



**Recommendation SFCG 23-1R2**

**EFFICIENT SPECTRUM UTILIZATION FOR SPACE  
RESEARCH SERVICE, DEEP SPACE (CATEGORY B),  
IN THE SPACE-TO-EARTH LINK**

The SFCG,

CONSIDERING

- a) that spectrum allocated to SRS, deep space, space-to-Earth, is limited to 10 MHz in the 2 GHz-band (2290-2300 MHz), 50 MHz in the 8.4 GHz-band (8400-8450 MHz), and 500 MHz in the 32 GHz-band (31.8-32.3 GHz);
- b) that users and data rates in the 8.4 GHz-band continue to increase and congestion in this band is more severe than in the 2 and 32 GHz bands;
- c) that the technology and ground support infrastructure for the 32-GHz allocation are available;
- d) that several future missions being planned are considering data rates in the 5-60 Msp range, and that advanced power generating technologies could enable an even higher data rate;
- e) that spacecraft in the Mars region are much more vulnerable to mutual interference due to lack of spatial separation, and that a single unrestricted high-rate mission could occupy the entire 50 MHz allocation in the 8.4 GHz band, preventing its use by any other user in the Mars region;
- f) that five or six high rate missions could conceivably coexist in the Mars vicinity in the future, making it necessary to limit the maximum allowable bandwidth for each mission to no more than 8 MHz in the 8.4 GHz band;
- g) that use of both left-hand and right-hand circular antenna polarizations can increase the number of deep space missions supported within the same bandwidth;

## NOTING

- a) that deep space missions designed for destinations other than Mars, should also have restrictions on their maximum allowable bandwidths in the 8.4 GHz band, although at a less severe level, so that costly operational coordination could be minimized every time a mission arrives in the vicinity of other missions in space;
- b) that an efficient spectrum usage policy should provide incentives to missions to achieve the most efficient utilization of the spectrum as practical;
- c) that several modulations use bandwidths more efficiently than the traditional BPSK and some of the most efficient ones are given in CCSDS Recommendation 2.4.17B;

## FURTHER NOTING

- a) that a 20 dB signal to interference ratio is used successfully as a criterion to prevent interference in the selection of frequencies for many deep-space missions, and separating two missions at the point where their power spectral densities (PSDs) are each 25 dB down from their own spectral peaks is generally sufficient to prevent mutual interference;
- b) that an interference spectral power flux density (SPFD) of  $-255.1$  dB(W/Hz/m<sup>2</sup>) would, when received by a 70 meter antenna, be 6 dB below the noise floor of the receiving system and would raise the system temperature by 1dB;
- c) that it is sometimes necessary for a deep space mission to use a telemetry subcarrier to isolate a residual carrier, which is needed for weak signal acquisition at low data rate, for radio metric measurement, or for a radio science experiment requiring spectral purity;

## RECOMMENDS

1. that, in the 8400-8450 MHz band, the maximum combined allowable bandwidth of telemetry signals in both polarizations be limited according to Figure 1<sup>1</sup>, wherein
  - a) the lower curve applies to all missions;
  - b) the upper curve applies only to the non-Mars-missions, strictly on condition that they would not interfere with the Mars missions;
2. that, in the 8400-8450 MHz band, the spectral power flux density outside the maximum allowable bandwidth be limited to  $-255.1$  dB(W/Hz/m<sup>2</sup>) on the surface of the Earth;

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<sup>1</sup> For the purpose of this Recommendation, the Symbol Rate ( $R_s$ ) is defined in Figure 2.

3. that member agencies use the 32 GHz-band for high rate telemetry with bandwidth requirements higher than those allowed in Figure 1;
4. that member agencies consider use of left-hand or right-hand circular antenna polarizations for their missions in order to increase utilization of the available spectrum;
5. that except for scientific or technical reasons, subcarrier frequencies above 60 kHz do not exceed 5 times the maximum symbol rate of the mission and do not exceed 300 kHz.

