ABSTRACT

This memo sets forth a method of correcting IRIG Scale Factor Tests for earth rate when the test is performed in Spacecraft orientation with the vehicle at any northern latitude and azimuth.

STIPULATIONS

1. A spherical earth is assumed.
2. The IMU is mounted in a spacecraft vertical to ± 1°.
3. Sunrise 69 program is in use.
4. $X_{NB}$ axis is inclined 32.5° from vertical.

REQUIREMENTS

1. Corrections are required for OG axis and IG axis only.
2. Vehicle azimuth is known to ± 1°.

FORMULATIONS AND DEFINITIONS

$$ W_e = \text{Average earth rate} = 15.041 \text{ arc sec/sec.} $$
$$ \lambda = \text{Latitude in Northern hemisphere} $$
$$ A_z = \text{Vehicle azimuth from North with North being zero } A_z, \text{ East being } +90^\circ \text{ AZ, etc.} $$
$$ T = \text{Test Time} = \text{approximately 17 minutes, 3 sec.} $$

Vertical is assumed to be parallel to earth radius.

SFE Convention: If $\Theta_T$ is larger than $\Theta_C$, the error is defined as positive where $\Theta$ is defined below.

$$ \Theta_C = \text{Angle through which IRIG is commanded.} $$
$$ \Theta_T = \text{Angle through which IRIG is torqued.} $$
The earth rate sensed about the Y Gyro axis will be \( W_y = -W_e \cos \lambda \sin \lambda_z \).

The earth rate sensed about the Outer Gimbal axis will be:
\[
W_x, z = W_e (\cos 32.5 \sin \lambda - \sin 32.5 \cos \lambda \cos \lambda_z)
\]

The earth rate induced error which must be compensated is then found by:
\[
\Delta \text{Angle}_y = (T)(-W_e)(\cos \lambda \sin \lambda_z)
\]
\[
= (-4.274^\circ)(\cos \lambda \sin \lambda_z)
\]
\[
\Delta \text{Angle} X, Z = (T)(W_e)(\cos 32.5 \sin \lambda - \sin 32.5 \cos \lambda \cos \lambda_z)
\]
\[
= (4.274^\circ)(0.84339 \sin \lambda - 0.53730 \cos \lambda \cos \lambda_z)
\]

Correction to the Dsky readout is then:
\[
(2777 \text{ PPM} \over \text{deg}) (\Delta \text{angle})
\]

Correct the Dsky readout as follows, for tests +00001, +00002 and +00003 subtract
the PPM correction as indicated above, -00001, -00002 and -00003 requires addition of the PPM correction.

Important Note: The earth rate induced corrections must be applied to the "sign corrected" Dsky output. Remember that the indicated Sunrise 69 IRIG Scale Factor error polarity has a sign reversal which must be corrected as the results are recorded.

EXCLUSIONS

This procedure does not correct for the earth rate terms which are caused by gyro misalignments and crosscoupling. An example of the error magnitude would be \( \sin(10 \text{ m/s}) (360\degree) (T)(W_e) (2777) \) or approximately 70 PPM considering \( X \) and \( Y \) axis.

EXAMPLE CALCULATION

Assume site is NAA:

Vehicle azimuth = 180\degree

\( X \) IRIG is under test (+ 00001)

\[
\Delta \text{Angle}_X = (T)(W_e)(\cos 32.5 \sin \lambda - \sin 32.5 \cos \lambda \cos A_z)
\]

\[
\Delta \text{Angle}_X = (4.2740)(\cos 32.5 \sin 360\degree - \sin 32.5 \cos 2777) = + 3.917 \text{°}
\]

PPM SFE therefore = (-) (Dsky R 1) - (+ 3.917\text{°})(2777) = (-) (Dsky R 1) - 10887 PPM

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