

# Solar-B Command Planning and Interface Issues for ISACS-PLN

## Appendix 3 Orbit, Pointing & Doppler Shift Compensation

Rev. 0.6: 2005 May 18

### Revision History

|          | Date        | Authors (Affiliation)    | Issue                           |
|----------|-------------|--------------------------|---------------------------------|
| Rev. 0.0 | 2005 Feb 08 | H. Hara (NAOJ/NINS)      | All new; not completed          |
| Rev. 0.4 | 2005 Apr 5  | H. Hara (NAOJ/NINS)      | Correction & addition           |
| Rev. 0.5 | 2005 Apr 13 | K. Matsuzaki (ISAS/JAXA) | Initial Release                 |
| Rev. 0.6 | 2006 Jun 15 | M. Shimojo (NAOJ/NINS)   | Revised the re-pointing section |

### Applicable Documents

|                            |  |
|----------------------------|--|
| JAXA/SLB/TechNote/MODA/010 | Solar-B Command Planning and Interface for ISACS-PLN |
|----------------------------|--|

### Appendix 3-1: Attitude Control Command and Memory Map for re-pointing

Format: **text file (ORL format) and IntelHex Memory Map**

Input to Solar-B AOCS unit:

The ORL file for AOCS unit includes the following OGs and commands.

1. The OGs for the changing the AOCS mode (Track/non-track) and changing the tracking parameters.
2. The OGs for the upload of the memory map for tracking parameters.

The IntelHex Memory Map for AOCS unit is uploaded in order to change the tracking parameters. The memory map includes the parameters for four tracking curves. And, there are four tracking parameters for one tracking curve.

[The parameters for the tracking curve]

S/C TI clock (4bytes), rotation rate (4bytes)

Heliocentric longitude (4bytes) and latitude (4bytes)

Command preparation:

The Chief Planner (CP) makes the re-pointing plan file (see next section) using the IDL program. The file is distributed to the Chief Observers (CO) of SOT, XRT and EIS. After the distribution, CP runs the other AOCS software to make the ORL file and the memory map based on the re-pointing plan file.

Note:

**The ORL file and the IntelHex memory map file for AOCS unit are not provided to COs.** Since all information about the re-pointing schedule is included in the re-pointing plan file, we do not use the ORL and the memory map files for the AOCS interface between CP and COs.

### Appendix 3-2: Re-pointing plan file

The file includes all information of the re-pointing schedule. The file is made by the Chief Planner using the AOCS software and distributed to the Chief Observers. The Chief Observers will prepare the commanding plans and the observation tables referring to the re-pointing plan file.

**Tracking curve:** Five tracking curves are defined in the Solar-B attitude control system (AOCS). One of tracking curves is set in AOCS during observations. Track 0 implies that the Solar-B spacecraft is looking at a fixed position on the solar surface. By setting two offset parameters (offset-X, offset-Y), a fixed-pointing observation can be performed at any position on the solar surface. On the other hand, when Track n (n = 1, 2, 3, or 4) is selected, the spacecraft tracks a differential rotation curve whose parameters are set in AOCS. (offset-X, offset-Y) shall be (0,0) when the tracking of a differential rotation curve is selected. Parameters of tracking curves are the reference date and time of tracking, heliocentric longitude and latitude in degree, and the speed of rotation rate in degree per second.

The future tracking position at a time can easily be calculated from the AOCS tracking parameters.

Format: ASCII characters

Users : Chief planner and chief observers.

Name of file: re-point\_YYYYMMDDhhmmNN;

YYYYMMDDhhmm is the start time of the pointing schedule in the file.

NN is the revision number of the file.

