University of Michigan
Space Physics Research Laboratory

TIDI **Scan Table File Format**	CAGE No. 0TK63 Drawing No. 055-3527G Project TIDI Contract No. NASW-5-5049 Page 1 of 9

REVISION RECORD

Rev	Description	Date	Approval
G	• Correct descriptions of interval records used in non-unison telescope motion • Correct example scanning table. As-built flight software allows only 2 binning tables to be loaded in the CCD controller, with indices 0 and 1.	31 Oct 2001	
F	• Correct assignment of telescopes to the forward (F) and backwards (B) identifiers in table 3	24 Aug 2001	
E1	• Correct location of scan tables to reflect actual POC configuration	3 Apr 2001	
E	• Delete colons from control record keywords. • Specify ranges and units for all quantities • Simplified expression for angle increment	15 Jul 1998	
D	• Changed exposure repeat count to exposure count. • Changed TM mode to Bin/Image • Removed erase time from interval definition • Changed shutter options to open/close from open/closed	14 Jul 1998	
C	• Change TM mode values to single character • Add note regarding digitization errors • Added appendix defining angle to altitude conversions • Add F & B telescope identifiers	22 Jun 1998	

APPROVAL RECORD

Function	Name	Signature	Date
Originator	D. Gell		
Flight Software	S. Musko		
Instrument Scientist	W. Skinner		
Program Manager	C. Edmonson		
Systems Engineer			
R&QA	John Eder		

REVISION RECORD

Rev	Description	Date	Approval
B	• Delete optional whitespace between . indicator character and control keyword. • Require all control records to be placed prior to the first interval record. • Note the maximum step size permitted in altitude and elevation.	5 Jun 1998	
A	• Added bin table keyword. • Added column to use to specify the binning table to be used for each altitude range. • Added independent telescope altitude scans, reordering columns.	5 May 1998	
	Initial Release	22 Oct 1997	

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1. References

1 Gell, D., "Measurement Sequence Specifications", SPRL File 055-3431, 3 September 1997

2 Musko, S., "TIDI Flight Software Requirements Specification", SPRL File 055-3320, 15 January 1997

3 Gell, D., "Scan Table Visualization Program", SPRL File 055-3528, 22 October 1997

4 Gell, D., "Coordinate Frames and Viewing Directions", SPRL File 055-3543, 29 January 1998

2. Introduction

The operation of the TIDI instrument is controlled by the flight software, which executes an uploadable control program. The control program can load and execute a scan table, which provides all of the information required to define the sequence of states that make up a TIDI scan.

The scan table is the principal means of defining the data collection scheme to be used to meet a particular objective and are defined in a scan table file. The scan table files are used as input to both the control program compiler and to visualization tools (reference 3). This document specifies the format used for the scan table files.

An example scan table file is included in Appendix B.

3. Record Definitions

A scan table file consists of control records, scan interval definition records, and comments. The control record specifies global information such as the name and ID number of the scan sequence. Scan interval definitions specify the state that the instrument is to be in at each scan position within an altitude or angle range. Comments are used to provide additional information to a user of the file.

Each record consists of an indicator character followed by one or more fields separated by whitespace.

3.1 Control Records

A control record is indicated by a period "." as the first non-whitespace character in the record. The record consists of a keyword—value pair, as shown in the example:

`<ws>.`*`keyword`*`<ws> `*`value`*

Where <ws> is any whitespace characters, "`keyword`" is any of the valid keywords as listed in Table 1, and `value` is a string containing an acceptable value for the keyword. Whitespace is not allowed between the indicator character and the keyword. Neither the keyword nor the value is case sensitive.

Table 1, Control Record Keywords		
keyword	acceptable values	notes
`name`	a character string	A short descriptive name
`id`	an integer from 1 to 65535	The scan table ID, reported in the telemetry when the scan table is being executed
`description`	a character string	A description of the measurement objective
`approved`	a character string in the form dd-Mon-yyyy	The date that the scan was approved. Omitted until the scan table is approved
`scan`	altitude angle	Specifies whether the scan intervals are defined by their altitude or angle endpoints.
`bin`	an integer (0…7) and a file specification separated by whitespace	identifies a binning table with an index

3.2 Comments

A comment record is indicated by a semi-colon, ";" as the first non-whitespace character in the record. Comments are ignored in any processing of the file.

3.3 Interval Definition Records

An interval definition record is any record that does not begin with either the period or semi-colon indicator characters. The record consists of whitespace separated fields, as listed in Table 2.

Table 2, Interval Definition Record Fields			
field number	field name	valid values	description
1	`waveln`	any real	The wave length, in nm, of the feature to be examined
2	`fw1`	1…8	The position of filter wheel 1
3	`fw2`	1…8	The position of filter wheel 2
4	`texpose`	a real 0 ≤ texpose ≤40.95	The CCD exposure time, in seconds.

5	`cal`	`off`
		`white1`
		`white2`
		`neon`
		`hak`
			The calibration lamp state.

