[DRAFT]

2.4.25   MODULATION METHODS FOR HIGH CODED SYMBOL RATE TRANSMISSIONS IN 25.25–27.5 GHz BAND, INTER-SATELLITE SERVICE, SPACE RESEARCH, SPACE-TO-SPACE

The CCSDS,

considering

(a)   that the 25.25–27.5 GHz band is allocated on a primary basis to the inter-satellite service for space research and Earth exploration-satellite applications, and also for transmission of data originating from industrial and medical activities in space (ITU-RR-5.536);

(b)   that use of the 25.25-27.5 GHz band by the inter-satellite service includes high data rate space-to-space links for data relay satellites as well as for proximity communication links;

(c)   that the SFCG has recommended[1] that use of the 25.25-27.5 GHz band for proximity communication links be constrained to the sub-bands 25.25-25.6 GHz and 27.225-27.5 GHz;

(d)   that the SFCG has recommended[2] that lunar surface-to-lunar orbit links and lunar relay-to-relay crosslinks use the 27-27.5 GHz band;

(e)   that efficient use of RF spectrum resources is imperative with the increasing congestion of the frequency bands;

(f)   that GMSK[3] and baseband filtered OQPSK[4] are spectrally and power efficient modulations, and have been recommended by the CCSDS for high symbol rate space-to-space transmissions in the 22.55-23.15 GHz band as well as high symbol rate space-to-Earth transmissions in the 25.5-27 GHz band[5];

(g)   that since GMSK modulation is inherently differential in nature, the use of GMSK with precoding is necessary to optimize bit error rate performance;

(h)   that GMSK[3] and baseband filtered OQPSK[4] modulation types can be demodulated using a conventional OQPSK receiver, but with higher end-to-end losses;

(i)   that GMSK[3] and baseband filtered OQPSK[4] modulations have only a small performance degradation as compared with ideal unfiltered suppressed carrier systems;

(j)   that GMSK[3] and baseband filtered OQPSK[4] modulations have immunity to interference (wideband and narrow band) comparable to unfiltered BPSK when demodulated with an OQPSK receiver matched to an unfiltered OQPSK waveform; the interference immunity of these modulations when demodulated with matched filter receivers is equivalent to or better than BPSK;

(k)   that the receiver tracking loops for GMSK BT_s=0.5 are able to track signals with higher Doppler rates compared to GMSK BT_s=0.25, assuming the same symbol SNR and data rate;

(l)   that GMSK BT_s=0.25 has better spectral efficiency (occupied bandwidth) than GMSK BT_s=0.5;

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[1] See SFCG Recommendation 15-2R4 or latest version.

[2] SFCG Recommendation 32-2R~~2~~4 or latest version.

[3] Gaussian Minimum Shift Keying ~~(BT_s = 0.25),~~ with pre-coding as in Figure 2.4.25-1. B refers to the one-sided 3-dB bandwidth of the filter.

[4] Filtered (Square Root Raised Cosine α = 0.5) Offset QPSK; Butterworth 6 poles, BT_S = 0.5; agencies may also utilize filtered OQPSK modulation with other types of bandpass filters provided that the equivalent baseband BT_S is not greater than 0.5 and they ensure compliance with SFCG Recommendation 21-2R3 (or latest version) and interoperability with the cross-supporting networks. B refers to the one-sided 3-dB bandwidth of the filter.

