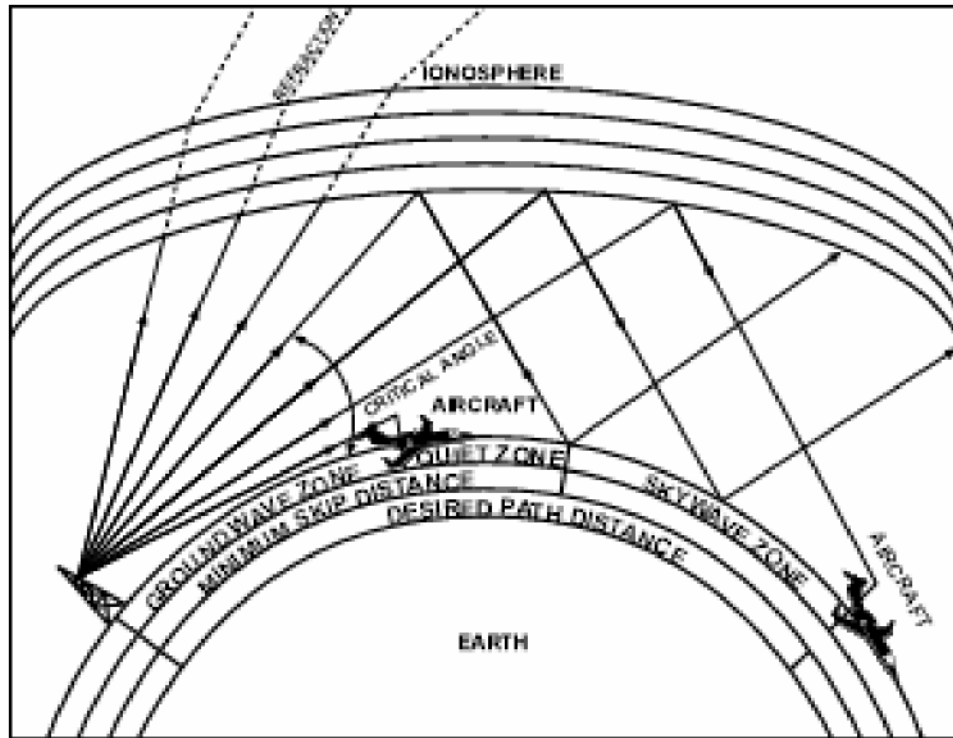
Solar disturbances including solar flares and magnetic storms can cause propagation of HF radio waves to deteriorate rapidly. HF signals can also suffer interference from such atmospheric disturbances as precipitation and thunderstorms.

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 950/990 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 1-1). 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). 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 anytime, 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.



# INTRODUCTION TO HF RADIO



## The Ionosphere

### The Regions of the Ionosphere

In a region extending from a height of about 50 km (27 nm) to over 500 km (270 nm), some of the molecules of the atmosphere are ionised by radiation from the Sun to produce an ionised gas. This region is called the ionosphere. Ionisation is the process in which electrons, which are negatively charged, are removed from (or attached to) neutral atoms or molecules to form positively (or negatively) charged ions and free electrons. It is the ions that give their name to the ionosphere, but it is the much lighter and more freely moving electrons which are important in terms of high frequency (HF: 3 to 30 MHz) radio propagation. Generally, the greater the number of electrons, the higher the frequencies that can be used. During the day there may be four regions present called the D, E, F1 and F2 regions.

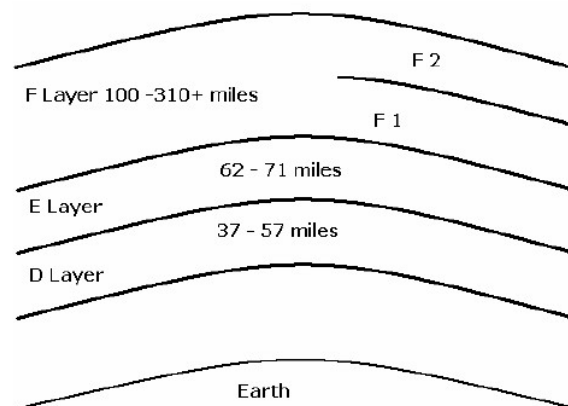
Their approximate height ranges are:

- D region 50 to 90 km; (27 nm to 49 nm)
- E region 90 to 140 km; (49 nm to 76 nm)
- F1 region 140 to 210 km; 76 nm to 1113 nm)
- F2 region over 210 km. (113 nm)

During the daytime, sporadic E (section 1.6) is sometimes observed in the E region, and at certain times during the solar cycle the F1 region may not be distinct from the F2 region but merge to form an F region. At night the D, E and F1 regions become very much depleted of free electrons, leaving only the F2 region available for communications; however it is not uncommon for sporadic E to occur at night. Only the E, F1, sporadic E when present, and F2 regions refract HF waves. The D region is important though, because while it does not refract HF radio waves, it does absorb or attenuate them.

