MOBIWAVE BLUETOOTH PROTOCOL ANALYSER (BPA-D10)

1. FRQUENCY HOPPING GENERATION AND EQUALLY AVERAGE USE OF HOPPING FREQUENCIES IN DATA MODE AND SHORT TRANSMISSIONS

The generation of the hopping sequence in connection mode depends essentially on two input values:

a. LAP/UAP of the master of the connection
b. Internal master clock

The Lower Address Part (LAP) is the 24 LSB's of the 48 Bluetooth Address (BD_ADDRESS). The BD_ADDRESS is an unambiguous number of every Bluetooth unit. The UAP (Upper Address Part) is the 24 MSB's of the 48 BD_ADDRESS. The internal clock of a Bluetooth unit is derived from a free running clock which is never adjusted and is never turned off. For synchronization with other units, only the offsets are used. It has no relation to the time of the day. Its resolution is a least half the RX/TX slot length of 312.5µs. The clock has a cycle of about one day (23h30). In most case it is implemented as 28 bit counter. For the deriving of the hopping sequence the entire LAP (24 bits), 4 LSB's (4 bits) (Input 1) and the 27 MSB's of the clock (Input 2) are used With this input values different mathematical procedures (permutations, additions, XOR-operations) are performed to generate the sequence. This will be done at the beginning of every new transmission.

Regarding short transmissions, the Bluetooth system has the following behavior:

The first connection between the two devices is established, a hopping sequence is generated. For transmitting the wanted data, the complete hopping sequence is not used and the connection ends. The second connection will be established. A new hopping sequence is generated. Due to the fact that the Bluetooth clock has different value, because the period between the two transmission is longer (and it cannot be shorter) than the minimum resolution of the clock (312.5µs). The hopping sequence will always differ from the first one.

Example of a 79 hopping sequence:

40, 21, 44, 23, 42, 53, 46, 55, 48, 33, 52, 35, 50, 65, 54, 67,
56, 37, 60, 39, 58, 69, 62, 71, 64, 25, 68, 27, 66, 57, 70, 59,
72, 29, 76, 31, 74, 61, 78, 63, 01, 41, 05, 43, 03, 73, 07, 75,
09, 45, 13, 47, 11, 77, 15, 00, 64, 49, 66, 53, 68, 02, 70, 06,
01, 51, 03, 55, 05, 04

2. DERIVATION AND EXAMPLES FOR A HOPPING SEQUENCE IN INQUIRY AND PAGE MODES

For the generation of the inquiry and page hop sequences the same procedures as in described for the data mode are used (Section 1), but this time with different input vectors:

For inquiry hop sequence, a predefined fixed address is always used. This result in the same 32 frequencies used by all devices doing an inquiry but every time with a different start frequency and phase in this sequence.

For the page hop sequence, the device address of the paged unit is used as the input vector. This result in the use of a subset of 32 frequencies which is specific for that initial state of the connection establishment between the two units. A page to different devices would result in a different subset of 32 frequencies.

Example of a hopping sequence in inquiry mode:

48, 50, 09, 13, 52, 54, 41, 45, 56, 58, 11, 15, 60, 62, 43, 47, 00, 02, 64, 68, 04, 06, 17, 21, 08, 10, 66, 70, 12, 14, 19, 23

Example of a hopping sequence in paging mode:

08, 57, 68, 70, 51, 02, 42, 40, 04, 61, 44, 46, 63, 14, 50, 48, 16, 65, 52, 54, 67, 18, 58, 56, 20, 53, 60, 62, 55, 06, 66, 64

3. RECEIVER INPUT BANDWIDTH, SYNRONIZATION AND REPEATED SINGLE OR MULTIPLE PACKETS

The input bandwidth of the receiver is 1MHz.In every connection, one Bluetooth device is the master and the other one is the slave. The master determines the hopping sequence. The slave follows this sequence. Both devices shift between RX and TX time slots according to the clock of the master. Additionally the type of connection (e.g. single or multi-slot packet) is set up at the beginning of the connection. The master adapts its hopping frequency and its TX/RX timing according to the packet type of the connection. Also, the slave of the connection uses these settings. Repeating of a packet has no influence on the hopping sequence. The hopping sequence generated by the master of the connection will be followed in any case. That means, a repeated packet will not be sent on the same frequency, it is sent on the next frequency of the hoping sequence.

4. DE FACTO EIRP LIMIT

The maximum output power level is 20dBm (100mW), 10dBm below the limit. The antenna used has a maximum gain of 1.7dBi. So the EIRP will not exceed 30dBm.

The antenna is part of the assembled unit and cannot be changed by users.

5. CO-ORDINATION OF THE HOPPING SEQUENCE IN DATA MODE TO AVOID SIMULATANEOUS OCCUPANCY BY MULTIPLE TRANSMITTERS

Bluetooth units which want to communicate with other units must be organized in a structure called piconet. This piconet consists of maximum of 8 Bluetooth units. One unit is the master and the other seven are the slaves. The master co-ordinates frequency occupation in this piconet for all units. As the master hop sequence is derived from its Bluetooth address (BD_ADDRESS) which is unique for every Bluetooth device, additional masters intending to established new piconets will always used different hop sequences.