

**University of Michigan
Space Physics Research Laboratory**

**TIDI
Engineering Data
EPET Specification**

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REVISION RECORD

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C	Update telescope epet	7/31/2001	
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APPROVAL RECORD

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1. References

- 1) Skinner, W.R, Gell, D.A., "TIDI Instrument Performance EPET Specification", SPRL File 055-3734
- 2) Musko, S. "Instrument Parameter Definitions", SPRL File 055-3519

2. Introduction

The TIDI EPET (Engineering Performance and Evaluation Test) is a routine automated test used to confirm that the TIDI instrument has not been adversely affected by age, handling or environmental conditions. The EPET consists of two segments, an engineering data evaluation and an instrument performance evaluation. This document describes the engineering data segment of the EPET. The performance segment is described in reference 1.

The engineering data EPET tests each filter wheel, each telescope gimbal, and each shutter, and records important electrical system health/status data. Each of the tests is performed under the control of a TIDI Instrument Control Language (TICL) program. Where possible, the TICL program also evaluates the result of the test and places the result in the telemetry. Processing of the test results consists of extracting the test results from the telemetry and storing them in a trend file for analysis and plotting. The tests for each of the mechanisms noted above are described in the following sections.

3. Filter Wheel Tests

3.1 Intent

The filter wheel motion is affected by the torque provided by the motor and by the motor bearing drag. This test determines if there has been a degradation in the filter wheel motor or filter wheel bearings. If the motor torque decreases or if the bearing drag increases, the time required to complete a large motion increases. If this time increases, a change in the motor and bearing characteristics may have occurred.

The filter wheel control electronics include a index mark in the encoder. This mark should be recognized each full rotation of the filter wheel. If the index is not detected, the filter wheel locations reported by the flight software may be incorrect. This test also confirms that the index mark is being detected.

3.2 Method

Each filter wheel is rotated 10 complete revolutions in each direction. The time required to complete the motion is recorded. Upon completion of the motion, the filter wheel index pulse latch is dumped into the telemetry. The test is repeated for each filter wheel.

The results of the test are reported in control program global variables which are transmitted to the ground at the end of each filter wheel motion. The variables used and their contents are listed in Table 3.2-1. The total movement time is reported in seconds, with the integer part of the time in global_05 and the fraction part of a second in global_06.

In addition to the results message, the processor memory location containing the index pulse latch register is dumped.

Table 3.2-1, Filter Wheel Test Results Message	
variable	contents
global_01	PID, process identifier, set to 200 to indicate filter wheel test
global_02	error flag, not used
global_03	filter wheel number, 1 or 2
global_04	direction of motion, 0 (increasing) or 1 (decreasing)
global_05	total movement time, seconds
global_06	fractional second of total movement time, centiseconds

3.3 Data Processing and Analysis

Data processing consists of extracting the data from the telemetry stream and appending a record to the EPET Filter Wheel trend file. The contents of the trend file record are shown in Table 3.3-1.

The filter wheel test is successful if the index error does not occur and if the filter motion times are consistent with those previously recorded.

Table 3.3-1, Filter Wheel EPET Trend Record		
field	name	description
1	record creation time	the time that the record was created
2	packet time	the mission time at which the test was completed
3	index error	1, error - latched index pulse not set at end of motion 0, no error - latched index pulse set at end of motion
4	filter wheel number	filter wheel number 1 or 2
5	filter direction	0, increasing filter position 1, decreasing filter position
6	movement time	time in seconds required to complete 10 revolutions

4. Telescope Gimbal Tests

4.1 Intent

The telescope motion is affected by the spring force applied by the flex circuits and by the bearing drag. This test determines if there has been a change to these quantities. If the spring force applied by the flex circuits changes, the servo current required to hold the telescope at its extreme positions will change. If the bearing friction changes the current required to move the telescope will change. This test measures the servo current to detect these changes.

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In addition, it is possible for the telescopes to move relative to the actuator armature. If this occurs, the telescope may reach the hard stop prior to reaching a commanded position near the limits of travel. A test to recognize this condition is added.

4.2 Method

The EPET gimbal tests are performed one telescope at a time. The telescopes which are not being tested are placed at a mid-scan elevation, 20.30 degrees. For each telescope, three subtests are performed. At the conclusion of each subtest, the results are reported through the control program globals, defined in Table 4.2-1. The first subtest measures the holding current at the maximum gimbal angle 29.80 degrees, the second measures the holding current at the minimum gimbal angle 10.80 degrees, and the third measures the current during continuous elevation slews.

The holding current tests are conducted by positioning the telescope to either the maximum or minimum gimbal angle. After a 0.1 second delay to allow the current to stabilize, the positive and negative servo supply currents are sampled each second for 10 seconds. The accumulated values are reported in the control program globals message.

The telescope slew current is measured by moving the telescopes continuously between the maximum and minimum gimbal angles for ten seconds. The servo supply currents are sampled each second during the telescope motion. At the end of the test the accumulated values of the currents are reported.

variable	contents
global_01	PID, process identifier, set to 210 to indicate filter wheel test
global_02	error flag, used only in the elevation limit test.
global_03	telescope number, 0, 1 ...4 0 indicates all telescopes during the limit position test
global_04	sub test number 1, holding current at maximum gimbal angle 2, holding current at minimum gimbal angle 3, current during telescope slew 4, elevation limit check, maximum elevation 5, elevation limit check, minimum elevation
global_05	number of current samples collected
global_06	accumulated servo negative 6 volt supply current
global_07	accumulated servo positive 6 volt supply current

The elevation limit test is performed for all telescopes simultaneously. All telescopes are moved to the maximum elevation, 29.80 degrees and held there for 30 seconds. At the end of that period, the overcurrent status for each telescope is tested. If an overcurrent has occurred, the error flag is set to indicate which telescope encountered the state and the results are reported. The error coded is formed by adding the mask values listed in Table 4.3-1 for each of the telescopes that suffered an overcurrent.

