

# **Appendix – Hybrid Digital Modulation Flexible Hopping Definition for Models with FCC ID LKT-IF-24-SYNC**

## **General**

**This addendum applies to BreezeACCESS II models that have been factory shipped or field upgraded to operate as a hybrid digital transmitter with FCC ID: LKT-IF-24-SYNC.**

**The hardware, software features, and menus all remain the same as the FHSS version of the product, except for the addition of the flexible hopping control menus as described below.**

**According to the FCC grant for models operating as HDM, the transmitted output power of the AU and SU units must be adjusted to limit the maximum power into the antenna to 19 dBm. Reference the BreezeACCESS Version 4.3 Revision 3.0 System Manual Book 4: Operations and Administration (2-44, 2-45) for detail description on menus and parameter settings.**

*For IF based units only (AU-BS/AU-NI; SU-A/SU-E) this is done by configuring the Transmit Power Control parameter to control the gain of the TX power circuits. Actual parameter setting is based on the IF cable attenuation relative to the cable length and type used at installation. For non-IF based SU units (SU-R/SU-I) power control is limited through a Power Level configuration which is based on High or Low value parameter.*

The process of setting the hopping sequence using the Flexible Hopping Definition mode includes the following steps:

1. Select the frequencies to be used using the Flexible Hopping Definition menu
2. Define the method of generating the basic hopping sequence based on the set of selected frequencies, using the Scrambling Definition sub-menu. The method of generating the basic sequence also defines the hopping shift mechanism for generating different actual hopping sequences.
3. Configure the Hopping Shift parameter to define a different hopping sequence for each AU in order to minimize interference between adjacent AUs.

The Flexible Hopping Definition menu enables defining the hopping frequencies and the method of scrambling the selected frequencies for generating the basic hopping sequence. It also enables to view the selected hopping frequencies and the current hopping sequence (based on the previous selections made before the last reset). The new selections will come into effect only after the next reset. In cases where all frequencies were deleted the default frequency is 2401 MHz.

# **Frequencies Selection and Basic Sequence Generation Using the Flexible Hopping Definition Menu**

The Flexible Hopping Definition menu includes the following options:

## **Add Frequencies**

The Add Frequencies option enables defining a new list of sub-bands and/or discrete frequencies. Enter a list of the required sub-bands and/or frequencies, using either sub-bands (f1-f2) or discrete frequencies, e.g. 2402-2412,2448,2470-2480. Use a comma to separate between entries, do not use spaces.

The usable center frequencies are from 2402 to 2480, using a 1 MHz resolution (2402,2403,2404 ... 2480).

The new selected set of frequencies (frequencies to be used) will become effective only after the next reset.

## **Remove Frequencies**

The Remove Frequencies option enables removing previously defined sub-bands and/or discrete frequencies. Enter a list of the required sub-bands and/or frequencies to remove, using either sub-bands (f1-f2) or discrete frequencies, e.g. 2402-2412,2448. Use a comma to separate between entries, do not use spaces.

## **Erase All**

The Erase All option enables erasing all previously defined sub-bands and/or discrete frequencies. Enter option selection 1- Erase All.

## Scrambling Definitions

The Scrambling Definition menu enables defining the method of organizing the selected frequencies to form the actual hopping sequence to be used. Proper organization of the hopping sequence is essential to guarantee minimal cross interference among several neighboring cells that use the same sequence with different Hopping Shift values.

### Scrambling Mode

Defines the scrambling mode. The following options are available:

#### Standard Scrambling

This mode is not recommended for sequences with 7 or more channels. The scrambled basic sequences for 3 to 6 frequencies when using Standard Scrambling are:

<b>Table Error! No text of specified style in document.Error! No text of specified style in document.-1: Basic Sequences using Standard Scrambling</b>	
<b>N (number of channels)</b>	<b>Scrambled Basic Sequence (channel indexes)</b>
3	1, 3, 2
4	1, 3, 2, 4
5	1, 3, 5, 2, 4
6	1, 3, 5, 2, 6, 4

Frequency 1 (index=1) is the lowest frequency in the list of frequencies to be used, frequency 2 is the next frequency and so on.

#### Manual Scrambling

For customized definition of the hopping sequence, using the Manual Sequence Definition option (see below).

