IEEE P802.11

Wireless Access Methods and Physical Layer Specifications

TITLE: **Proposal For The Specification Of: The FH Transmitter Modulation For 1Mb/sec 2GFSK**

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ABSTRACT

This paper is aimed at generating an acceptable specification for Spread Spectrum Frequency Hopping Transmission modulation characteristics. One of the most important specifications in the PHY is the transmitter modulation, designers of the Radio receivers must know what they have to demodulate. This paper looks at both the specification from a practical and measurable perspective.

1. INTRODUCTION

This paper looks at the modulation specification by first explaining the potential problems, how it can be measured then proposes some text for the specification.

The likely problems are viewed from the receiver and transmitter designers perspective. From the receivers point of view the key parameters are: Eye opening, Zero crossing, Centre Frequency stability. From the measurement perspective, it is seen as important that all developers and approvers of products can measure the performance to an acceptable level with a reasonable cost, commercially available test equipment. Regarding the specification, the aim is to make it as close as possible to that which can be measured. First the following terms are defined:

Nominal Centre Frequency — Centre frequency of the carrier, that is the mid point of say a 101010 (2GFSK) pattern encoded on the RF carrier.

Minimum Deviation — Minimum deviation from the nominal carrier centre frequency at the mid time point of a symbol.

Maximum Deviation — Maximum deviation from the nominal centre frequency.

2. POTENTIAL PROBLEMS

As stated earlier, the problems are: Eye opening, Zero crossing, Centre Frequency stability. Eye Opening is the most obvious, this is generally over filtering of the transmit modulation, this is shown in figure 1. Here the frequency deviation is plotted as a function of time. The trace generated requires the transmitter clock to be recovered and the display triggered using this clock. Figure 1 shows the meaning of maximum and minimum deviation. It is essential to specify the minimum eye opening. This minimum

deviation should be set to a limit that enables reasonable cost modulators, accounts for the phase noise of the transmitter LO and any measurement error. Maximum deviation can be specified, but is in general limited to the spectrum mask.

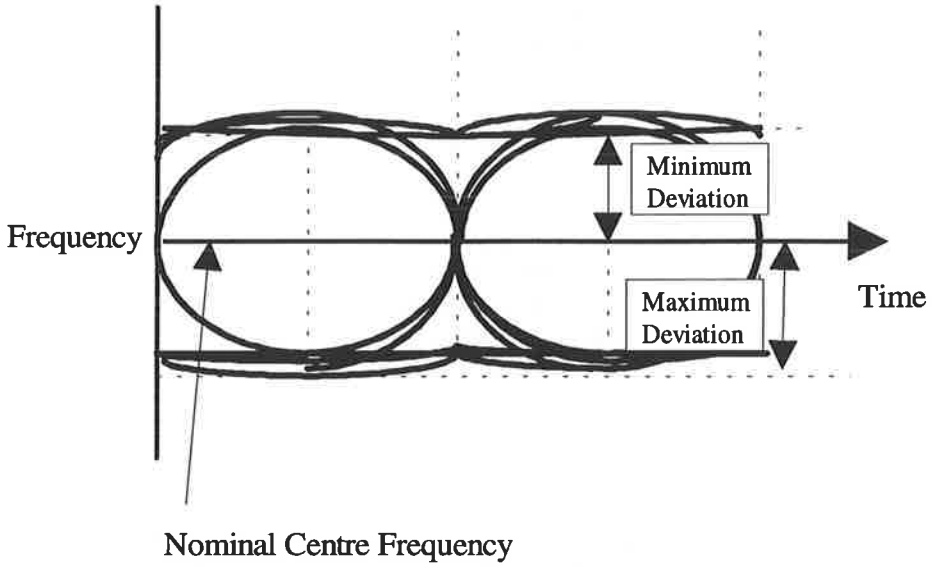

Figure 1: :Showing Eye Pattern and Definition of minimum deviation

Zero crossing error can be causes by errors in the transmit clock, or more generally the asymmetric modulation, that is the frequency deviation for a '1' is different to that for a '0'. This is difficult to recover in the demodulator and needs specification. It is suggested that the zero crossing error is <1/10 of a Symbol to be at a level where it is of little concern.

The centre frequency stability of the transmit signal has a number of components, those due to the accuracy of the reference oscillator (assuming frequency synthesis), then those due to transients in the radio, i.e. a 'kick' on the VCO when turning on the transmitter and finally any symbol pattern dependence on centre frequency. This symbol pattern dependence is effectively due to a VCO being modulated, where there is a PLL stabilising the long term frequency of the VCO and this is effected by the modulation. Any receiver has to track out the frequency changes to enable correct demodulation.

At a global level the frequency accuracy is +/-50kHz (20ppm), however a +/-50kHz error on a bit by bit basis would be difficult to demodulate, especially when the modulation deviation is of the order of 150kHz. So there needs to be a short term specification for VCO stability, that is on say a 16 symbol measurement, the nominal centre frequency should not vary greater than +/-10kHz.

In addition to this, there longer term centre frequency accuracy requires setting, the demodulator can only track out a certain rate of change of centre frequency. So over a succession of octets of symbols, the nominal centre frequency should change slowly. A suggestion for this figure is <40kHz/msec.