### Example 1: re-point\_200610111802

```

/* re-pointing and tracking schedule */
Fm: 2006/10/11 18:00:00
To: 2006/10/12 10:00:00
/*          Date          Time   Tracking   Offset-X Offset-Y */
/*          (UT)         Curve No. (deg)   (deg)   */
Latest re-pointing 2006/10/11 12:12:00   1      00.0000  00.0000 /* Information of initial position */
AOCS Mem-Upload-01 2006/10/11 18:05:00                                     /* Memory upload */
RRe-point Start    2006/10/11 18:06:00   2      00.0223  00.0051
ORe-point Start    2006/10/11 21:59:30   0      00.0000  00.0000 /* Sun-center observation */
ORe-point Start    2006/10/11 22:09:50   2      00.0223  00.0051
ORe-point Start    2006/10/12 04:59:30   0     -00.2777  00.0000
AOCS Mem-Upload-02 2006/10/12 05:05:00
ORe-point Start    2006/10/12 05:09:30   2      00.0223  00.0051
/* End of re-pointing and tracking schedule */

/* AOCS Tracking Parameters before the memory upload */
TR_MEM_ID:01-0610101759-01
/*   Track No.  Ref-Time of Tracking Helio-long. Helio-lat.  Rot. Rate */
/*   Date      Time(UT) (degree) (degree) (deg/sec) */
Track 1      2006/10/09 10:22:11   10.26   -00.55   0.00016793
Track 2      2006/10/08 11:32:10   12.53   -13.76   0.00016072
Track 3      2006/10/07 13:10:20   33.86   -22.57   0.00015883
Track 4      2006/10/10 18:05:00  -40.37    20.08   0.00015427

/* New AOCS Tracking Parameters after the memory upload*/
TR_MEM_ID:01-0610111805-02
Fm: 2006/10/11 20:00:00
/*   Track No.  Ref-Time of Tracking Helio-long. Helio-lat.  Rot. Rate */
/*   Date      Time(UT) (degree) (degree) (deg/sec) */
Track 1      2006/10/09 10:22:11   10.22   -00.55   0.00016733
Track 2      2006/10/11 12:00:53  -70.53   -13.73   0.00016034
Track 3      2006/10/07 13:10:20   33.84   -22.55   0.00015834
Track 4      2006/10/10 12:35:20   43.36    20.07   0.00015276

/* New AOCS Tracking Parameters after the memory upload*/
TR_MEM_ID: 02-0610111805-02
Fm: 2006/10/12 05:09:30
/*   Track No.  Ref-Time of Tracking Helio-long. Helio-lat.  Rot. Rate */
/*   Date      Time(UT) (degree) (degree) (deg/sec) */
Track 1      2006/10/09 10:22:11   10.22   -00.53   0.00016723
Track 2      2006/10/12 12:11:53  -10.53   -14.34   0.00016045
Track 3      2006/10/07 13:10:20   33.84   -22.53   0.00015846
Track 4      2006/10/10 12:35:20   43.33    12.33   0.00015872
/* End of Tracking Curve Information */

```

The example re-pointing plan file indicates that there are two memory-uploads during the scheduling period.

Example file : Example1.txt (Example1.pdf shows the positions[number of rows/columns] of each letter.)

## Explanations of the re-point plan file (re-point\_200610111802)

<<The time-line of the re-pointings and the memory uploads of AOCS>>>

/\* re-pointing and tracking schedule \*/

Fm: 2006/10/11 18:00:00

To: 2006/10/12 10:00:00

Fm: YYYY/MM/DD hh:mm:ss      The start time of the pointing schedule in the file.  
(the time is the same as the time in the filename)

To: YYYY/MM/DD hh:mm:ss      The end time of the pointing schedule in the file

| /*                 | Date       | Time     | Tracking  | Offset-X | Offset-Y | */ |
|--------------------|------------|----------|-----------|----------|----------|----|
| /*                 |            | (UT)     | Curve No. | (deg)    | (deg)    | */ |
| Latest re-pointing | 2006/10/11 | 12:12:00 | 1         | 00.0000  | 00.0000  |    |

Lastet re-pointing YYYY/MM/DD hh:mm:ss    XX.XXXXX    YY.YYYY

The line indicates that the last parameters of changing the tracking curve in the previous re-point plan file.  
In the other words, SOLAR-B is controlled using the parameters before the start time of the schedule.

AOCS Mem-Upload-01 2006/10/11 18:05:00

AOCS MEM-Upload-UU YYYY/MM/DD hh:mm:ss

The line indicates that the time of the memory-upload.

UU: The number of the upload in the file.

|                 |                     |   |         |         |
|-----------------|---------------------|---|---------|---------|
| RRe-point Start | 2006/10/11 18:06:00 | 2 | 00.0223 | 00.0051 |
| ORe-point Start | 2006/10/11 21:59:30 | 0 | 00.0000 | 00.0000 |

|                 |                     |   |         |        |           |
|-----------------|---------------------|---|---------|--------|-----------|
| RRe-point Start | YYYY/MM/DD hh:mm:ss | L | XX.XXXX | YY.YYY | /*.....*/ |
| ORe-point Start | YYYY/MM/DD hh:mm:ss | L | XX.XXXX | YY.YYY | /*.....*/ |

The line indicates that the start time of the re-pointing, Tracking Curve number and offset

RRe-pointing Start      The command is executed by the commander at USC during the pass

ORe-pointing Start      The command is excuted by OP.

