2.2.~~9~~10 USE OF SUPPRESSED CARRIER MODULATIONS FOR HIGH RATE ~~EARTH~~SPACE-TO-SPACE LINKS, SPACE RESEARCH AND INTER-SATELLITE, AT ~~[22.55-23.15][23.15-23.55]~~ ~~[~~22.55-23.15~~]~~ GHZ

The CCSDS,

considering

(a) that the frequency band 22.55-23.15 GHz is allocated to ~~Earth-to-space links of~~ to the Space Research Service (Earth-to-space) ~~missions~~and the band 22.55-23.55 GHz is allocated to the Inter-Satellite Service ~~and human mission~~;

(b) that Lunar missions in the near future will require high-rate ~~Earth~~space-to-space links, up to 200 coded Msymbol/s, for functions other than telecommand;

(c) that the SFCG has approved a Recommendation[1] specifying that links from ~~Earth~~ space to Lunar orbit or to Lunar surface shall use the frequency allocation ~~22.55~~-23.15-23.55 GHz;

(d) that it is important to limit the occupied bandwidth at high rates to reduce out-of-band interference;

(e) that GMSK[2] and baseband filtered OQPSK[3] modulations have only a small performance degradation as compared with ideal unfiltered suppressed carrier systems;

(f) that since GMSK[2] modulation is inherently differential in nature, the use of GMSK with precoding is necessary to optimize bit error rate performance;

(g) that a phase imbalance of less than 5 degrees and an amplitude imbalance of less than 0.5 dB should result in acceptable performance degradation.~~;~~

(h) that recommended maximum values of phase noise is needed to ensure small end-to-end losses;

recommends

(1) that GMSK[2] or baseband filtered OQPSK[3] modulations be used for high data rate transmissions with coded symbol rate in the range ~~[~~5~~/10]~~-200 coded Msymbol/s[4] in communications systems operating for high rate ~~Earth~~space-to-space links in the 22.55-23.15 GHz band;

---

[1] See SFCG recommendation 32-2R2 or latest version.

[2] Gaussian Minimum Shift Keying (BT_S = [0.25/0.5]), with pre-coding as in Figure 2.2.10-1~~Figure 2.2.10-1~~~~Figure 2.2.9-1~~ (see CCSDS 413.0-G-3). B refers to the one-sided 3-dB bandwidth of the filter.

[3] Filtered (Square Root Raised Cosine $\alpha = 0.5$) Offset QPSK; Butterworth 6 poles, BT_S = [0.25/0.5]; 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 interoperability with the cross-supporting networks. B refers to the one-sided 3-dB bandwidth of the filter.

[4] For the purpose of this Recommendation, the coded symbol rate is defined in Figure 2.2.10-2~~Figure 2.2.10-2~~~~Figure 2.2.9-2~~.

(2) that CCSDS agencies use a data randomizer as specified in the CCSDS telemetry synchronization and channel coding blue book, CCSDS 131.0-B-3 (or latest edition);

2.2.109 USE OF SUPPRESSED CARRIER MODULATIONS FOR HIGH RATE EARTH-TO-SPACE LINKS, SPACE RESEARCH, AT 22.55-23.15 GHZ (Continued)

(3) that the modulator's phase imbalance shall not exceed 5 degrees, and the amplitude imbalance shall not exceed 0.5 dB between the constellation points.;

~~(4)~~ that the phase noise of the communication chain should be limited according to the mask in the Annex~~.~~

