

## **Changes:**

1. Removed all image processing options and Extract region center position from FDB. This allows FDB's to be used for a greater variety of images.
2. Re-Added image processing options to the framelist definition.
3. Updated the AIA\_SQ\_FTS\_OP command to allow, UPDATE\_TABLE operation to be specified as an OP parameter.
4. Added additional AIA tables. Redlined suggested changes based on Sequencer meeting 11-06-06.

**AIA Sequence Control:****1. AIA Sequence Control Tables:**

The AIA observational program is controlled by a set of tables which specify the characteristics of the CCD frames as well as their timing and processing. These tables are listed below;

1. Frame Definition Block: The FDB specifies the CCD configuration, number and dimensions of any sub-regions to be extracted from the CCD frame.
2. Frame List: A frame list is a chronological list of frames to be acquired. It specifies the relative timing between a set of CCD frames. Only one frame list is active at any given time. A frame list covers the operation of all four telescopes. This makes it easier to coordinate timing of images from different telescopes. Framelist includes image processing options.
3. Frame list Timeline Schedule (FTS): A FTS describes an optional delay before a Frame List is activated, the number of times it is repeated and intervals between repeats. The set of active FTS's constitute an Observation List.
4. AEC Table: AEC control table.
5. Exposure Table: Exposure control table.
- ~~6. Focus Table: Not needed, focus settings are directly set as an offset from center.~~
7. Offset Table: Y and Z offsets
8. Wavelength Table: Maps a wavelength to a telescope, filter wheel position, Aperture Selector position, Focus setting, ISS offset, and 4 pointers to AEC tables, selected based on target type.
9. Filter wheel table: Maps a filter wheel position (1-5) to an encoder position.
10. Aperture Selector table: Maps an aperture selector position (1 - 2) to an encoder position.

**1. Frame Definition Block:**

Field Name	Size (Bits)	Description
ID	8	A number to identify the Frame Definition Block
Readout Mode	4	1 = 4 port readout 2 = 2 port Readout 3 = 1 port readout
Summing Mode	4	0 = 1x1 1 = 2x2 2 = 4x4
Num Windows	4	Maximum 2
NumRows1	16	Length of Region 1 (in pixels)
NumCols1	16	Height of Region 1 (in Pixels)
NumRows2	16	Length of Region 2 (in pixels)
NumCols2	16	Height of Region 2 (in Pixels)
Row Length	16	Row length for extract regions

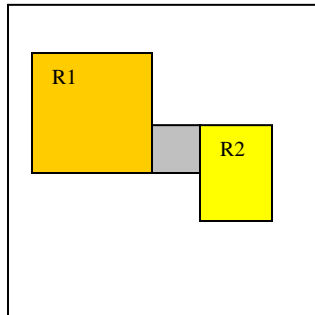
Notes:

1. The FDB is used to determine the values of some entries of the Image Configuration Table which is used by the camera system to acquire and process the image as shown below;

Readout Mode → TAP Config → One of 7 readout tables  
 Summing Mode → Waveform Table → One of 3 waveform tables  
 ROI Regions → Crop Table (generated on board)  
 Exposure → Clear Table

(The image configuration block will be identical to the HMI).

2. Sub-image Extraction:  
 The FDB allows up to 2 regions of interest to be extracted from the CCD frame. (Since only one skip-take pair can be specified per row any overlap in rows causes the intervening columns to be extracted as well (The grey area in the diagram below). This makes allowing more than two extract region to become less useful).



The locations of the extract regions may be absolute or relative to a target point. Specification relative to a target precludes the use of pre-defined extraction tables (skip-take or crop tables). However, the image can still be reconstructed as described below.

The camera header contains 7 bytes of user specified data fields. In addition, it contains a 12 bit user specified Crop Table ID field. Therefore, there are a total of 68 bits which can be specified by the user. These are sufficient to specify reconstruction parameters unambiguously. One scheme is shown below.

PktLoc	Byte#	0	1	2	3	4	5	6	7
23	0	Frame Serial Number (Bits 0 – 7) (MSB)							
24	1	Frame Serial Number (Bits 8 – 15)							
25	2	Frame Serial Number (Bits 16 – 23)							

26	3	Frame Serial Number (Bits 24 – 31) (LSB)			
27	4	Target 1 Row Number			T1CN(0)
28	5	Target 1 Column Number (Bits 1 – 6)		T2RN(0-1)	
29	6	Target 2 Row Number (Bits 2 – 6)		T2CN(0-2)	
30	7	Target 2 Column Number (Bits 3 – 6)	Frame Definition Block (0 – 3)		
31	8	Frame Definition Block (4 – 7)	Readout Mode	Error	OvFlow

## Notes:

1. The target position can be specified to the nearest 32<sup>nd</sup> row or column (~16"). This is based on 4096 pixels covering ~2000" FOV.
2. The ground processing software will determine the sizes of the extract region using the FDB\_ID from a data base (just like the crop ID's). The AIA and HMI image processing software will differ at this step.
3. Image parameters such as, Exposure (including dark frames), Focus and Wavelength etc. will be downlinked in a separate Image Status Packet. The ISP will also include the Frame Serial Number to enable it to be associated with an image packet. These are not needed for image reconstruction but may be useful information to be displayed.