YYYY/MM/DD hh:mm:ss    The start time of the re-pointing

L                        The number of tracking curve

XX.XXXX                The offset from the tracking curve or the sun center (X axis / degree)

YY.YYYY                The offset from the tracking curve or the sun center (Y axis / degree)

/\*.....\*/              Comments for the re-pointing

|                 |                     |   |          |         |
|-----------------|---------------------|---|----------|---------|
| ORe-point Start | 2006/10/11 22:09:50 | 2 | 00.0223  | 00.0051 |
| ORe-point Start | 2006/10/12 04:59:30 | 0 | -00.2777 | 00.0000 |

AOCS Mem-Upload-02 2006/10/12 05:05:00  
ORe-point Start 2006/10/12 05:09:30 2 00.0223 00.0051  
/\* End of re-pointing and tracking schedule \*/

---

<<<The information of the memory map (Tracking Curve)  
on the satellite at the start time of the schedule>>>

The part is the copy of the last memory-map part in the previous re-pointing plan file.

---

/\* AOCS Tracking Parameters before the memory upload \*/  
TR\_MEM\_ID:01-0610101759-01

---

TE\_MEM\_ID:UU-YYMMDDhhmm-NN

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The line indicates the serial number of the memory map.

---

| /*    | Track No. | Ref-Time of Tracking | Helio-long. | Helio-lat. | Rot. Rate | */           |
|-------|-----------|----------------------|-------------|------------|-----------|--------------|
| /*    |           | Date                 | Time(UT)    | (degree)   | (degree)  | (deg/sec) */ |
| Track | 1         | 2006/10/09           | 10:22:11    | 10.26      | -00.55    | 0.00016793   |

---

| Track | L | YYYY/MM/DD hh:mm:ss | OO.OO | AA.AA | R.RRRRRRRR |
|-------|---|---------------------|-------|-------|------------|
|-------|---|---------------------|-------|-------|------------|

---

The line indicates the parameters of the tracking curve no. L

Track L: The number of the tracking curve

YYYY/MM/DD hh:mm:ss: The reference time of tracking curve

OO.OO: The helio-longitude\* of the target *at the reference time*. (degree).

AA.AA: The helio-latitude\* of the target *at the reference time* (degree).

R.RRRRRRRR: The differential rotation speed (angular velocity) at the target (degree/sec).

\* The coordinate system of the parameters is the heliographic coordinate.

---

|       |   |            |          |        |        |            |
|-------|---|------------|----------|--------|--------|------------|
| Track | 2 | 2006/10/08 | 11:32:10 | 12.53  | -13.76 | 0.00016072 |
| Track | 3 | 2006/10/07 | 13:10:20 | 33.86  | -22.57 | 0.00015883 |
| Track | 4 | 2006/10/10 | 18:05:00 | -40.37 | 20.08  | 0.00015427 |

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<<<The information of the memory map (Tracking Curve)  
that will be uploaded during the period of the schedule in the file>>>

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/\* New AOCS Tracking Parameters after the memory upload\*/  
TR\_MEM\_ID:01-0610111805-02

---

TE\_MEM\_ID:UU-YYMMDDhhmm-NN

---

The line indicates the serial number of the memory map.

The serial number is inserted as the comment in the first line of the IntelHEX file.

UU: The number of the upload in the file.

YYMMDDhhmm: the start time of the pointing schedule in the file.

NN: the revision number of the file.

\*YYMMDDhhmm-NN is the same as the part of the filename (re-point\_YYYYMMDDhhmmNN).

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Fm: 2006/10/11 20:00:00

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Fm: YYYY/MM/DD hh:mm:ss

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The start time of the first re-pointing after the memory-upload.

**Caution:** The time is **not** the time of the upload. Immediately after the memory-upload, the parameters of the uploaded memory map are not used. The upload parameters are used at the first re-pointing after the memory-upload.

---

| /*    | Track No. | Ref-Time of Tracking | Helio-long. | Helio-lat. | Rot. Rate | */           |
|-------|-----------|----------------------|-------------|------------|-----------|--------------|
| /*    |           | Date                 | Time(UT)    | (degree)   | (degree)  | (deg/sec) */ |
| Track | 1         | 2006/10/09           | 10:22:11    | 10.22      | -00.55    | 0.00016733   |

---

Track L YYYY/MM/DD hh:mm:ss OO.OO AA.AA R.RRRRRRRR

---

The line indicates the parameters of the tracking curve no. L

Track L: The number of the tracking curve

YYYY/MM/DD hh:mm:ss: The reference time of tracking curve.