The F2 region is the most important region for high frequency radio propagation as:

- its present 24 hours of the day;
- its high altitude allows the longest communication paths;
- its usually refracts the highest frequencies in the HF range



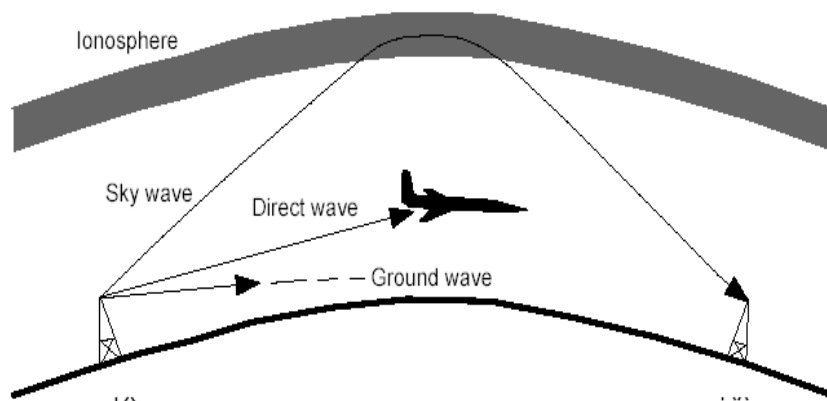
**The Layers of the Ionosphere**

## Frequency Limits of Sky Waves

Not all HF waves are refracted by the ionosphere, there are upper and lower frequency bounds for communications between two terminals. If the frequency is too high, the wave will penetrate the ionosphere, if it is too low, the strength of the signal will be lowered due to absorption in the D region. The range of usable frequencies will vary:

- throughout the day;
- with the seasons;
- with the solar cycle;
- from place to place;

depending on the ionospheric region used for communications. While the upper limit of frequencies varies mostly with these factors, the lower limit is also dependent on receiver site noise, antenna efficiency, transmitter power, E layer screening and absorption by the ionosphere.



## The Usable Frequency Range

For any circuit there is a Maximum Usable Frequency (MUF) which is determined by the state of the ionosphere in the vicinity of the refraction area(s) and the length of the circuit. The MUF is refracted from the area of maximum electron density of a region. Therefore, frequencies higher than the MUF for a particular region will penetrate that region. During the day it is possible to communicate via both the E and F layers using different frequencies. The highest frequency supported by the E layer is the EMUF, while that supported by the F layer is the FMUF.

The F region MUF in particular varies during the day, seasonally and with the solar cycle. The data collected over the years displays a range of frequencies observed and the IPS predictions mirror this. A range of F region MUFs is provided in the predictions and this range extends from the lower decile MUF (called the Optimum Working Frequency, OWF), through the median MUF to the upper decile MUF. These MUFs have a 90%, 50% and 10% chance of being supported by the ionosphere, respectively. IPS predictions usually cover a period of one month, so the OWF should provide successful propagation 90% of the time or 27 days of the month. The median MUF should provide communications 50% or 15 days of the month and the upper decile MUF 10% or 3 days of the month. The upper decile MUF is the highest frequency of the range of MUFs and is most likely to penetrate the ionosphere.

## Noise

Radio noise arises from internal and external origins. Internal or thermal noise is generated in the receiving system and is usually negligible when compared to external sources of noise. External radio noise originates from natural (atmospheric and galactic) and man-made (environmental) sources.

Atmospheric noise, which is caused by thunderstorms, is normally the major contributor to radio noise in the HF band and will especially degrade circuits passing through the day-night terminator. Atmospheric noise is greatest in the equatorial regions of the world and decreases with increasing latitude. Its effect is also greater on lower frequencies, hence it is usually more of a problem around solar minimum and at night when lower frequencies are needed.

## Air/Ground International Radio Service

ARINC's Air/Ground International Voice Service provides high-frequency (HF) single side band aeronautical operational control (AOC) voice communications for aircraft flying over the Atlantic, Caribbean, and Pacific oceans; Canadian and Arctic regions; and the Gulf of Mexico and Central and South America. ARINC connects far-reaching corners of the world to one of two ARINC long-distance operational control facilities located in New York and San Francisco. The radio operators at these facilities also control remote, high-powered HF radio sites located in Molokai, Hawaii; Guam; Barrow, Alaska; and Long Island, New York.



The service is augmented by ARINC's VHF Air/Ground Domestic Voice Service, which provides coverage for overland routes in the United States and Canada and at oceanic gateways along the East, West, and Gulf coasts, and Hawaii.

### **The Air/Ground International Service is used to:**

- Coordinate ground and flight activities—Airlines can better control and track arrival times, allowing more efficient handling of ground operations
- Inform dispatch of important events—This includes emergency and other situations
- Handle irregular operations—Pilots can resolve fuel situations with dispatch when experiencing weather-induced irregular operations
- Make ground arrangements—Corporate jets can use a phone patch to contact a fixed-base operator and arrange for various services on landing
- React quickly to changes—Dispatch can divert an aircraft from its flight plan to pick up unscheduled passengers or freight

- Stay in touch while aloft—Aircraft maintaining the Selective Calling System (SELCAL) watch on assigned frequencies can be contacted by ARINC radio operators for delivery of ground-party messages.
- Provide timely flight following information—This includes delivery of position reports and reroute information to dispatchers and flight followers

**ARINC's radio operators are on duty 24x7. They handle messages by:**

- Sending transcribed messages to any ARINC data network service, teletype subscriber, or any International Civil Aviation Organization address, worldwide
- Delivering messages by telephone
- Delivering messages by fax
- Establishing a phone patch between aircraft and any ground facility
- Delivering ground-originated calls to aircraft anywhere in the coverage area

Signaling the aircraft's SELCAL system that a message is incoming, relieving the pilot of the need to continually monitor the call frequency.

**Air/Ground Communications Procedures**  
**ARINC Voice Services**

An HF ramp check at selected airports may be arranged by calling an ARINC Communications Center on an international VHF network or a domestic VHF network. The Radio Operator responding to the call will provide the appropriate HF frequency for the HF communication check. HF frequencies for ramp/SELCAL checks may also be coordinated by calling the NYC or SFO duty manager (24 X 7). When calling, state the aircraft location, callsign, SELCAL, and destination; request a primary and secondary HF frequency for an HF check.

**SFO: 800-621-0140 or 925-294-8297**

**NYC: 631-589-7272 or 631-244-2483**