



Technical Note

## **WipLL 5.8 GHz**

Wireless IP-Based Local Loop System

# **Hopping Algorithms and Compliance with FCC 15.247 (a) (1)**

Connecting the World with Wireless Access Solutions

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## 1. Introduction

This document provides a description of the Frequency Hopping and Hybrid systems for WipLL 5.8 GHz products. The Frequency Hopping system is for 1 Mbps, 2 Mbps and 3 Mbps; the Hybrid system (HS) is for 1.33 Mbps and 4 Mbps.

## 2. Hopping and Hybrid System Algorithms

- The hopping algorithm is defined by a table of  $n$  frequencies, where  $n$  is greater or equal to 75 when the system is configured for 1 Mbps, 2 Mbps and 3 Mbps, and where  $n$  is greater or equal to 62 when the system is configured for 1.33 Mbps and 4 Mbps. The hopping sequence follows cyclically the frequencies in the table, remaining in each frequency for a constant period. The frequencies in the table are all in the 5.726 to 5.849 range, with at least 1 MHz between any two frequencies in the table for systems configured for 1 Mbps, 2 Mbps, and 3 Mbps; and at least 2 MHz for systems configured for 1.33 Mbps and 4 Mbps. The order of frequencies in the table is pseudorandom.
- In Section 7, “Receiver Synchronization”, two modes (1 MHz-channel spacing and 2 MHz-channel spacing) are described in Table 1.

## 3. Hopping Time

The hopping time in a given is constant (typically WipLL uses 50 msec).

## 4. Number of Channels

The number of channels is determined by the table size  $n$  frequencies, depending on transmission speed configured for the WipLL system:

- For 1 Mbps, 2 Mbps, and 3 Mbps,  $n$  is equal to at least 75 (WipLL uses  $n = 79$ )
- For 1.33 Mbps and 4 Mbps,  $n$  is equal to at least 62

## 5. Resolution

The minimum difference between any two channels is:

- 1 MHz for 1 Mbps, 2 Mbps, and 3 Mbps
- 2 MHz for 1.33 Mbps and 4 Mbps

## 6. Channel Distribution

Since any used channel is included once in the table, all the channels are equally used, each channel occupying  $1/n$  of the time.

## 7. Receiver Synchronization

The system receiver input bandwidth filter matches the hopping channel bandwidth and synchronizes with the corresponding transmitter on the hopping sequence.

Table 1: Frequency Hopping System (1, 2 and 3 Mbps) and Hybrid System (4 Mbps)

15.247 Spec.	Requirement	WipLL Capability	Comply
Spread Spectrum	FHSS or DSSS	FHSS	Yes
<ul style="list-style-type: none"> <li>Minimum channel separation at 1, 2, and 3 Mbps</li> <li>Minimum channel separation at 4 Mbps</li> </ul>	<ul style="list-style-type: none"> <li>-20 dB bandwidth (1 MHz)</li> <li>-20 dB bandwidth</li> </ul>	<ul style="list-style-type: none"> <li>-20 dB bandwidth (1 MHz)</li> <li>2 MHz</li> </ul>	<ul style="list-style-type: none"> <li>Yes</li> <li>Yes</li> </ul>
List of Freq.	Pseudo-random ordered list	Pseudo-random ordered list	Yes
Use of Freq.	Equal use of frequencies: 5.726 to 5.849	Constant hop period (50 msec) each frequency used once in a table	Yes
<ul style="list-style-type: none"> <li>Number of Frequencies at 1, 2, and 3 Mbps</li> <li>Number of frequencies at 1.33 Mbps and 4 Mbps</li> </ul>	<ul style="list-style-type: none"> <li>Min. 75</li> <li>15 non-overlapping channels with total span 123 MHz</li> </ul>	<ul style="list-style-type: none"> <li>79</li> <li>62</li> </ul>	<ul style="list-style-type: none"> <li>Yes</li> <li>Yes</li> </ul>
<ul style="list-style-type: none"> <li>Occupied BW per hop at 1, 2, and 3 Mbps</li> <li>Occupied BW per hop at 1.33 Mbps and 4 Mbps</li> </ul>	<ul style="list-style-type: none"> <li>&lt; 1 MHz at -20 dB</li> <li>&gt; 1 MHz</li> </ul>	<ul style="list-style-type: none"> <li>&lt; 1 MHz at -20 dB</li> <li>1 MHz &lt; BW &lt; 2 MHz at -20 dB</li> </ul>	<ul style="list-style-type: none"> <li>Yes</li> <li>Yes</li> </ul>
Average time of occupancy	<ul style="list-style-type: none"> <li>Hopping mode: &lt; 0.4 sec within 30 sec period average</li> <li>Hybrid mode: &lt; 0.4 sec within <math>N \cdot 0.4</math> sec period average, where <math>N</math> is the number of channels</li> </ul>	<ul style="list-style-type: none"> <li>Hopping mode: 362 msec</li> <li>Hybrid mode: 380 msec</li> </ul>	<ul style="list-style-type: none"> <li>Yes</li> <li>Yes</li> </ul>

