Bluetooth operational description

Bluetooth operates in the unlicensed Industrial, Scientific and Medical (ISM) band at 2.4Ghz to 2.48Ghz, using frequency hopping spread spectrum, up to 1600 Hops/sec. The signal hops among 79 frequencies at 1MHz intervals to give a high degree of interference immunity.

The channel is represented by a pseudo-random hopping sequence hopping through all the 79 RF channels equally on the average by each transmitter. The hopping sequence is unique for each link and is determined by the master device; the phase in the hopping sequence is determined as well by master clock. The slave is getting the hopping sequence from the master and following it.

The channel is divided into time slots where each slot corresponds to an RF hop frequency. Consecutive hops correspond to different RF hop frequencies. The nominal hop rate is 1600 hops/s. All Bluetooth units participating in the piconet are time- and hop-synchronized to the channel.

The channel is divided into time slots, each 625 μs in length. The time slots are numbered according to the Bluetooth clock of the master. The slot numbering ranges from 0 to 2^{27-1} and is cyclic with a cycle length of 2^{27}.

In the time slots, master and slave can transmit packets.

A time-division duplex (TDD) scheme is used where master and slave alternatively transmit. The master shall start its transmission in even-numbered time slots only, and the slave shall start its transmission in odd-numbered time slots only. The packet start shall be aligned with the slot start. Packets transmitted by the master or the slave may extend over up to five time slots.

The RF hop frequency shall remain fixed for the duration of the packet. For a single packet, the RF hop frequency to be used is derived from the current Bluetooth clock value. For a multi-slot packet, the RF hop frequency to be used for the entire packet is derived from the Bluetooth clock value in the first slot of the packet. The RF hop frequency in the first slot after a multi-slot packet shall use the frequency as determined by the current Bluetooth clock value.

Concerning FCC Part 15.247 (a)(1), (g), (h)

1. The Device is a smart camara that allow to pass data over BT SPP connection
2. The transmit up to 920 Kbps data.
3. The system is a point to point connection with one master (Computer or smart phone) connect with the system. The device acts as a slave.
4. Network comprises one network coordinator (Computer, or smart phone) that generates a systems hoping clock of 1600 hopes per second.
5. The system frequencies hops the at a pseudo random algorithm.

6. There are total of 79 frequencies used between 2.402 to 2.48 GHz, with a separation of 1MHz between each frequency (f=2402+k MHz, k=0, ..,78).
7. Each of the frequencies is used equally on the average by the transmitter.
8. Transmitter spends 635uS on each of the 79 frequency channels.
9. The master sends the pseudo hoping sequence – AFH (Adaptive Hoping Frequency) table to the slaves. In case of interference in one of the 79 channels, the channel is being eliminated from the table and restored once the interference is gone.
10. Total pseudo random cycle is 2^{27} states and it rolls over every 23.3 hours (about one day).
11. The Device (Slave) uses the CSR Bluetooth chip BC41C671A-IPK-E4 running at a clock of 26MHz.
12. Hoping clock of 1600 hops/s is derivate from the 26MHz clock through a divider of 16250.
13. Transmitter & Receiver supports $\pi/4$ DQPSK modulation with a data rate of up to 2Mbps
14. The receiver RF filter is based on a Johansson Technology balloon band pass filter of 2400MHz – 2500MHz with a central frequency of 2450MHz. In addition the Bluetooth CSR contains integrated channel filters, allowing the receiver to set a 1MHz filter that follows the pseudo random hoping channel.
15. Below is an example of a hoping sequence. {k} represent the channel where the center frequency f=2402+k MHz.
16. Based on the above, as per FCC Part 15.247 (a)(1), (g), and (h), the E.U.T.:
    a) satisfies the requirement that its associated receiver's input bandwidth matches the bandwidth of the transmitted signal (FCC's Public Notice DA 00-705), and
    b) complies with the requirement that it not have the ability to be coordinated with other FHSS systems in an effort to avoid the simultaneous occupancy of individual hopping frequencies by multiple transmitters (FCC's Public Notice DA 00-705 regarding Section 15.247(h)).