OO.OO: The helio-longitude\* of the target at *the reference time* (degree).

AA.AA: The helio-latitude\* of the target at *the reference time* (degree).

R.RRRRRRRR: The differential rotation speed (angular velocity) at the target (degree/sec).

\* The coordinate system of the parameters is the heliographic coordinate.

---

|       |   |            |          |        |        |            |
|-------|---|------------|----------|--------|--------|------------|
| Track | 2 | 2006/10/11 | 12:00:53 | -70.53 | -13.73 | 0.00016034 |
| Track | 3 | 2006/10/07 | 13:10:20 | 33.84  | -22.55 | 0.00015834 |
| Track | 4 | 2006/10/10 | 12:35:20 | 43.36  | 20.07  | 0.00015276 |

---



## Example 2: re-point\_200610111801

```

/* re-pointing and tracking schedule */
Fm: 2006/10/11 18:00:00
To: 2006/10/12 10:00:00
/*          Date          Time   Tracking   Offset-X Offset-Y */
/*          (UT)    Curve No. (deg)    (deg)    */
Latest re-pointing 2006/10/11 12:12:00    1      00.0000  00.0000 /* Information of initial position */
ORe-point Start    2006/10/11 20:00:00    2      00.0223  00.0051
ORe-point Start    2006/10/11 21:59:30    0      00.0000  00.0000 /* Sun-center observation */
ORe-point Start    2006/10/11 22:09:50    2      00.0223  00.0051
ORe-point Start    2006/10/12 04:59:30    0     -00.2777  00.0000
ORe-point Start    2006/10/12 05:09:30    2      00.0223  00.0051
/* End of re-pointing and tracking schedule */

/* AOCS Tracking Parameters before the memory upload */
TR_MEM_ID:01-0610101759-01
/*   Track No.  Ref-Time of Tracking Helio-long. Helio-lat.  Rot. Rate */
/*          Date      Time(UT)  (degree)    (degree)    (deg/sec) */
Track  1      2006/10/09 10:22:11   10.26      -00.55      0.00016793
Track  2      2006/10/08 11:32:10   12.53      -13.76      0.00016072
Track  3      2006/10/07 13:10:20   33.86      -22.57      0.00015883
Track  4      2006/10/10 18:05:00  -40.37       20.08      0.00015427

```

The example re-pointing plan file indicates that there is no memory-upload for the AOCS unit during the schedule period.

Example file : Example2.txt (Example2.pdf shows the positions of each letter.)