## Enhanced Scrambling

Automatically generates hopping sequences using an enhanced algorithm. It is recommended that Enhanced Scrambling rather than Standard Scrambling be used. If the Enhanced Scrambling Mode is selected, the Spanning Factor parameter (see below) must be configured in the AU. The Enhanced Mode is not suitable for sequences with 6 or less frequencies. If Enhanced Scrambling is selected with sequences that have 6 or less frequencies, than Standard Scrambling is used by default.

The scrambled sequence is generated according to the following rules:

1. The first channel in the basic scrambled sequence is frequency 1 (Frequency 1 (index=1) is the lowest frequency in the list of frequencies to be used, frequency 2 is the next frequency and so on.)
2. The index of each of the other channels is calculated by adding the Spanning Factor to the index of the previous channel. Note that the sequence is cyclic, meaning that adding 1 to the highest index in the sequence (Index=N where N is the number of channels in the sequence) will result in the first channel (Index=1).

The scrambled basic sequence can also be calculated using the formula:  $P_x$

$$P_x(j) = \{(j-1)*X\} \bmod(N) + 1$$

Where:

X is the Spanning Factor

N is the number of channels in the sequence (modulus)

J is the sequence index

Example: N=8, X=3

$$P_1(5) = \{(1-1)*3\} \bmod 8 + 1 = 1$$

$$P_2(5) = \{(2-1)*3\} \bmod 8 + 1 = 6$$

$$P_3(5) = \{(3-1)*3\} \bmod 8 + 1 = 3$$

$$P_4(5) = \{(4-1)*3\} \bmod 8 + 1 = 8$$

$$P_5(5) = \{(5-1)*3\} \bmod 8 + 1 = 5$$

$$P_6(5) = \{(6-1)*3\} \bmod 8 + 1 = 2$$

$$P_7(5) = \{(7-1)*3\} \bmod 8 + 1 = 7$$

$$P_8(5) = \{(8-1)*3\} \bmod 8 + 1 = 4$$

And the basic scrambled sequence is: 1, 4, 7, 2, 5, 8, 3, 6.

## Manual Sequence Definition

Manually defines the hopping sequence, using numbered channel indexes (from 1 to “Number of Hopping Frequencies”). The sequence length must be equal to “Number of Hopping Frequencies” (all the defined frequencies must be used).

## Erase Manual Sequence

Erases the manually defined hopping sequence.

## Spanning Factor (AU only)

Defines the Spanning Factor to be used by the Enhanced Scrambling mechanism. The Spanning Factor should be chosen so that the GCD (Greater Common Divisor) of the Spanning Factor and the Number of Hopping Frequencies would be 1 (e.g. for 8 frequencies possible values for the Spanning Factor are 1, 3, 5 and 7). The SU learns the value of the Spanning Factor from the AU during the association process.

Use of different spanning factors by non-synchronized neighboring base stations reduces the probability of interference between adjacent sectors.

Valid values: 1 to Number of Hopping Frequencies minus 1, provided it meets the GCD requirement as described above.

It is not recommended to use spanning factors of 1 and N-1, as they result in hopping on consecutive channel (assuming that the available channels are consecutive). In these cases the advantage of using frequency hopping is not fully utilized, since narrow band interference may affect several consecutive hops. Spanning factors of 2 and N-2 also result in a relatively poor spread of the hopping frequencies over the available frequency band.

Default Value: 1

### NOTE



It is always recommended to use a mid range or  $\frac{1}{2} N$  total channels used for the AU Spanning Factor. For Example, If your AU Scrambling Definition is configured for a total of 24 flexible hopping channels, choose a Spanning Factor of 12 or 13.

## Show Flexible Hopping Parameters

Displays the following information:

- An updated list of the defined sub-bands and discrete frequencies to become effective after the next reset. A sub-band is defined by the first and last hopping frequency in a series of consecutive frequencies, with 3MHz separation between frequencies.
- An updated list of all the hopping frequencies to be used after the next reset.
- Scrambling Mode
- Manual Sequence Definition (if applicable)
- Spanning Factor (if applicable. In the SU it will be shown only when operating in the Enhanced Scrambling mode)
- The current sequence of operational hopping frequencies

After configuring the flexible hopping parameters, conclude your configuration in accordance with the System Manual sections for Commissioning and Operations and Administration.