CPFSK Modulation Process

The Blackfin DSP generates I & Q samples which are fed to the AD9857 digital upconverter. This process creates the CPFSK (continuous-phase frequency shift keying) modulation.

The radio uses 3-level partial response modems to create modem data rates of 4800, 9600, and 19200bps respectively. Since the process is common for each, a common explanation of operation is provided below.

In the description below, "N" applies to values of 4800, 9600, and 19200bps, with modem names of MODEM 4800F, MODEM 9600, and MODEM 19200, respectively.

Although the data rate is (N) bits/second, the average signaling rate is less than half this value. Root-duobinary signal coding ensures a maximum signaling rate of (N/2) b/s. However, this would only occur during a run of alternating 1s and 0s. However, the SD4 modem employs a data scrambler circuit which converts an alternating 1,0 pattern into a pseudo-random bit pattern. Any other bit pattern is likewise scrambled into a pseudo-random bit pattern. Further insight into the modulation rate can be seen from a consideration of the two possible extremes. The scrambler could, over a limited time, produce a run of all 1s or all 0s, which would be a signaling rate very close to zero (DC). At the other extreme, the scrambler could produce an alternating pattern of 1s and 0s for a limited time. This would be a signaling rate of (N/2) b/s. The two extremes are at the tails of the probability distribution, and are very unlikely. The most likely situation is at the mean of (N/4) b/s. Since the likeliness relates directly to the time spent in such a condition, the power spectral density is likewise directly related, and behaves as if the signaling rate is (N/4) b/s.

In addition to the above considerations, the scrambled signal passes through a digital low-pass filter with a 3 dB point of (N/2) Hz. This means that when a brief run of (N/2) b/s signal occurs, *it will deviate the radio to only one-half of the peak deviation.* This has a direct effect on reducing the occupied bandwidth of the emissions of the radio. Runs of (N/4) b/s or less deviate the transmitter fully, while runs of (N/2) b/s deviate to only half full deviation.

It should be evident that the modulation process for the partial-response modem is complex and statistical in nature, and does not easily translate to the formulas for calculation of necessary bandwidth given in Part 2.202.

Based on the above considerations, we have requested a necessary bandwidth on the emission designator to equal the maximum authorized bandwidth for the respective channel spacing choices in this operating frequency range.

- 6.25KHz -- 6.0KHz necessary bandwidth
- 12.5KHz -- 11.2KHz necessary bandwidth
- 25.0KHz -- 20.0KHz necessary bandwidth