6	`expose`	`an integer 1…31`	Exposure count
7	`TM Mode`	`B` `I`	Specifies the type of science TM packet to create, B(Binned) or I(Image)
8	`bin table`	`an integer 0…7`	the index, defined by the bin control record, specifying the binning table to be used during the interval

Table 2, Interval Definition Record Fields

field number	field name	valid values	description
9	`telescope selection`	A W, C F, B 1,2,3,4	The telescope(s) to which the position information in fields 10 through 13 apply.
10	`start`	a real number	initial altitude (km) or angle (deg) of the scan interval
11	`end`	a real number	final altitude (km) or angle (deg) of the scan interval
12	`step`	a real number, limits specified in text following.	the altitude (km) or angle (deg) increment between scan steps in the interval. If the value of `start` is greater than that of `end`, `step` should be negative.
13	`shutter`	`open` `close`	The position of the safety shutter in the telescopes. `Open` admits light from the sky, `close` prevents the interferometer from viewing the sky

Fields 1 through 8 specify the configuration of the profiler to be used during an interval of altitude scanning.

Telescope motion is defined in fields 9 through 13. Field 9 indicates the telescopes to which the motion definitions in the remaining columns is to be applied. The value **A** indicates that all telescopes are to move in unison. For telescope selectors other than **A**, the main interval definition record, defining the state of the profiler and the motion of a subset of the telescopes is followed by additional records to specify the motion of the remaining telescopes. The telescope viewing directions and nominal azimuths (reference 4) and identifiers are listed in Table 3.

The maximum elevation angle step size is 0.64 degrees, which corresponds to an elevation increment of 30.8 km at a tangent height of 60 km and an increment of 23.6 km at a tangent altitude of 300 km. The minimum elevation angle step size is 0.005 degrees, which corresponds to a tangent altitude step of 0.24 km at a tangent altitude of 60 km and 0.18 km at a tangent altitude of 300 km.

Table 3, Telescope Identifiers

telescope	package ID	nominal azimuth	viewing direction	Telescope Identifiers		
1	A300	45	cold side	**C**	**F**	1
2	A301	135	cold side	**C**	**B**	2
3	A302	225	warm side	**W**	**B**	3
4	A303	315	warm side	**W**	**F**	4

4. File Organization

A template for a scan table file is located on the TIDI ground segment computer system at `/tidi/sequences/000template.scan`. By convention control records are collected at the beginning of the file, followed by comments amplifying the measurement objective given in the purpose control record. Following these two section are comments containing the change history. The final section of the file is a header for the interval definitions, listing the field names, followed by all of the interval definition records. All control records must precede the first interval definition record.

An interval in which the telescopes are moving in unison is denoted by one interval definition record with all fields filled. For example the following interval record specifies that the telescope move in unison from 57.5 to 87.5 km in 2.5 km steps. The profiler is configured with each filter wheel in the first position, integrating for 1 second, with 0.1 second allocated for erase time.

867.24	1	1	1.0	off	1	B	1	A	57.5	87.5	2.5	open

An interval in which the warm and cold side telescopes move independently is specified by a pair of consecutive interval definition records. The first record consists of all 13 fields, with either the **W** or **C** telescope identifier specified and the corresponding telescope positions specified. The second record contains only fields 9 through 13. Field 9 contains the identifier for the pair of telescopes not specified in the preceding record.

557.70	3	1	1.0	off	1	B	1	W	110.	142.5	2.5	open
								C	90.0	100.	2.5	open

An interval in which the forward viewing and backwards viewing telescopes move independently is specified by a pair of consecutive interval definition records. The first record consists of all 13 fields, with either the **F** or **B** telescope identifier specified and the corresponding telescope positions specified. The second record contains only fields 9 through 13. Field 9 contains the identifier for the pair of telescopes not specified in the preceding record.

557.70	3	1	1.0	off	1	B	1	F	110.	142.5	2.5	open
								B	90.0	100.	2.5	open

An interval in which each telescope moves independently is specified by a set of 4 consecutive interval definition records. The first record consists of all 13 fields, with a numeric telescope identifier specified and the telescope positions specified for the identified telescope. The following three records define the motion for the other telescope and contain only fields 9 through 13. Each of these records has a numerical identifier in field 9 and the telescope positions for the identified telescope in fields 10 through 13.

557.70	3	1	1.0	off	1	B	1	1	110.	142.5	5.0	open
								2	90.0	100.	2.5	open
								3	110.	142.5	5.0	open
								4	90.0	100	2.5	open

5. File Locations and Naming

All approved scan tables are to be placed in the `/tidi/flt_ticl/scans` directory. The file names should consist of the value used in the name control record with `.scan appended.`

Appendix A. Calculation of Angle and Angle Step from Tangent Point Altitude

The angle required to view a particular tangent altitude can be determined from the geometry shown in Figure 1. This calculation assumes that the earth is spherical.

