

XIX. SATELLITE TIME-DILATION MEASUREMENT*

Prof. J. R. Zacharias
Prof. C. L. Searle
Prof. J. W. Graham
R. S. Badessa

V. J. Bates
D. Buhl
J. R. Cogdell

B. L. Diamond
R. Huibonhoa
R. L. Kent
R. C. Rennick

A. GRAVITATIONAL RED SHIFT INVESTIGATION

1. Introduction

Several possible communication systems for frequency comparison in the proposed satellite gravitational red shift experiment have been considered. Preliminary findings indicate that a cw system utilizing a frequency offset is the most suitable. The advantages of the cw system can be summarized as follows:

(a) Since the satellite transmitter will employ transistor output stages that are essentially peak-power-limited, highest average power will be received at the ground station if a cw system is employed.

(b) There is no need for high-speed, signal-controlled switching in the satellite, as would be required in a pulsed system to avoid oscillation caused by spillover; instead, the frequency offset between ground and satellite transmitters guards against instability.

(c) The satellite equipment is considerably less complex than that which would be required for a pulsed system.

The disadvantages of the cw frequency-offset technique are:

(a) There is a possibility of self-oscillation in the satellite as a result of spurious generation of the signal frequency in mixers and harmonic generators.

(b) The complexity of the Doppler-cancellation operations required in the ground installation may tend to obscure the basic simplicity of the method.

Several precise frequencies in the 1 mc-500 mc range are employed in the cw system (for example, of local oscillators, transmitters, etc.), and a frequency synthesizer is being constructed to obtain all such frequencies from a single 5-mc crystal-controlled oscillator. Signals obtained from this unit will be mixed, amplified, and so on, to investigate the generation of undesired signals that might cause measurement errors or instability.

Transistor i-f amplifiers and i-f and uhf power amplifiers are under development. Effort is also being devoted to the possible use of tunnel diodes in the satellite receiver and to the problem of reference-signal generation for frequency comparison at the ground station.

*This work was supported in part by National Aeronautics and Space Administration under Contract NASw-33; and in part by Purchase Order DDL B-00283 with Lincoln Laboratory, a center for research operated by Massachusetts Institute of Technology with the joint support of the U.S. Army, Navy, and Air Force under Air Force Contract AF 19(604)-5200.

(XIX. SATELLITE TIME-DILATION MEASUREMENT)

2. Transistor UHF Power Amplifier

In conjunction with the satellite gravitational red shift investigation, a 425-mc transistor transmitter is being designed. As a preliminary step, measurements are being made of input impedance, output admittance, and power gain of several transistors at this frequency. The measurement has been completed for a silicon mesa transistor (Motorola type 2N700) in the common base configuration. For a conjugate-matched stage at 425 mc, the results are:

power gain : 10 db

input impedance : $50 + j300$ ohms

output admittance : $0.0015 + j0.012$ mho

After measurement of these parameters and the common-base h-parameters of several transistors, a two-stage transistor power amplifier to yield 50-100 mw at 425 mc will be designed and constructed.

3. Low-Frequency Reference-Signal Generation

The data-analysis equipment for the proposed experiment requires a highly stable and tunable low-frequency reference signal. The signal received at the ground station from the satellite will be mixed to a frequency of approximately 500 cps. The frequency deviation to be measured represents approximately one part in 10^4 of this receiver output frequency. A comparison will be made with a reference signal of nearly the same frequency, in order to determine the relativistic frequency shift.

In order not to degrade the experimental accuracy, the low-frequency reference signal should be accurate within a few parts in 10^6 . In order to compensate for long-term drifts between the oscillators that are being compared, the low-frequency reference signal will be tunable over a range of ± 40 cps in 2-cps steps. Effort is being devoted to the design and construction of a simple but accurate source for these reference signals.

C. L. Searle, R. S. Badessa, V. J. Bates, D. Buhl,
J. R. Cogdell, R. L. Kent, R. C. Rennick