## 8. Frequency Hopping and Hybrid Modes

The tables below provide sequential and pseudo-random hopping frequencies for the Frequency Hopping mode and Hybrid mode.

### 8.1. Frequency Hopping Mode

**Table 2: Frequency Hopping Mode with Pseudo-Random Hopping**

Frequency Assignment	Frequency (MHz)	Frequency Assignment	Frequency (MHz)	Frequency Assignment	Frequency (MHz)
F1	5729	F35	5804	F69	5730
F2	5752	F36	5733	F70	5757
F3	5791	F37	5789	F71	5784
F4	5737	F38	5756	F72	5764
F5	5772	F39	5741	F73	5782
F6	5745	F40	5754	F74	5753
F7	5800	F41	5743	F75	5773
F8	5776	F42	5786	F76	5780
F9	5748	F43	5770	F77	5767
F10	5790	F44	5803	F78	5759
F11	5805	F45	5761	F79	5775
F12	5758	F46	5799		
F13	5788	F47	5738		
F14	5751	F48	5787		
F15	5781	F49	5728		
F16	5792	F50	5774		
F17	5755	F51	5749		
F18	5727	F52	5802		
F19	5760	F53	5793		
F20	5731	F54	5768		
F21	5747	F55	5742		
F22	5740	F56	5762		
F23	5765	F57	5794		
F24	5801	F58	5779		
F25	5783	F59	5785		
F26	5798	F60	5771		
F27	5750	F61	5777		
F28	5732	F62	5744		
F29	5766	F63	5734		
F30	5739	F64	5746		
F31	5763	F65	5735		
F32	5795	F66	5796		
F33	5736	F67	5778		
F34	5797	F68	5769		

## 8.2. Hybrid Mode

**Table 3: Hybrid Mode with Pseudo-Random Hopping**

Frequency Assignment	Frequency (MHz)	Frequency Assignment	Frequency (MHz)
F1	5730	F32	5812
F2	5776	F33	5794
F3	5746	F34	5748
F4	5816	F35	5846
F5	5762	F36	5728
F6	5824	F37	5820
F7	5768	F38	5770
F8	5788	F39	5808
F9	5848	F40	5756
F10	5774	F41	5796
F11	5834	F42	5830
F12	5782	F43	5842
F13	5726	F44	5814
F14	5792	F45	5826
F15	5734	F46	5760
F16	5766	F47	5740
F17	5752	F48	5764
F18	5802	F49	5742
F19	5838	F50	5828
F20	5772	F51	5810
F21	5736	F52	5732
F22	5804	F53	5786
F23	5750	F54	5840
F24	5798	F55	5800
F25	5744	F56	5836
F26	5738	F57	5778
F27	5784	F58	5818
F28	5754	F59	5832
F29	5780	F60	5806
F30	5758	F61	5790
F31	5844	F62	5822

## 9. Receiver and Transmitter Compliance

### 9.1. Receiver Compliance with 15.247 (a) (1) / 2.1033 (a) (10)

The system receiver has an input bandwidth that matches the hopping bandwidth of the corresponding transmitters. The receiver shifts its frequency in accordance with the same frequency hopping table and pattern as the transmitters.

### 9.2. Transmitter Compliance with 15.247 (g), 15.247 (h)

■ **15.247 (g):**

The equipment fully complies with the requirements of this section. In our case, each transmission employs all available hopping channels, performed according to the requirements of 15.247.

■ **15.247 (h):**

The equipment fully complies with the requirements of this section. There is no coordination between the systems to avoid simultaneous occupancy of the hopping frequencies by multiple transmitters. Each transmitter operates independently and there is no synchronization with other transmitters.