Spektrum Coding and Modulation Characteristics

How can Spektrum™ be allowed the power levels of a Frequency Hopping Spread Spectrum (FHSS) system according to EN 300-328 v1.7.1 when it is a Direct Sequence Spread Spectrum (DSSS) system?

Spektrum's DSM® system is actually hybrid system that combines the advantages of DSSS coding with the bandwidth characteristics of FHSS modulation.

From a coding standpoint, it is a DSSS system, with the transmitter identifying the open channels and locking on to those channels for communications between transmitter and receiver. This aspect provides Spektrum with multiple advantages over the traditional FHSS system. First, the coding gain yields a higher range for the same power compared to other FHSS systems. Spektrum is 18dB better, or triple the range, for the same power. Second, the DSSS coding enables much faster synchronization after loss of signal occurrences. The robustness and security of the DSSS system is also evident in its immunity to on-channel narrow-band.

From a bandwidth perspective, though, Spektrum's DSM technology was designed to meet all of the requirements of FHSS modulation as specified in EN 300-328 v.1.7.1 clause 4.2.1:

> *FHSS modulation shall:*
>
> *either:*
>
> > *a) make use of at least 15 well defined, non-overlapping hopping channels separated by the channel bandwidth as measured at 20 dB below peak power;*
>
> *or if capable of adaptive frequency hopping:*
>
> > *b) at least be capable of operating over a minimum of 90 % of the band specified in table 1, from which at any given time a minimum of 20 channels or hopping channels shall be used.*
>
> *For both cases, the minimum channel separation shall be 1 MHz, while the dwell time per channel shall not exceed 0,4 s.*
>
> *While the equipment is operating (transmitting and/or receiving) each channel of the hopping sequence shall be occupied at least once during a period not exceeding four times the product of the dwell time per hop and the number of channels. Systems that meet the above constraints shall be tested according to the requirements for FHSS modulation.*

Spektrum is not an adaptive frequency hopping system, so clause (a) above applies. Conformity tests at Elliott Laboratories, Inc. in Sunnyvale, California, USA confirmed that DSM utilizes 40 non-overlapping channels, well above the minimum requirement of 15. Further, the test confirmed that DSM has 2 MHz of separation between the channels, again well above the minimum requirement, and that the dwell time per channel is only 2 ms, well below the specified maximum of 400 ms.

Spektrum is unique in its method of utilizing the 40 non-overlapping channels. Only two of the 40 channels are used for transmitting, allowing the coding advantages as in a DSSS system. The other 38 channels are used for receiving. Note that the standard specifies "*transmitting and/or receiving*". DSM defines 47 hopping slots, repeating the two transmitting channels at varying intervals within the sequence of the 38 receiving channels. The standard requires that each channel be occupied at least once in 320 ms given our above dwell time and number of channels. DSM occupies each of the 40 channels at least once every 94 ms, well below the 320ms maximum. Please note that transmitting on only two hopping channels is not a disadvantage to DSM. First, the RC has very low data rate that the two hopping channels can more than handle. Second, the two channels provide excellent frequency diversity. Limiting DSM to two channels also avoids polluting the 2.4GHz band unnecessarily and allows for the expansion to future features such as telemetry.

Spektrum's DSM technology satisfies each of the requirements of FHSS modulation as specified in EN 300-328 v.1.7.1. As the closing sentence of that clause states, "*Systems that meet the above constraints shall be tested according to the requirements for FHSS modulation.*" Therefore, DSM is subject to the maximum power level of 100mW as detailed in clause 4.3.1.2, and not subject to the limit of non-FHSS systems of 10mW as specified in section 4.3.2.2. Conformity tests as well as on-going production tests confirm that EU versions of DSM products meet the 100mW requirement.

DSM then combines the coding advantages of traditional DSSS systems within the modulation requirements for FHSS to yield a secure, robust, full range radio control system.