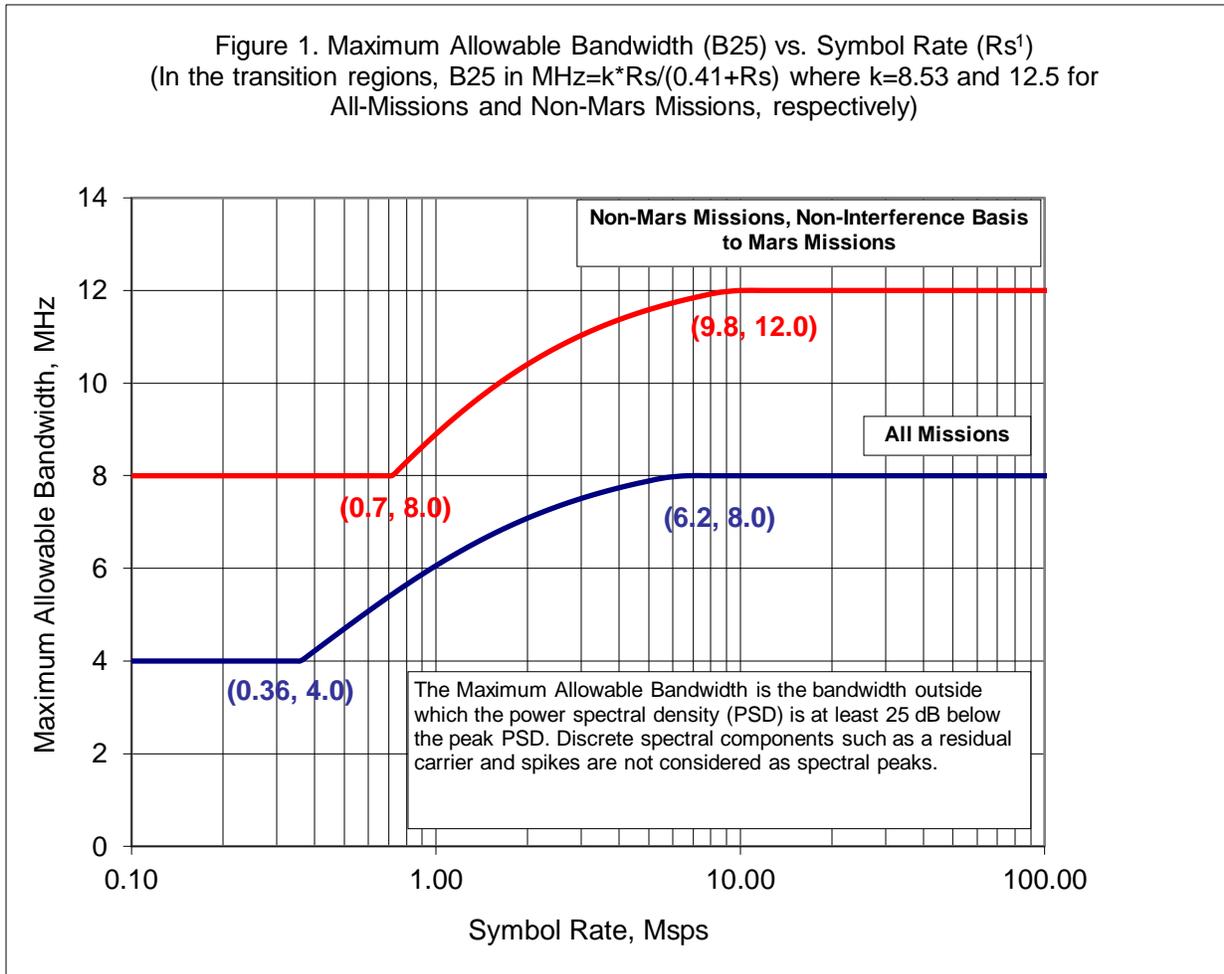


Figure 2. SFCG Symbol Rate Definition