### Example 3: re-point\_200610111803

```

/* re-pointing and tracking schedule */
Fm: 2006/10/11 18:00:00
To: 2006/10/12 10:00:00
/*
      Date      Time   Tracking   Offset-X Offset-Y */
/*
      (UT)      Curve No. (deg)    (deg)    */
Latest re-pointing 2006/10/11 12:12:00   1      00.0000  00.0000 /* Information of initial position */
AOCS Mem-Upload-01 2006/10/11 18:05:00                                     /* Memory upload */
ORe-point Start    2006/10/11 20:00:00   2      00.0223  00.0051
ORe-point Start    2006/10/11 21:59:30   0      00.0000  00.0000 /* Sun-center observation */
ORe-point Start    2006/10/11 22:09:50   2      00.0223  00.0051
ORe-point Start    2006/10/12 04:59:30   0     -00.2777  00.0000
ORe-point Start    2006/10/12 05:09:30   2      00.0223  00.0051
/* End of re-pointing and tracking schedule */

/* AOCS Tracking Parameters before the memory upload */
TR_MEM_ID:01-0610101759-01
/*   Track No.   Ref-Time of Tracking Helio-long. Helio-lat.   Rot. Rate */
/*
      Date      Time(UT) (degree)    (degree)    (deg/sec) */
Track 1      2006/10/09 10:22:11   10.26     -00.55     0.00016793
Track 2      2006/10/08 11:32:10   12.53     -13.76     0.00016072
Track 3      2006/10/07 13:10:20   33.86     -22.57     0.00015883
Track 4      2006/10/10 18:05:00  -40.37      20.08     0.00015427

/* New AOCS Tracking Parameters after the memory upload*/
TR_MEM_ID:01-0610111805-03
Fm: 2006/10/11 20:00:00
/*   Track No.   Ref-Time of Tracking Helio-long. Helio-lat.   Rot. Rate */
/*
      Date      Time(UT) (degree)    (degree)    (deg/sec) */
Track 1      2006/10/09 10:22:11   10.22     -00.55     0.00016733
Track 2      2006/10/11 12:00:53  -70.53     -13.73     0.00016034
Track 3      2006/10/07 13:10:20   33.84     -22.55     0.00015834
Track 4      2006/10/10 12:35:20   43.36      20.07     0.00015276

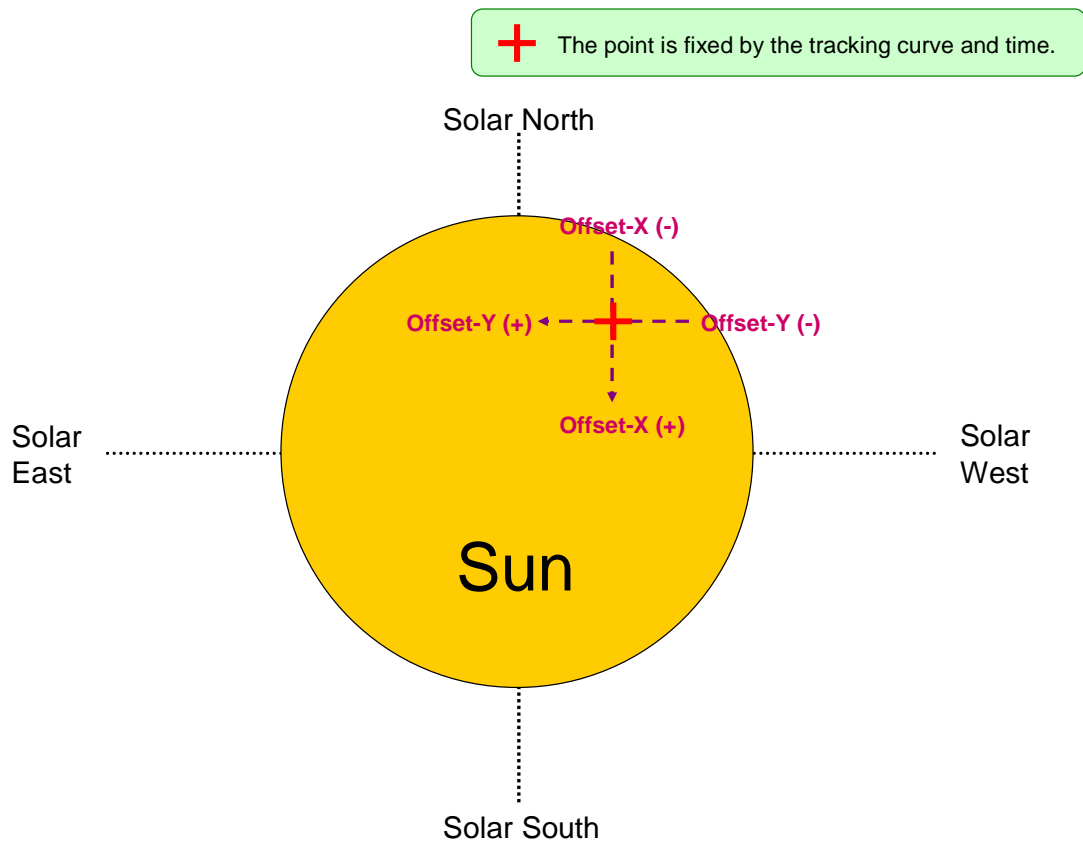
```

The example re-pointing plan file indicates that there is only one memory-upload during the scheduling period.

Example file : Example3.txt (Example3.pdf shows the positions of each letter.)

**Note: The offset parameters of the re-pointing command**

The re-pointing command has two offset parameter, “Offset-X” and “Offset-Y”. The “Offset-X” is not meaning the East-West offset, and the “Offset-Y” is not meaning the North-South offset. The value of the “Offset-X” is the offset of the pitch angle (the offset angle of the satellite’s X-axis). Also, the value of the “Offset-Y” is the offset of the yaw angle (the offset angle of the satellite’s Y-axis). Hence, the coordinate of the “Offset-X/Y” is following;



Please be careful for the different coordinate.

### **Appendix 3-3: Doppler shift compensation for SOT Operation (TBD)**

BLANK at the moment.

Reference document: JAXA Solar-B SOT Progress Report section 3.4.