BLUETOOTH APPROVALS.

The following exhibit indicates the FCC Spread Spectrum requirements in Section 15.247 for devices meeting the Bluetooth Specifications in the 2.4 GHz band as of Feb 2001 operating in the USA. The purpose of this exhibit is to help expedite the approval process for Bluetooth devices. This exhibit provides items that are common to all Bluetooth devices. The list of common items can be submitted for each application for equipment authorization.

Items Common to all Bluetooth Devices.

1. Output power and channel separation of a Bluetooth device in the different operating modes. The different operating modes (data-mode, acquisition-mode) of a Bluetooth device don't influence the output power and the channel spacing. There is only one transmitter, which is driven by identical input parameters concerning these parameters. Only a different hopping sequence will be used. For this reason the RF parameters in one-op mode is sufficient.
2. Frequency range of a Bluetooth device. The maximum frequency range of the Bluetooth device is 2402 to 2480 MHz. This is according to the Bluetooth Core Specification V 1.0B (+ critical errata) for devices which will be operated in the USA.
3. Co-ordination of the hopping sequence in data mode to avoid simultaneous occupancy of multiple transmitters. Bluetooth units, which want to communicate with other units, must be organised in a structure called a piconet. The piconet consists of a maximum of 8 Bluetooth units. One unit is the master; the other seven are the slaves. The master coordinates frequency occupation in this piconet for all units. As the master hop sequence is derived from its BD address which is unique for every Bluetooth device, additional masters intending to establish new piconets will always use different hop sequences.
4. Example of a hopping sequence in data mode. The following is a sample of a 79 hopping sequence in data mode: 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.
5. Equally average use of frequencies in data mode and short transmissions. The generation of the hopping sequence in connection mode depends essentially on two input values:

- LAP/UAP of the master of the connection.
- Internal master clock.

The LAP (lower address part) are the 24 LSBs of the 48 BD_ADDRESS. The BD_ADDRESS is an unambiguous number of every Bluetooth unit. The UAP (upper address part) are the 24 MSBs 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 day. Its resolution is at least half the RX/TX slot length of 312.5 μs. the clock has a cycle of about one day (23h30). In most case it is implemented as a 28 bit counter. For the deriving of the hopping sequence the entire LAP (24 bits), 4 LSBs (4 bits) (1 input) and the 27 MSBs 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 each new transmission. For short transmissions, the Bluetooth system behaves in the following manner. 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 is established and a new hopping sequence is generated. Because the Bluetooth clock has a different value, because the period between the two transmissions is longer (and it cannot be shorter) than the minimum resolution of the clock (312.5 μs). The hopping sequence will always differ from the first one.

6. Receiver input bandwidth, synchronization and repeated single or multiple packets. The input bandwidth of the receiver is 1 MHz. In every connection one Bluetooth device is the master and the other is the slave. The master determines the hopping sequence and the slave follows this sequence. Both devices shift between RX and TX time slot 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 will be sent on the next frequency in the hopping sequence.
7. Dwell time in data mode. The dwell time of 0.3797 s within a 30 s period in data mode is independent from the packet type (packet length). The calculation for a 30 s period is as follows:

Dwell time= time slot length* hop rate/ number of hopping channels * 30 s. For a DH1 packet, dwell time = 0.3797 s, in a 30 s period.

For a multi-slot packet the hopping sequence is reduced according to the length of the packet. For example a DH5 packet, dwell time = 0.3797 s, in a 30 s period. This is according to the Bluetooth Core Specification V 1.0B (+ critical errata) for all Bluetooth devices. All Bluetooth devices, therefore, comply with the FCC dwell time requirement in the data mode. This was checked in the Bluetooth Qualification tests.

The dwell time in Hybrid mode is approximately 2.6 ms (in a 12.8 s period).

8. Channel separation in hybrid mode. The nominal channel spacing of the Bluetooth system is 1 MHz independent of the operating mode. The maximum initial carrier frequency tolerance which is allowed for Bluetooth is fcenter = 75 kHz. This was checked during the Bluetooth Qualification tests under test case TRM/CA/07/E for three frequencies, 2402, 2441, 2480 MHz.

9. Derivation and examples for a hopping sequence in hybrid mode. For the generation of the inquiry and page hop sequences the same procedure as previously described for the data mode are used, but this time with different input vectors. For the inquiry hop sequence, a predefined fixed address is always used. This results 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.

- 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.
  For the page hop sequence, the device address of the paged unit is used as the input vector. This results 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. This ensures that in hybrid mode the frequency is used equally on average.
- Example of a hopping sequence in inquiry 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.

10. Receiver input bandwidth and sychronization in hybrid mode. The receiver input bandwidth is the same as in the data mode (1 MHz). When two Bluetooth devices establish contact for the first time, one device sends an inquiry access code and the other device is scanning for this inquiry access code. If two devices have been connected previously and want to start a new transmission, a similar procedure takes place. The only difference is, instead of the inquiry access code, a special access code, derived from the BD_ADDRESS of the paged device will be sent by the master of this connection. Due to the fact that both units have been connected before (in the inquiry procedure) the paging unit has timing and frequency information about the page scan of the paged unit. For this reason the time to establish the connection is reduced.
11. Spread rate/ data rate of the direct sequence signal. The spread rate/ data rate in inquiry and paging mode can be defined via the access code. The access code is the only criterion for the system to check if there is a valid transmission or not. If you regard the presence of a valid access code as one bit of information, and compare it with the access code of 68 bits, the Spread rate/ Data rate will be 68/1.
12. Spurious emissions in hybrid mode. The dwell in hybrid mode is shorter than data mode. For this reason the spurious emissions average level in data mode is the worst case. The spurious emissions peak level is the same for both modes.