Hop sequence {k} for CONNECTION STATE (Basic channel hopping sequence)

#ticks:	00 02	04 06	08 0a	0c 0e	10 12	14 16	18 1a	1c 1e
0x0000010:	08 66	10 70	12 19	14 23	16 01	18 05	20 33	22 37
0x0000030:	24 03	26 07	28 35	30 39	32 72	34 76	36 25	38 29
0x0000050:	40 74	42 78	44 27	46 31	48 09	50 13	52 41	54 45
0x0000070:	56 11	58 15	60 43	62 47	32 17	36 19	34 49	38 51
0x0000090:	40 21	44 23	42 53	46 55	48 33	52 35	50 65	54 67
0x00000b0:	56 37	60 39	58 69	62 71	64 25	68 27	66 57	70 59
0x00000d0:	72 29	76 31	74 61	78 63	01 41	05 43	03 73	07 75
0x00000f0:	09 45	13 47	11 77	15 00	64 49	66 53	68 02	70 06
0x0000110:	01 51	03 55	05 04	07 08	72 57	74 61	76 10	78 14
0x0000130:	09 59	11 63	13 12	15 16	17 65	19 69	21 18	23 22
0x0000150:	33 67	35 71	37 20	39 24	25 73	27 77	29 26	31 30
0x0000170:	41 75	43 00	45 28	47 32	17 02	21 04	19 34	23 36
0x0000190:	33 06	37 08	35 38	39 40	25 10	29 12	27 42	31 44
0x00001b0:	41 14	45 16	43 46	47 48	49 18	53 20	51 50	55 52
0x00001d0:	65 22	69 24	67 54	71 56	57 26	61 28	59 58	63 60
0x00001f0:	73 30	77 32	75 62	00 64	49 34	51 42	57 66	59 74
0x0000210:	53 36	55 44	61 68	63 76	65 50	67 58	73 03	75 11
0x0000230:	69 52	71 60	77 05	00 13	02 38	04 46	10 70	12 78

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0x0000250: 06 40 | 08 48 | 14 72 | 16 01 | 18 54 | 20 62 | 26 07 | 28 15 |
0x0000270: 22 56 | 24 64 | 30 09 | 32 17 | 02 66 | 06 74 | 10 19 | 14 27 |
0x0000290: 04 70 | 08 78 | 12 23 | 16 31 | 18 03 | 22 11 | 26 35 | 30 43 |
0x00002b0: 20 07 | 24 15 | 28 39 | 32 47 | 34 68 | 38 76 | 42 21 | 46 29 |
0x00002d0: 36 72 | 40 01 | 44 25 | 48 33 | 50 05 | 54 13 | 58 37 | 62 45 |
0x00002f0: 52 09 | 56 17 | 60 41 | 64 49 | 34 19 | 36 35 | 50 51 | 52 67 |
0x0000310: 38 21 | 40 37 | 54 53 | 56 69 | 42 27 | 44 43 | 58 59 | 60 75 |
0x0000330: 46 29 | 48 45 | 62 61 | 64 77 | 66 23 | 68 39 | 03 55 | 05 71 |
0x0000350: 70 25 | 72 41 | 07 57 | 09 73 | 74 31 | 76 47 | 11 63 | 13 00 |
0x0000370: 78 33 | 01 49 | 15 65 | 17 02 | 66 51 | 70 67 | 03 04 | 07 20 |
0x0000390: 68 55 | 72 71 | 05 08 | 09 24 | 74 59 | 78 75 | 11 12 | 15 28 |
0x00003b0: 76 63 | 01 00 | 13 16 | 17 32 | 19 53 | 23 69 | 35 06 | 39 22 |
0x00003d0: 21 57 | 25 73 | 37 10 | 41 26 | 27 61 | 31 77 | 43 14 | 47 30
0x00003f0: 29 65 | 33 02 | 45 18 | 49 34 | 19 04 | 21 08 | 23 20 | 25 24 |
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