The test is repeated at the minimum elevation, 10.80 degrees and the results reported in the same fashion.

Table 4.2-2, Limit Test Result Codes	
mask value	condition
1	telescope 1 overcurrent occurred
2	telescope 2 overcurrent occurred
4	telescope 3 overcurrent occurred
8	telescope 4 overcurrent occurred

4.3 Data Processing and Analysis

For the first 3 sub-tests, data processing consists of extracting the results from the telemetry stream, converting the values to engineering units and appending a record to the EPET Telescope trend file. The servo currents are obtained by converting the accumulated servo currents, global_06 and global_07 to engineering units, using the conversions in reference 2. The average current is obtained by dividing the accumulator values by the number of current samples collected, global_05. The contents of the trend file are listed in Table 4.3-1.

The test is successful if the servo currents are consistent with the values previously recorded in the trend file.

Table 4.3-1, Telescope Gimbal EPET Trend Record		
field	name	description
1	record creation time	the time that the record was created
2	packet time	the mission time at which the test was completed
3	error code	always 0.
4	telescope number	telescope number, 1 ...4
5	subtest number	sub test number 1, holding current at maximum gimbal angle 2, holding current at minimum gimbal angle 3, current during telescope slew
6	negative supply current	servo negative 6 volt supply current. amps
7	positive supply current	servo positive 6 volt supply current, amps

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For the final two sub-tests, data processing consists of confirming that the error code in global 2 is zero. If it is not, the telescope that suffered the overcurrent is determined by comparing the error code to the error mask values in Table 4.2-2. The magnitude of the telescope holding current while the telescopes are at their extreme travel is extracted and trended.

The test succeeds if the error code is zero and the magnitude of the holding current is comparable to the trend of previous tests.

5. Shutter Tests

5.1 Intent

Each telescope is equipped with a shutter used to interrupt the optical path when the sun is near the bore sight, reducing the dynamic range over which the CCD must operate. The shutters operate in an open-loop manner without position feedback. This test is intended to determine that the shutters are changing from open to closed state.

5.2 Method

Each telescope is sealed with a cover that includes a window that will admit ambient light. This test positions the shutter to the closed and open position and compares the signal levels in the closed and open positions.

Data collection is performed under the control of a scan table, positioning the filter wheels to the open-open (filter wheel 1 in position 6 and filter wheel 2 in position 1) setting. The telescopes are positioned to their maximum depression. One second exposures are collected with the shutters closed and open.

5.3 Data Processing and Analysis

The mean and standard deviation of the signal is determined for each field for each state of the shutter using the following algorithm:

$$S_1 = \sum_{i=n_1}^{n_2} x_i^2$$

$$S_2 = \sum_{i=n_1}^{n_2} x_i$$

where n_1 and n_2 are the first and last bin within a telescope field of view and x_i is the signal level in counts in bin i .

The mean signal within the telescope field is

$$\bar{x} = \frac{S_2}{N}$$

$$N = n_2 - n_1 + 1$$

with N the total number of bins within the telescope field of view. The standard deviation is

$$\sigma_x = \sqrt{\frac{NS_1 - S_2^2}{N(N-1)}}$$

A shutter is deemed to be open if the difference between the mean signal in the commanded open state and the signal in the commanded closed state is three times the standard deviation of the commanded open state. If this condition is not met, the test fails.

The trend file for this test contains the mean and standard deviation of the signals in each of the four fields and the derived shutter state.

Table 5.3-1, Telescope Shutter EPET Trend Record		
field	name	description
1	record creation time	the time that the record was created
2	packet time	the mission time at which the test was completed
3	telescope number	the telescope number to which the data applies
4	mean_closed	mean signal with shutter commanded closed
5	sigma_closed	standard deviation of signal with shutter commanded closed
6	mean_open	mean signal with shutter commanded open
7	sigma_open	standard deviation of signal with shutter commanded open
8	position_ok	0, if closed when commanded open 1, if open when commanded open

6. Engineering Data

6.1 Intent

Electronics health and status data is recorded as a potential aid in analyzing the other EPET results. Certain important parameters are routinely trended that might provide advance notification of drifts or anomalies. All others are available and can be extracted and trended on demand if needed to aid in detail evaluation of other EPET data.

6.2 Method

Document reference 2 lists all parameters recorded for each EPET run including engineering data. The data is written to a time and date tagged file for retrieval as needed.

6.3 Data Processing and Analysis

Table 6.3 lists the specific engineering parameters for which trend files will be derived.

Table 6.3-1, Engineering Data EPET Trend Record		
field	name	description
1	Power_Sup_SC_Input_Volts	Spacecraft Input Voltage
2	Power_Sup_SC_Instance_Curr	Spacecraft Input Current

Table 6.3-1, Engineering Data EPET Trend Record		
field	name	description
3	Power_Sup_Pos_5_V olts	Power Supply Voltage, +5
4	Power_Sup_Pos_15_ Volts	Power Supply Voltage, +15
5	Power_Sup_Neg_15_ _Volts	Power Supply Voltage, -15
6	Power_Sup_Servo Pos_6_V	Power Supply Voltage, +6 Servo Motor
7	Power_Sup_Servo Neg_6_V	Power Supply Voltage, -6 Servo Motor
8	Power_Sup_Lamp_P os_28_V	Power Supply Voltage, +28 Cal Lamp
9	Power_Sup_Pos_28 _Cal_Curr	+28 Calibration Lamp Current
10	Power_Sup_CCD_Po s_26_V	Power Supply Voltage, +26 CCD