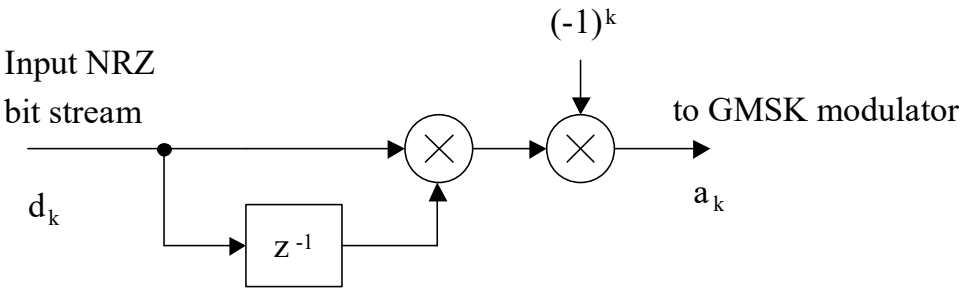

Figure 2.2.10~~2.2.9~~-1: GMSK Precoder

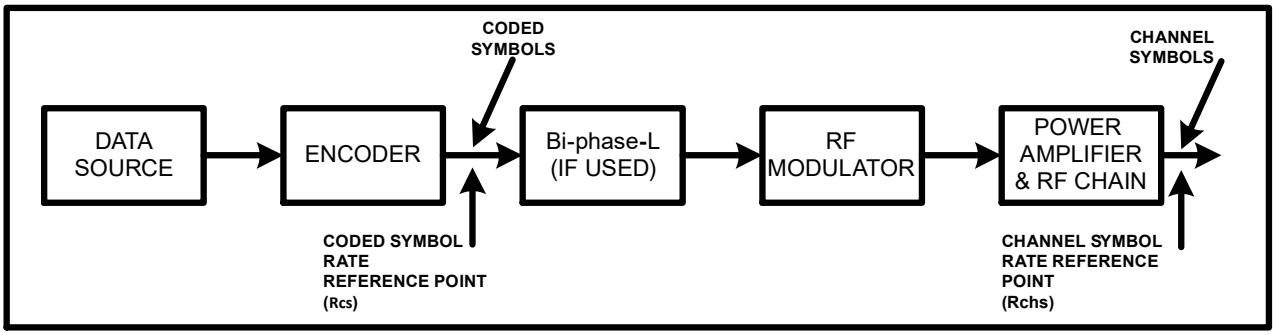

Figure 2.2.10~~2.2.9~~-2: Telemetry Rates Definition

2.2.9 USE OF SUPPRESSED CARRIER MODULATIONS FOR HIGH RATE EARTH-TO-SPACE LINKS, SPACE RESEARCH, AT 22.55-23.15 GHZ (Continued)

ANNEX

PHASE NOISE

(Normative)

The phase noise for all the oscillators of the communication chain shall be limited according to the mask given in Figure Error! Reference source not found.-3~~Figure 2.2.9-3~~.

NOTE – The figure shows the double-sided phase noise mask 2L(f) in dBc/Hz versus frequency in Hz.

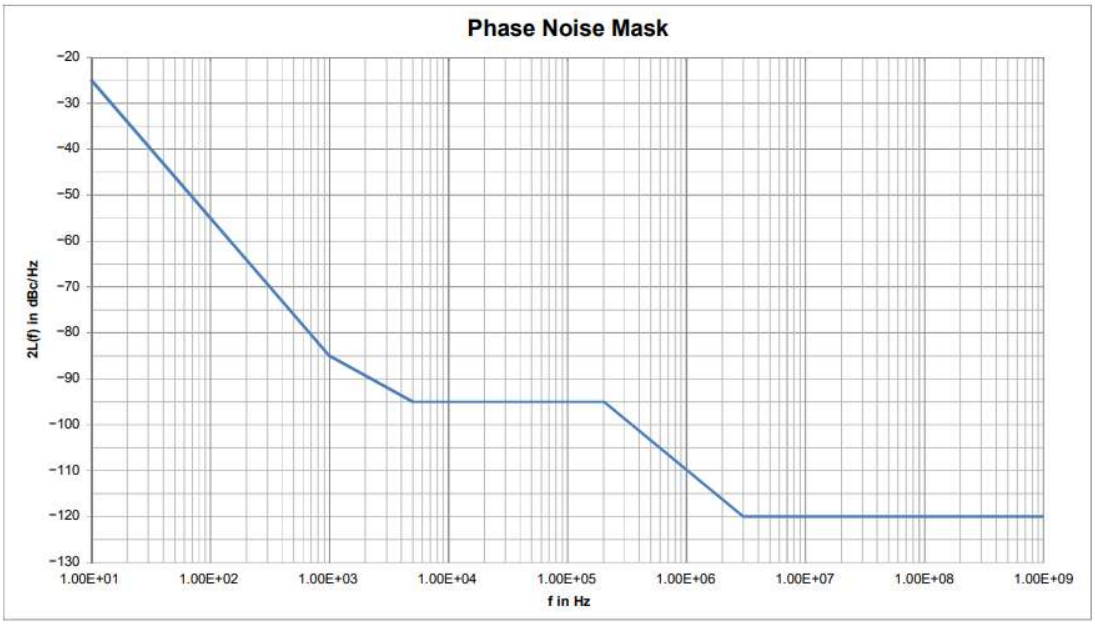

Figure Error! Reference source not found.~~2.2.9~~-3: Phase noise mask recommendation