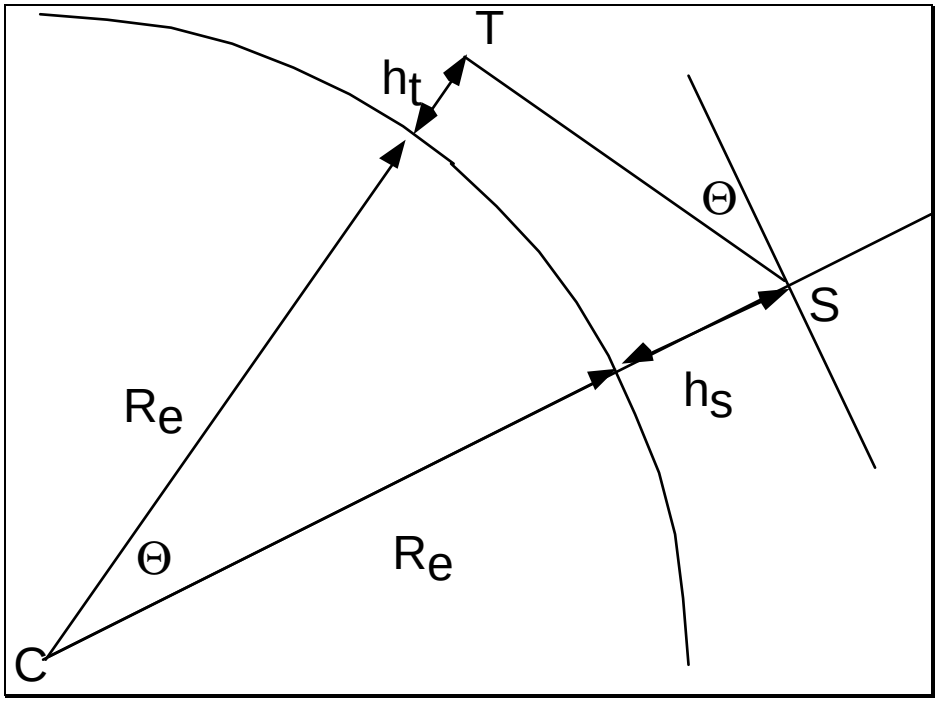

Figure 1, Tangent Point Geometry

In the Figure, C is the center of the Earth, T is the tangent point and S is the satellite location. The tangent altitude is h_t and the spacecraft altitude is h_s. With these definitions, the viewing angle, measured from the local horizon downwards is given by:

$$\Theta = \arccos\left(\frac{h_t + R_e}{h_s + R_e}\right)$$

The change in angle in radians corresponding to a change in tangent point altitude is given by

$$\Delta\Theta = \frac{-\Delta h_t}{\sqrt{h_s^2 - h_t^2 + 2R_e(h_s - h_t)}}$$

For TIDI, the nominal spacecraft altitude h_s is 625 km. The nominal equatorial radius of the earth, R_e is 6378.140 km.

Appendix B. Example Scan Table

```
.name        daybase
.id          1
.description  baseline daytime wind sequence
.approved     04-May-1998
.scan        altitude
;-------------------------------------------------------------
; change history
; by      date        description
; D. Gell  4 May 1998   initial coding, with independant
;                       telescope motion
; D. Gell  5 Jun 1998   added rate control records
;-------------------------------------------------------------
;
.bin    1   /tidi/binning/baseline.bin
.bin    0   /tidi/binning/greenline.bin
;
; col     parameter
;  1      wavelength, anotation
;  2      filter wheel one position 1,2,...8
;  3      filter wheel two position 1,2,...8
;  4      exposure time, seconds
;  5      cal lamp state, off, white1, white2, neon, hak
;  6      exposure count
;  7      Science TM Mode,        B(Binned according to binning table)
;                                 I(50X600 image)
;  8      binning table to use
;  9      telescope id            A-all, W-warm side, C-cold side,
;                                 F-forward viewing, B-Backward Viewing
;                                 1,2,3,4 - specific telescope
; 10      starting position, altitude (km) or angle (deg)
; 11      final position, altitude or angle
; 12      step size, altitude or angle
; 13      shutter position, open or close
;
; 1       2   3   4     5    6    7    8    9     10      11     12     13
867.24    1   1   1.0   off  1    B    1    A     57.5    87.5    2.5   open
763.74    2   1   1.0   off  1    B    1    A     90.0   107.5    2.5   open
557.70    3   1   1.0   off  1    B    0    A    110.0   142.5    2.5   open
630.00    5   1   1.0   off  1    B    0    A    160.0   320.0   20.0   open
732.00    4   2   1.0   off  1    B    0    A    320.0   160.0  -20.0   open
557.70    3   1   1.0   off  1    B    0    A    142.5   142.5   -2.5   open
557.70    3   1   1.0   off  1    B    0    A    140.0   110.0   -2.5   open
765.16    6   1   1.0   off  1    B    1    A    107.5    90.0   -2.5   open
866.23    7   1   1.0   off  1    B    1    A     87.5    57.5   -2.5   open
```