[5] CCSDS Recommendations 401 (2.2.10) B-1 and 401 (2.4.21A) B-1

2.4.25   **MODULATION METHODS FOR HIGH CODED SYMBOL RATE TRANSMISSIONS IN 25.25–27.5 GHz BAND, INTER-SATELLITE SERVICE, SPACE RESEARCH, SPACE-TO-SPACE (Continued)**

(k)(m)   that some agencies channelize the frequency band and for this they prefer to use GMSK[3] BT_s=0.25 in order to maximize the total number of channels available;

recommends

(1)   that, for space-to-space transmissions to ensure an ability to obtain cross support in the 25.25–27.5 GHz inter-satellite service band, GMSK[3] BT_s=0.25 or baseband filtered OQPSK[4] be used when [channelization of the band and/or a tighter spectral requirement][better spectral efficiency] is needed; otherwise GMSK[3] BT_s=0.5 should be used when the coded symbol rate exceeds 10 coded Msymbol/s;

(2)   that, to ensure an ability to obtain cross support in the 25.25–27.5 GHz inter-satellite service band, GMSK[3] BT=0.25 or baseband filtered OQPSK[4] be used when channelization of the band and/or a tighter spectral requirement is needed; otherwise GMSK[3] BT=0.5 should be used for space-to-space transmissions when the coded symbol rate is below or equal to 10 coded Msymbol/s[6];

(3)   that, for space-to-space transmissions to ensure an ability to obtain cross support in the 25.25–27.5 GHz inter-satellite service band, the residual carrier modulation schemes of Recommendations 2.3.1 and 2.4.7 may be used when the coded symbol rate is below 1 coded Msymbol/s[6] and the suppressed carrier modulation schemes of Recommendation 2.3.2 may be used when the coded symbol rate is below 10 coded Msymbol/s[6].
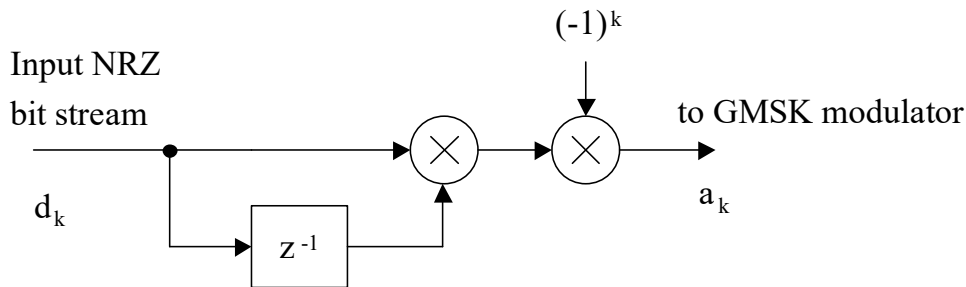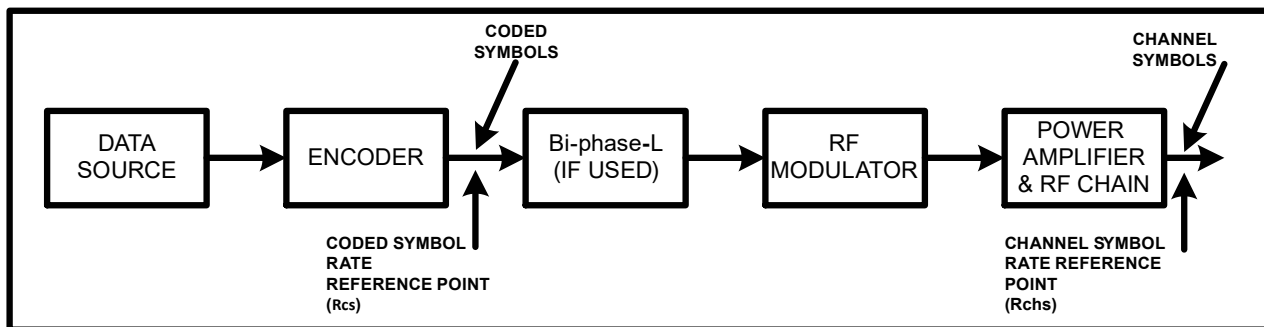

Figure 2.4.25-1: GMSK Precoder

Figure 2.4.25-2: Telemetry Rates Definition

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[6] For the purpose of this Recommendation, the coded symbol rate is defined in Figure 2.4.25-2.