

At low SNR, the receiver symbol synchronization loop will be increasingly sensitive to transmitter timing jitter. Excessive timing jitter can cause bit slips in the receiver synchronization loop, which will in turn cause frame losses and potentially lead to receiver and/or decoder loss-of-lock. Therefore, it is necessary to investigate what symbol timing jitter requirements on the satellite transmitter are needed to support the next generation of NASA coded modulation techniques.

Measurements of ground segment receiver sensitivity to transmitter bit jitter were conducted using a satellite transponder and two different commercial staggered quadrature phase-shift keying (SQPSK) receivers. The symbol synchronizer loop transfer functions were characterized for each receiver. Symbol timing jitter was introduced at

the transmitter. Effects of sinusoidal (tone) jitter on symbol error rate (SER) degradation and symbol slip probability were measured. These measurements were used to define regions of sensitivity to phase, frequency, and cycle-to-cycle jitter characterizations. An assortment of other band-limited jitter waveforms was then applied within each region to identify peak or root-mean-square measures as a basis for comparability.

Receiver clock recovery loops that operate in low SNR ratio environments require that transmit clock jitter be constrained by several measures on different dimensions and operating regions. In this work, effects of transmit phase jitter (PhJ), frequency jitter (FJ), and cycle-to-cycle jitter (CCJ) were studied for sinusoidal and multi-tone jitter profiles on receiver performance. It was demonstrated that the receiver must have a loop band-

width tight enough to avoid cycle slips, but loose enough to track some movement in the data signal. Movement that a tight loop cannot track is usually manifested first as intersymbol interference (ISI) (SER degradation) and then ultimately as cycle slipping in the receiver.

Results from the tests indicate that the receiver symbol synchronization loop is more sensitive to certain types of symbol jitter and jitter frequencies, depending on the selection of the loop filter and damping ratio. A framework is provided to properly compose a transmit jitter mask depending on receiver design parameters such as damping ratio in order to limit receiver performance degradation at low SNR regions.

This work was done by Chatwin Lansdowne and Adam Schlesinger of Johnson Space Center. Further information is contained in a TSP (see page 1). MSC-24810-1

Lightweight, Miniature Inertial Measurement System

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A miniature, lighter-weight, and highly accurate inertial navigation system (INS) is coupled with GPS receivers to provide stable and highly accurate positioning, attitude, and inertial measurements while being subjected to highly dynamic maneuvers. In contrast to conventional methods that use extensive, ground-based, real-time tracking and control units that are expensive, large, and require excessive amounts of power to operate, this method focuses on the development of an estimator that makes use of a low-cost, miniature accelerometer array fused with traditional measurement systems and GPS. Through the use of a posi-

tion tracking estimation algorithm, onboard accelerometers are numerically integrated and transformed using attitude information to obtain an estimate of position in the inertial frame. Position and velocity estimates are subject to drift due to accelerometer sensor bias and high vibration over time, and so require the integration with GPS information using a Kalman filter to provide highly accurate and reliable inertial tracking estimations.

The method implemented here uses the local gravitational field vector. Upon determining the location of the local gravitational field vector relative to two consecutive sensors, the orientation of

the device may then be estimated, and the attitude determined. Improved attitude estimates further enhance the inertial position estimates. The device can be powered either by batteries, or by the power source onboard its target platforms. A DB9 port provides the I/O to external systems, and the device is designed to be mounted in a waterproof case for all-weather conditions.

This work was done by Liang Tang of Impact Technologies and Agamemnon Crassidis of the Rochester Institute of Technology for Goddard Space Flight Center. Further information is contained in a TSP (see page 1). GSC-16132-1

Optical Density Analysis of X-Rays Utilizing Calibration Tooling to Estimate Thickness of Parts

This method uses off-the-shelf data analysis software and a digitized x-ray for nondestructive testing.

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This process is designed to estimate the thickness change of a material through data analysis of a digitized version of an x-ray (or a digital x-ray) containing the material (with the thickness in question) and various tooling. Using this process, it is possible to estimate a

material's thickness change in a region of the material or part that is thinner than the rest of the reference thickness. However, that same principle process can be used to determine the thickness change of material using a thinner region to determine thickening, or it can

be used to develop contour plots of an entire part.

Proper tooling must be used. An x-ray film with an S-shaped characteristic curve or a digital x-ray device with a product resulting in like characteristics is necessary. If a film exists with linear