**2. Framelist Definition:**

The framelist specifies the order in which frames are acquired. Frames may be acquired concurrently from all four telescopes.

Field Name	Size (Bits)	Description
Relative Time	16	Time at which CCD frame is acquired relative to the cadence mark. This is in milliseconds ( <b>TBD</b> )
Wavelength	8	Wavelength (This determines the camera as well)
<del>Focus</del>	<del>8</del>	<del>Focus Setting Moved into Wavelength table.</del>
<del>Focus Flag</del>	<del>2</del>	<del>0 = Enable   1 = Disable focus changes   2 = Use global focus flag Always use global flag to determine whether or not to apply focus setting from wavelength table.</del>
Target Type	2	Solar Target Type (Quiet Sun/Limb/Flare...). A separate AEC table is used for each target type.
AEC Mode	1	Use / Do not use AEC table to set exposure
AEC Exposure	1	Use Default or Current AEC exposure
AEC Update	1	A flag to indicate if exposure for current wavelength should be updated based upon the AEC
Exposure Type	1	Dark / Light
Exposure Index	8	Index into exposure table if AEC is OFF;

		If AEC is ON this value is used to offset current AEC exposure. When used as offset this value is treated as a signed number.
CCD Clear Flag	1	Clear CCD prior to exposure
FDB	8	Frame Definition Block ID
Scale Param. (R)	4	Data is right - shifted R bits before compression
Compr. Param.(N)	4	If N < 6, No compression is performed
Compr. Param. (K)	4	If K > 8, No compression is performed
LUT_ID	8	Lookup Table ID (if ID = 0, no scaling is performed)
<del>Offset Y</del>	<del>8</del>	<del>Secondary mirror (ISS) offset in Y</del> Moved into Wavelength table.
<del>Offset Z</del>	<del>8</del>	<del>Secondary mirror (ISS) offset in Z</del> Moved into Wavelength table.
Event 1 Response	16	Event Response FTS ID (or Name)
Event 2 Response	16	Event Response FTS ID (or Name)

Notes:

- ~~1. The Y and Z offsets are added to the offsets specified by the FDB. If they are within range the secondary is commanded to the computed offsets. The range values can be changed by command.~~ Moved into Wavelength table.
- ~~2. The Focus parameter is an index into the focus table. A value of 0xFF specifies the default focus for the wavelength. The default focus values are changeable by command. If the Focus Flag is set, the focus position is not changed during the execution of the framelist.~~ Moved into Wavelength table.
3. The FDB ID is written to the CCD frame header. This allows all image reconstruction parameters to be determined from the image packet header.
4. Image processing parameters, R, N, K and LUT\_ID are written to the image packet header.
- ~~5. DC Offset: This specifies the base position of the secondary mirror as an index into a table of DC offsets. The table contains up to TBD entries. Each entry specifies a pair of offset values for the Y and Z axes. This offset is specified as linear translation in Y and Z directions (or possibly as the angle of rotation about the Y and Z directions) in TBD units. The range of the offsets is 0 to 255 (TBD units).~~ Moved into Wavelength table.
6. Event response fields contain FTS ID's which are activated upon detection of an event.
- ~~7. AEC is disabled if the eclipse flag is set. AEC is disabled if the AEC Enable Flag is set to disable. When an eclipse is entered, a script will be executed which will command this flag to disabled. When an eclipse is exited, a script will be executed which will restore this flag.~~

**4. Registers:**

1. Mechanical configuration delay (4)
2. CCD Clear delay (4)
3. Target Set 1 (4)
4. Target Set 2 (4)
5. default Cadence
6. Default Readout configuration
7. Focus Enable/Disable Flag
8. ~~Eclipse Flag AEC enable/disable flag.~~

**5. AEC Parameters:**

Parameter	Byte	Description
DefExp	0	Default Exposure (index into the exposure table)
<del>ExpCur</del>	<del>1</del>	<del>Current Exposure (index into the exposure table) Maintained independently for each wavelength, not built into each table.</del>
StepDn	2	Over exposure decrement
StepUp	3	Under exposure increment
OExpArea	4	Percentage overexposure to cause a StepDn
UExpArea	5	Percentage underexposure to cause a StepUp
OExpBin	6 – 7	Overexposure histogram index
UExpBin	8 – 9	Underexposure histogram index
MinExp	10	Minimum Exposure Index
MaxExp	11	Maximum Exposure Index

The quantities, UExpArea and UexpCount are related as follows;

$$UExpCount = \frac{UExpArea}{100} \times Npixels$$

where *Npixels* is the total number image pixels

The above discussion assumes that the pixel counts are normalized for on chip summing and the exposure duration.

