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NASA TECH BRIEF

NASA Pasadena Office

Accurate Measurement of Telemetry Performance

The performance of the high-rate telemetry stations used in the deep-space network had to be verified. For this purpose, the word-error rate of the demodulated telemetry as a function of the RF-input signal-to-noise ratio was considered to be a measure of performance, but available methods could not provide the required accuracy of measurement. For example, preliminary considerations indicated that the accuracy required would have to be better than 0.44 dB at a signal-to-noise energy per-bit ratio of 3 dB.

The entire high-rate telemetry function was included by introducing the test signal at the S-band carrier frequency. The carrier is converted to an intermediate frequency of 10 MHz by the receiver and is further processed by the telemetry demodulator assembly. The side-band modulation index of the S-band test signal is first adjusted for a specific sideband-to-carrier ratio. Then a signal-to-noise energy per bit is determined which will produce a desired word error rate in the demodulated data. Next, the carrier-to-noise ratio is set to give the required sideband-to-noise energy ratio when modulation is applied. Finally, modulation is applied, and the performance of the high-rate telemetry function is judged by the word error rate of the output bit stream. It is important to establish accurately the signal-to-noise ratio and modulation index used in the test.

The output demodulated data error rate depends on four fundamental parameters. The general equation for effective sideband signal-to-noise ratio is:

$$R = [ST_B/N_0]\,(l)\,(m)(n)\,(p)$$

where

R = effective sideband signal-to-noise energy ratio per bit.

ST_B/N_0 = input sideband signal-to-noise energy ratio per bit required for the test.

l = degradation caused by inaccuracy in setting the carrier-to-noise energy ratio.

m = degradation caused by inaccuracy in setting the subcarrier modulation index.

n = degradation caused by the IF reference error.

p = degradation caused by phase errors in the telemetry demodulation assembly, including subcarrier reference error, bit synchronization error, and bit detection errors.

The parameter p is determined during subsystem testing and has a design goal of 0.2 dB; n, a function of signal level and modulation index, is the result of signal processing between S-band and the telemetry demodulator assembly and has a design goal of 0.1 dB. A test accuracy goal has been established for each of the other two parameters. This goal is 0.1-dB maximum degradation when the probability of word error for the output bit stream is 0.01.

Note:

Requests for further information may be directed to:

Technology Utilization Officer
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Reference: TSP72-10089

(continued overleaf)

Patent status:

No patent action is contemplated by NASA.

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