

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 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 proximity communication links;
- (c) that the SFCG has recommended¹ 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)~~ (d) that the SFCG has recommended² that lunar surface-to-lunar orbit links use the 25.5-27 GHz band and that lunar relay-to-relay crosslinks use the 27-27.5 GHz band;
- ~~(d)~~(e) that efficient use of RF spectrum resources is imperative with the increasing congestion of the frequency bands;
- ~~(e)~~(f) that GMSK³ and baseband filtered OQPSK⁴ 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 band⁵;
- ~~(f)~~(g) that since GMSK modulation is inherently differential in nature, the use of GMSK with precoding is necessary to optimize bit error rate performance;
- ~~(g)~~(h) that GMSK² and baseband filtered OQPSK³ modulation types can be demodulated using a conventional OQPSK receiver, but with higher end-to-end losses;
- ~~(h)~~(i) that GMSK² and baseband filtered OQPSK³ modulations have only a small performance degradation as compared with ideal unfiltered suppressed carrier systems;
- ~~(i)~~(j) that GMSK and baseband filtered OQPSK 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;

recommends

- (1) that, to ensure an ability to obtain cross support in the 25.25–27.5 GHz inter-satellite service band, GMSK² or baseband filtered OQPSK³ shall be used for space-to-space transmissions when the coded symbol rate exceeds 10 coded Msymbol/s⁶;

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

² SFCG Recommendation 32-2R2 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 $\alpha = 0.5$) 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

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

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- (2) that, to ensure an ability to obtain cross support in the 25.25–27.5 GHz inter-satellite service band, GMSK² or baseband filtered OQPSK³ should be used for space-to-space transmissions when the coded symbol rate is below or equal to 10 coded Msymbol/s⁵;
- (3) that, 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/s⁵ and the suppressed carrier modulation schemes of Recommendation 2.3.2 may be used when the coded symbol rate is below 10 coded Msymbol/s⁵.

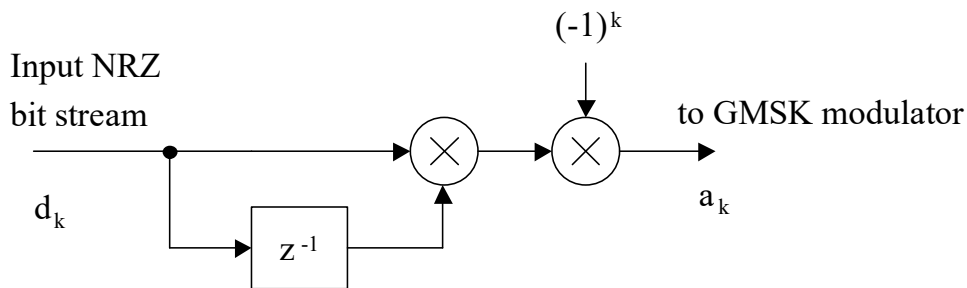


Figure 2.4.25-1: GMSK Precoder

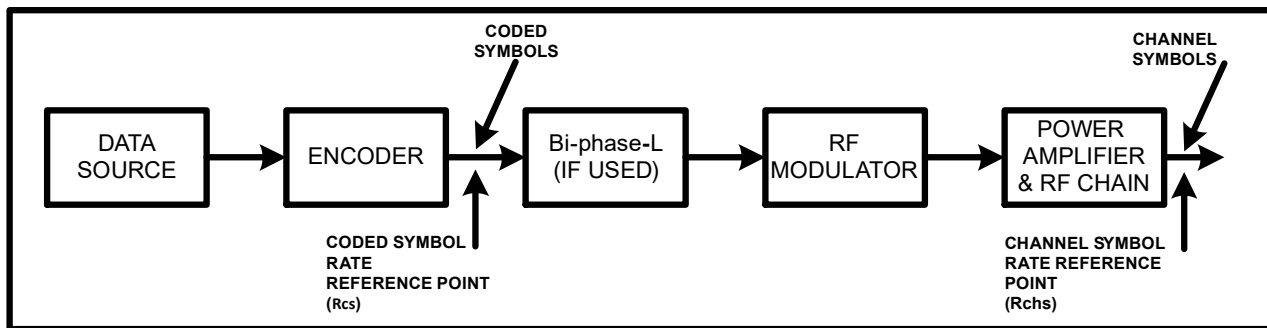


Figure 2.4.25-2: Telemetry Rates Definition