AEC Tables:

A separate AEC table is needed for each wavelength and (perhaps) Target Type. Target Type allows for multiple AEC tables to be associated with a particular wavelength (e.g. quiet Sun or Flare or active region or Limb/offpoint)

Therefore, 10 AIA wavelengths combined with upto 4 (TBD) target types, requires,

20 x 4 = 80 Tables  
= 1280 bytes since each AEC table is 16 bytes long

4 Exposure entries per index (?)  
HMI has 2 exposure entries per exposure index

## 6. Wavelength Table

Parameter	Byte	Description
Wavelength	0 - 1	Wavelength this entry describes. (Range: TBD )
ATA	2	ATA this wavelength uses. (Range: 1 - 4 )
Filterwheel Position	3	Filterwheel position this wavelength uses. (Range: 1 - 5)
Aperture Selector Position	4	Aperture Selector position this wavelength uses. (Range: 0 - 2, 0 means unused)
Focus Setting	5 - 6	Focus Setting this wavelength uses. (Range: [-700] - [700])
ISS Offset	7	ISS Settings this wavelength uses. (Range: TBD)
AEC table for Target 1	8 - 9	ID of AEC table used by this wavelength for target 1.
AEC table for Target 2	10 - 11	ID of AEC table used by this wavelength for target 2.
AEC table for Target 3	12 - 13	ID of AEC table used by this wavelength for target 3.
AEC table for Target 4	14 - 15	ID of AEC table used by this wavelength for target 4.

## 7. Filterwheel Table

Parameter	Byte	Description
Position	0	Position this entry describes. (Range: 1 - 5 )
Encoder Setting	1 - 2	Encoder setting this Position uses. (Range: 0 - 323 )

Notes: There are four tables, one for each ATA

## 8. Aperture Selector Table

Parameter	Byte	Description
Position	0	Position this entry describes. (Range: 1 - 2 )
Encoder Setting	1	Encoder setting this Position uses. (Range: 0 - 35 )

Notes: There is one table for ATA 2.

## 2. AIA Sequencer Commands:

### 1. AIA\_SEQ\_OP

a. OPERATION={ START | STOP | ABORT }

This command controls sequence operation as described below;

**START:** Starts the main loop which looks for any active FTS's. The Active FTS Table is scanned for a framelist to execute. If an active FTS is found, the corresponding framelist begins execution at the start of the next cadence period. If no active FTS's are found a warning message is generated. Warning message is generated once per default cadence period. If active FTS's are found they are executed in the order of their priorities. If an FTS has been designed to run for a limited period only, the sequencer may appear to be inactive as no frames are generated. However, no warning messages are issued in this condition.

**STOP:** The sequencer main loop is terminated at the end of the current framelist. The Active FTS table remains unchanged.

**ABORT:** The sequencer is stopped after the current entry in the framelist has been processed. The Active FTS Table remains unchanged.

### 2. AIA\_SEQ\_CONFIG

a. PARAMETER

i.

b. VALUE

### 3. AIA\_SEQ\_FTS\_OP

a. OP={ UPDATE\_TABLE | ACTIVATE | CLEAR | CLEAR\_ALL }

b. FTS\_ID={16 bit value}

c. PRIORITY={n} ( 0 <= n <= 15 )

This command allows the Active FTS Table to be manipulated. The options are described below;

**UPDATE\_TABLE:** Sets a previously loaded FTS table as the active table.



**ACTIVATE:** The FTS specified by the parameter, FTS\_NAME is loaded into the Active FTS Table at the priority slot specified by PRIORITY. This command may be executed while the sequencer is running. The new FTS will be included in the list of FTS's scanned at the start of the next cadence period. If an FTS is already loaded at the priority slot, it will be replaced by the new FTS. If a FTS is active when it is replaced, the current framelist will continue execution until it has been completed.

**CLEAR:** The FTS specified by FTS\_NAME is removed from the Active FTS Table. The PRIORITY parameter is ignored.

**CLEAR\_ALL:** The Active FTS Table is cleared. Both FTS\_NAME and PRIORITY parameters are ignored.

A new **START** command begins at the end of the current framelist (cadence period)

1. Separate clear and readout tables are preferable. When can separate tables not be used?
2. Dynamic table modification simplifies design considerably. Is there a reason to not use this capability?
3. What is the required accuracy for the Eon-Of\_Clear to Start-Of\_Readout interval? Is a jitter of ~8ms acceptable?
4. If the time T1 was determined by on-board computation (rather than being specified by a register), the same algorithm can be used to determine the start of both AIA and HMI exposures. T1 is the time required to configure the mechanism in HMI.
5. For AIA is it necessary to include the capability to specify the shutter direction for each frame independently or can a default be used?
6. Is an exposure table necessary?