3. MEASUREMENT

What do we want to measure? We need to take snap shots of the modulated carrier, with the radio operating dynamically, ideally with switching from transmit to receive as is required in such a CSMA system. These snap shots should be performed on say 16 symbols, to measure eye opening, nominal centre frequency an minimum deviation and zero crossings. A number of snapshots should taken over a transmit packet to measure the nominal centre frequency drift. As the transmitter is effectively a black

box, no access to transmitter enable lines or bit clock is available. It is proposed that the measurement is performed, triggering the measurement apparatus with the RF envelope of the transmit signal.

So we take a number of 'snapshots', measure the nominal centre frequency, minimum deviation, zero crossing. Zero crossing is measured by looking at the symbol duration (t) from one zero crossing to another, ideally on a 1010101 pattern. The nominal centre frequency is the mean of the deviation at the mid Symbol timing period. We take these measurements at the end of the transmit packet, at the end of the 1010101 preamble before the unique word and mid packet. This is illustrated in Figure 2.

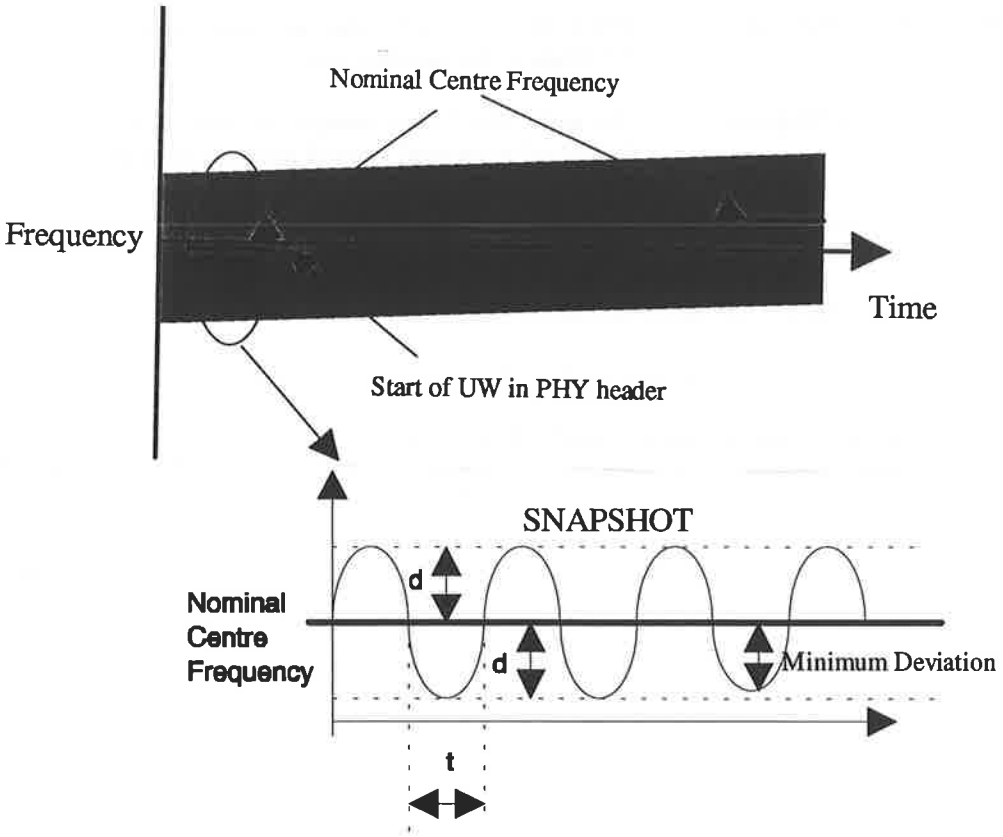

Figure 2. Proposed Measurement Of Carrier Modulation.

In order to measure the effect of the modulation on a PLL (If used), the transmit data pattern in the packet should be representative data, to be defined, with reasonable length strings of 1's and 0's. Ideally this would be measured with a packet with 64 1's, 64 0's and 32 bits of '101010' repeated and scrambling disabled. The Nominal centre frequency, minimum deviation and zero crossing are measured on the 10101 pattern.

We want to measure these parameters, preferably with a commercially available equipment. Ideally the measurement equipment to perform these tests would demodulate, with a wide band system store this data and then process the information. To date, we have not identified such an apparatus and have had to build specialist equipment to perform such tests.

Presently, a Modulation Domain Analyser (HP------) is probably the best way forward. This equipment can demodulate a 1Mb/sec modulated carrier. However it builds up the display by averaging over number of transmissions, but this is effectively what we wish to measure. The accuracy of measurements with this apparatus are +/-5kHz, which needs to be taken into account in the specification.

4. THE TEXT

Definition Of Terms:

Minimum deviation:	This is the smallest frequency offset from the nominal centre frequency measured at the mid symbol interval.
Zero Crossing Accuracy:	This is the time interval between successive crossings of the nominal centre frequency.
Nominal Centre Frequency	This is the short term mean of the deviation measured at the mid symbol interval, on a DC balanced pattern.

Specifications:

The minimum deviation should be >140kHz.

Zero crossing error should be <1/8th of a symbol.

Nominal centre frequency should change <40kHz/msec.