MEASUREMENT OF IMPLEMENTATION LOSS FOR HRIT RECEIVER

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ABSTRACT:

From the IF (Intermediated Frequency) loop-back test, BER (Bit Error Rate) degradation of processed data, HRIT (High Rate Information Transmission), is estimated by proposed measurement configuration. The specific parameters, likely data rate, FEC (Forward Error Correction), and modulation method, are based on the outcomes of SRR (System Requirements Review) which was held on 13-14 June 2005, in Toulouse. The proposed measurement procedure is that combined 70MHz modulated signal and noise is connected to the spectrum analyzer and receiver. The former measures the C/No (Carrier to Noise density ratio) and the latter estimates BER of FEC decoded data. Implementation loss can be obtained by subtracting measured BER from calculated BER which is also subtracted data rate from measured C/No. This test procedure is very simple and can be applied to assess the implementation loss of dedicated receiver for HRIT in the future.

KEY WORDS: COMS, Implementation loss, HRIT, Receiver

1. INTRODUCTION

The raw sensor data generated by the Meteorological Imager (MI) and Geostationary Ocean Color Imager (GOCI) in COMS are downlinked in L-Band in real time to the ground segment, Meteorological/Ocean Data Application Center (MODAC), which is the primary Data Processing Center (DPC). This center generates calibrated image data as well as derived products and uplinks them in S-Band back to the spacecraft. Data are then disseminated in L-Band to regional users. This dissemination will comply with the international HRIT/LRIT (High/Low Rate Information Transmission) standard. The link parameters of HRIT are described in Table 1, which is based on the outcomes of SRR which was held on 13-14 June 2005, in Toulouse.

Table 1. The link parameters of HRIT

Parameter	HRIT
Data Rate	3 Mbps
Downlink Frequency [MHz]	TBD (To Be Determined) Between 1670 and 1710
Uplink Frequency [MHz]	TBD between 2025 and 2110
G/T of the user antenna [dB/K]	10.3
Polarization of user antenna	Linear
Modulation	PCM/QPSK
FEC (Forward Error Correction)	Viterbi/Reed-Solomon
BER	10^{-8}
Required Link Margin	≥ 3 dB

The required G/T of the HRIT receiving segment, MDUS (Medium-scale Data User Station), is 10.3 [dB/K], which is mated to achieved by 3.6M parabolic antenna system Figure 1 illustrates the expected block diagram of MDUS.

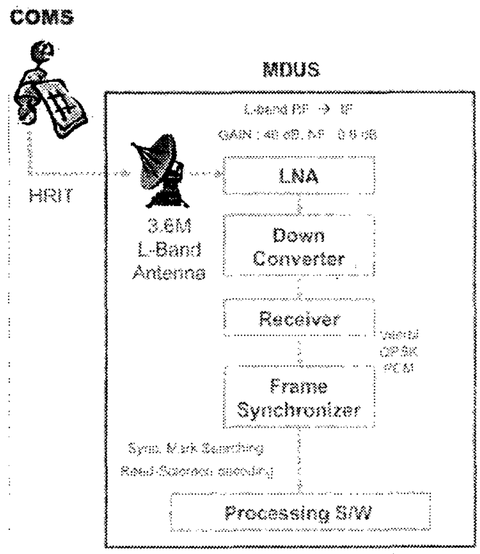


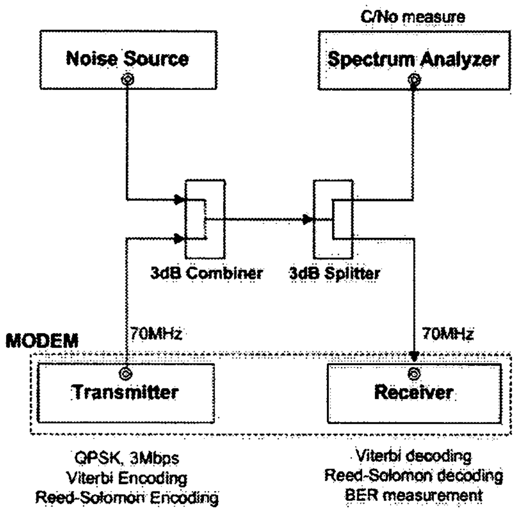
Figure 1. Block diagram of MDUS

Due to the large space loss, the weak HRIT is amplified through LNA (Low Noise Amplifier) which plays a very important role to assess noise performance in entire receiving system. After being converted to IF (Intermediated Frequency) in receiver bandwidth, the amplified signal is sent to receiver. The Viterbi decoding, QPSK (Quadrature Phase Shift Keying) demodulation, and PCM decoding is accomplished in receiver. After synchronous mark searching, Reed-Solomon decoding for bit streams of HRIT in frame synchronizer, the separated frames are transmitted to processing S/W.

In this paper, the measurement of implementation loss for receiver is described. This loss in performance of receiver is the difference between theoretical detection performance and the actual performance due to imperfections such as timing error, frequency offsets, finite rising and falling times of waveforms, and finite-value arithmetic. [1] The measured loss has to be considered for link analysis during the phase of preliminary MDUS design. Common receive is adopted for measurement because dedicated receiver is not developed yet.

