

Recommendation 21-3R1

**USE OF SUB-CARRIERS FOR SPACE SCIENCE SERVICES
ON SPACE-TO-EARTH LINKS; CAT. A**

The SFCG,

CONSIDERING

- a) that frequency bands allocated to the space science services are becoming more congested as space missions multiply, data rates increase, and other services enter these bands;
- b) that usage of spectrum beyond what is actually required increases the potential for interference to other users and at the same time may result in a higher susceptibility to interference from other users in the band;
- c) that sub-carrier modulation techniques require substantially more spectrum compared to suppressed carrier modulation techniques;
- d) that the required bandwidth with sub-carrier modulation is a function of the sub-carrier frequency and the sub-carrier-to-symbol rate ratio;
- e) that for telemetry sub-carrier frequencies above 60 kHz, a sub-carrier frequency-to-highest symbol rate ratio not exceeding 4 is generally sufficient to obtain acceptable performance;
- f) that the presence of telecommand feed-through and/or ranging signals may require the selection of a slightly higher value of sub-carrier frequency-to-highest symbol rate ratio ¹;
- g) that sub-carriers are not required any longer to separate telemetry data streams because several channels can be present simultaneously on a single RF carrier if virtual channels are used ²;

¹ CCSDS Recommendations 401.0 (2.4.14A) B-1

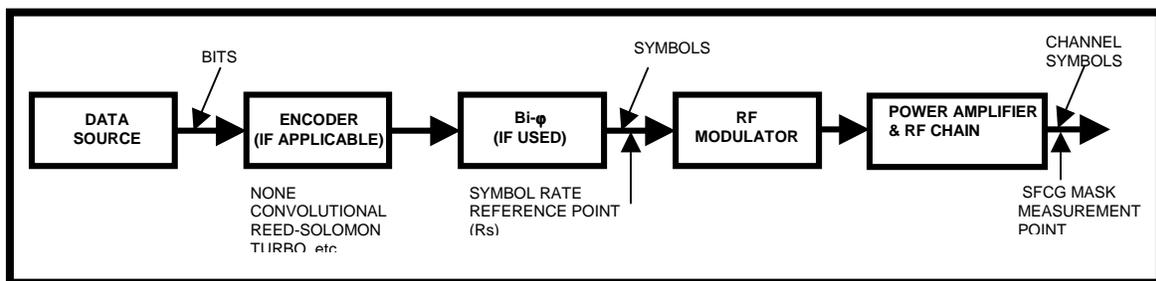
² CCSDS Recommendation for Packet Telemetry (CCSDS 102.0-B-2)

- h) that no technical reasons have been identified which would require the use of sub-carrier modulation for symbol rates above approximately 60 kilobaud/second (ks/s)³;
- i) that eliminating sub-carriers simplifies both spacecraft and earth station data system complexity and reduces losses in the demodulation process;

RECOMMENDS

- 1. that, with immediate applicability to all space science service bands Cat. A, sub-carrier modulation shall not be used except where absolutely required and then only for symbol rates below or equal to 60 ks/s;
- 2. that, with immediate applicability to all space science service bands Cat. A, if a sub-carrier is required, it shall comply with the specifications set forth in considering e) and f);

Figure 1: Modulation Definitions



³ For purposes of this Recommendation, the symbol rate is defined as the baseband equivalent single line bit rate following error correcting coding (if applicable) and Bi-phase encoding (if used) but excluding any other spectrum modifying modulation. See figure 1.