# EU BASE STATION ADAPTIVE FREQUENCY HOPPING

## Background

The Clear-com DX wireless intercom systems utilize a **Frequency Hopping Spread Spectrum** (FHSS) radio in order to provide robust communications.

This system operates in the unlicensed 2.4 GHz band. With the proliferation of other devices over the past few years in the same 2.4 GHz band, instances where these devices and systems can interfere with each other has greatly increased.

To further complicate matters, the European Union has introduced new radio standards for equipment operating in this band in an attempt to reduce interference between equipment from different manufacturers. This European Telecommunications Standards Institute (ETSI) harmonized European standard is known as EN 300 238 v1.8.1.

## CLEAR-COM Adaptive Frequency Hopping

In order to reduce interference with other equipment and comply with these new regulations, Clear-Com has implemented an **Adaptive Frequency Hopping** (AFH) mode for the new DX EU base stations. The key idea behind AFH is using only the good frequencies, or channels, unoccupied by other equipment. The system scans for other signals and avoids these signals during operation. Since the radio environment is constantly changing, there is a continuous process of scanning for used frequencies and updating the list of good channels.

The Clear-Com system utilizes 46 discrete frequencies, or channels, within the 2.4 GHz spectrum in order to communicate voice and data. The process of deciding which channels should be used is a 3-stage process. The process includes scanning for occupied channels, the broadcast of a channel exclusion list and the use of the exclusion list. The process is completed in three steps coexisting in time.

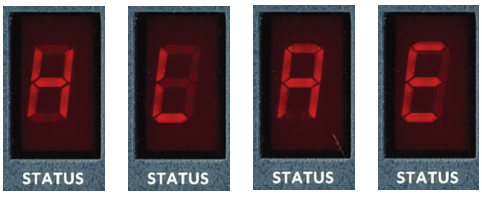
Below is the process is shown in Time. First, the system performs a channel scan to determine occupied channels. This list is then broadcast to the communicator. The communicators and base station will use this list during period three. The process is continuous, and as is illustrated below, the list could be constantly changing. Depending on the radio environment, a maximum of 46 channels, and a minimum of 15 channels may be used by the system at any time.

**Time ⇒**

| Ch. 1 | Ch. 2 | Ch. 3 | Ch. 4 | Ch. 5 | Ch. 6 | Ch. 7 | Ch. 8 |
|---|---|---|---|---|---|---|---|
| Scan | Broadcast | Use | | | | | |
| | Scan | Broadcast | Use | | | | |
| | | Scan | Broadcast | Use | | | |
| | | | Scan | Broadcast | Use | | |
| | | | | Scan | Broadcast | Use | |
| | | | | | Scan | Broadcast | Use |

For instructions describing the process of setting the base to AFH or another scanning mode, see Appendix E: Interference Avoidance Through Spectrum Friendly, pg. 34.

Available settings include:




**High** (**H**) - Scans the Higher frequencies.

**Low** (**L**) - Scans the Lower frequencies.

**All** (**A**) - All frequencies are scanned.

**AFH** (**E**) - (European Mode) Advanced Frequency Hopping searches for the best frequency.

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## Operation in Severe Environments

During normal operation, the fact that the system is constantly changing the channel list in use is transparent to the user. It is possible, however, that in an environment with severe interference that the system may experience a slight degradation. In the AHF mode, the Clear-Com system will use a minimum of 15 channels. If the environment is very crowded and less than 15 channels are truly available, there could be increased radio 'packet loss' due to the high interference. The following symptoms may be observed with AFH systems in a highly congested radio environment:

- This may result in system 'busy' indications. Channel lists are updated every few seconds, and in a severe environment it is possible that these lists get missed by the communicator.
- Slight degradation in audio fidelity between the headsets and base station. This would be due to the same symptom as the 'busy' indications. The HD audio processing is tolerant to this condition, which is why the degradation may only be slight.
- Longer times to register. Registration may take longer, since the headset has to acquire the channel list from the base station. If the base station has excluded a lot of channels, this takes longer as the communicator does not have the exclusion list and looks for the base on channels it is not using.
- Initial sync time increase. For the same reason registration may take longer, the initial headset sync on power up may take longer.

## Required AFH Equipment

In order to utilize AFH, the base station must be set to European mode. The headsets and belt packs must also be AFH capable. AFH capable headsets and belt packs will have the letters 'AFH' labeled on the belt pack and headsets. AFH communicators will auto detect if the system is in AFH mode and adjust their operation accordingly.

## Non-AFH Equipment

Headsets and belt packs that are not AFH capable must be operated with either a non-AFH base station or an AFH base station selected to operate in All, High or Low band mode. Headsets and belt packs that are not AFH capable will not have the letters 'AFH'.

## Interference Mitigation

Certain techniques can be used in an attempt to mitigate interference between different equipment in the 2.4 GHz spectrum. Some of these are:

- **Physical separation**. If possible, equipment operating in the 2.4 GHz spectrum should be operating as far as physically possible from the HME base station. A WiFi access point or router is a common piece of equipment that could interfere with the HME system, or vice versa. These two pieces of equipment in particular should not be located close together.
- **Spectral separation**. Most WiFi access points allow the administrator to set the channel and bandwidth that system operates on. Some systems employ an 'auto' mode, in which the WiFi access point will automatically selected the channel. With WiFi access points, it is sometimes advantageous to manually select a channel number to keep the WiFi transmission at a fixed location.

**NOTE:** If the Clear-Com system does not have AFH, then the base station should be set to operate in the region of the 2.4 GHz band where the WiFi access point is not operating. For example, if the WiFi access point is set to WiFi channel 1, the base station should be set to operate in the 'High' band. If the WiFi access point is set to channel 11, the base should be set to operate in the 'Low'.

- **Spectral efficiency**. WiFi systems employ a standard sometimes referred to as 802.11 802. The number “11” is simply the number given to the standard by the Institute of Electrical and Electronics Engineers (the IEEE). Modern WiFi routers will allow operation employing the 802.11n mode. This mode will allow higher data rates, but it also may consume twice the number of radio channels. If the WiFi router is set to 802.11n mode, it is best to limit WiFi bandwidth to 20 MHz.
- **Alternate band selection**. While most WiFi systems operate at 2.4 GHz, which is the same band as the HME system, most allow operation at 5 GHz. If possible, move any WiFi access points and equipment to 5 GHz. This of course requires all WiFi equipment to be 5 GHz capable, and most older equipment may only allow 2.4 GHz operation. Selection of 5 GHz may also not be desirable if the WiFi network is for customer access.