2. MEASUREMENT CONFIGURATION

Figure 2 illustrates the proposed measurement configuration and related equipments.



(a) Block diagram

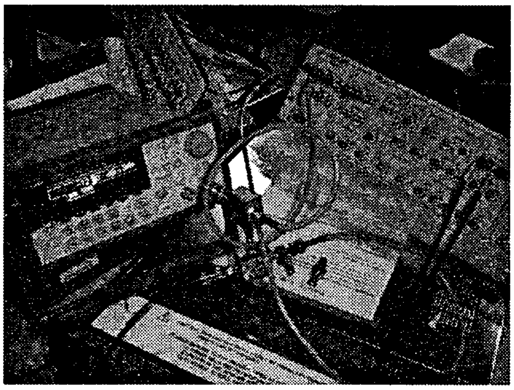
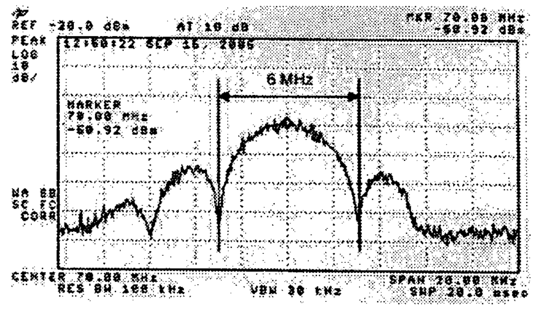

(b) Picture

Figure 2. Measurement configuration of implementation loss

Common receiver which is indicated as MODEM has a self-memory and transmitting function to accomplish 70MHz IF loop-back. The Reed-Solomon (223/255, depth=4) encoded data saved internal memory of receiver is processed as written in table 1, 3Mbps of data rate, Viterbi (R=1/2, K=7) encoding and QPSK modulation. The spectrum of combining 70MHz QPSK signal and noise generated by noise source is described in figure 3.



(a) 70 MHz QPSK signal

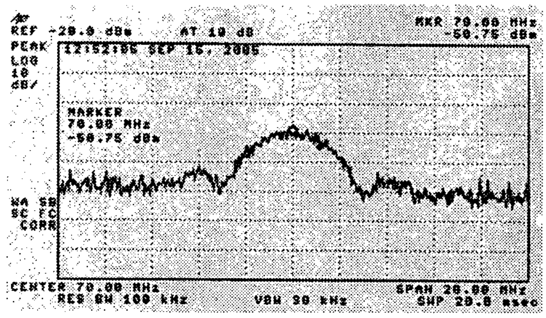

(b) Combined signal with noise

Figure 3. Measured spectrum by spectrum analyzer

The 70MHz combined signal has 6MHz bandwidth, which results from the viterbi encoding.

Then, the combined signal is separated through 3 [dB] splitter, the one is transmitted spectrum analyzer for measuring C/No (ratio of carrier to noise) and the other one is sent to receiver for FEC decoding and BER measurement.

The coding gain and implementation loss is calculated as follows.

$$\text{Coding Gain} = (\text{BER})_{\text{after}} - (\text{BER})_{\text{before}} \quad (1)$$

$$\text{Loss} = (C/N_o)_{\text{measured}} - \text{Data Rate} - (\text{BER})_{\text{before}} \quad (2)$$

Equation (1), (2) are written in decibel. The (C/No) is measured C/No at spectrum analyzer, $(\text{BER})_{\text{before}}$ is measured BER of FEC coded data, and $(\text{BER})_{\text{after}}$ is measured BER of FEC decoded data.

Table 2 illustrates the outputs of measurement.

Table 2. The outputs of measurement

C/No [dB-Hz]	BER (Expected)	BER (Before)	BER (After)	Gain	Loss
67.33	0.0288	0.0552	0	N.a*	1.5078
67.23	0.0303	0.0577	0	N.a*	1.5268
67.18	0.031	0.0593	3.7E-7	10.0	1.5528
67.13	0.0318	0.0605	6.28E-7	9.9	1.5608
67.03	0.0333	0.0635	1.03E-5	8.9	1.5978
66.93	0.0349	0.0666	2.99E-5	8.54	1.6398
66.83	0.0365	0.0694	1.31E-4	7.84	1.6638
66.73	0.0382	0.0729	4.95E-4	7.10	1.7168

* N.a = Not available

From the outputs of measurement, the coding gain seems to be increasing but the loss seems to be decreasing for the high BER. Due to the resolution of noise source, the exact coding gain and implementation loss cannot be obtained but, considering the neighbour output, we can estimate that the gain is about 10[dB] and implementation loss is about 1.55 [dB

3. CONCLUSION

This paper proposes a measurement configuration and equations for the estimation of implementation loss for common receiver. The coding gain and implementation loss can be extracted by equation which shows the relation among measured C/No and BER. This configuration can be used to measure the implementation loss for dedicated HRIT receiver in the future.

4. REFERENCE

[1] Bernard Sklar, 2001. *Digital Communications*, Prentice-Hall, Inc., Upper Saddle River, N.J.