ADP Source Packet Data Formats for HESSI

Draft 007 28-Apr-99

Note: The first and second level HW (FPGA) for RAS is not defined yet, therefore the description will change. However the packet data format is fixed.

Table of Contents

Figure Caption

Table Caption

1 Overview Aspect Data Processor (ADP) Operation

1.1 ADP Data Flow

The data flow of the ADP is controlled by 3 different entities; namely

1. First level HW mode: under control of the front-end SAS/RAS FPGA CCD controller
2. Second level HW mode: under control of the ADP SAS/RAS FPGA
3. DSP controlled SW modes

The modes are controlled by parameters in the parameter file (PF) see sect. ??

1.1.1 The first level SAS and RAS HW modes

1.1.1.1 SAS first Level Modes

Mode	FS0	FS1	FS2	FS3	FS4	FS5	FS6	FS7
Descript.	Normal	Hi-Res	Test Signal	Test Offset	LED mode	½ LED mode	Commu nication	Running Average
Bits in Packet Data	8	10 LSB of 12	10 MSB of 12	10 MSB of 12	8	8	10	8
LSB resolution	4 mV	0.5 mV	2 mV	2 mV	4 mV	4 mV	NA	4 mv
Subtract Offset.	yes	yes	no	no	yes	yes	NA	yes
Used for	Event Image	Diag.	Diag.	Diag.	Diag.	Diag.	Diag.	Event Image

Figure 1: First level HW Modes controlled by SAS Front-End FPGA.

Bits in packet data are number of bits that are transmitted via the source packet data. The resolution is achieved by the mapping of bits from the 12 bit CCD ADC into the packet data. This mapping is made partly in the front-end FPGA and also in the second level FPGA and by DSP S/W.

Subtraction means that the offset level is subtracted from the signal level.

In mode FS4 and FS5 mode the built in LED is fired either in continuos mode (FS4) or with a duty cycle of ½ (FS5).

In mode FS6 mode a fixed pattern of date is generated namely 64 times (16 times 155 , followed by16 times 2AA) = 2048 10bit data.

In FS7 mode a running average of the SAS pixel is formed for further processing in the second level mode.

1.1.1.2 RAS first Level Modes (Not to be used, must be discussed)

Mode	FR0	FR1	FR2	FR3	FR4	FR5	FR6	FR7
Descript.	Normal	Hi-Res	Test Signal	Test Offset	LED mode	½ LED mode	Commu nication	Running Average
Bits in Packet Data	10	10 LSB of 12	10 MSB of 12	10 MSB of 12	8	8	10	8
LSB resolution	0.5 mV	0.5 mV	2 mV	2 mV	4 mV	4 mV	NA	4 mv
Subtract Offset.	yes	yes	no	no	yes	yes	NA	yes
Used for	Event Image	Diag.	Diag.	Diag.	Diag.	Diag.	Diag.	Event Image

Figure 2: First level HW Modes controlled by RAS front-end FPGA.

1.1.2 Second Level SAS and RAS HW Modes

The second level SAS FPGA is programmed for the following modes:

Mode	All pixel	Odd pixel	Even pixel	Average
Length	2048	1024	1024	1024
Name	SS0	SS1	SS2	SS3

Figure 3: Second level SAS HW modes

In the SS0 mode all pixels are transmitted

In the SS1 and SS2 modes only the odd or the even channels are transmitted, respectively

In the SS3 mode the average of n and n+1 pixel is transmitted, starting at n=0

The second level RAS FPGA is programmed for the following modes:

Mode	no x sum; no t sum	x sum; no t sum.	t sum, no x sum	x sum ; t Sum.
Name	SR1	SR2	SR3	SR4

Figure 4: Second level RAS HW modes. x sum means: summing of contents of adjacent pixel (spatial summing)

t sum means: summing of same pixel # but adjacent time frame (time summing)

For details see RAS operation sect ??.

1.1.2.1 ADP Data Format Matrix (needs update)

Not all combinations of modes are meaningful. The possible combinations of S/W and H/W data formats are given by the matrix see Figure 5. All HW,SW modes are controlled by parameters in the parameter file (PF)

1^{st} level SAS	FS0	FS1	FS2	FS3	FS4	FS5	FS6	FS7
SAS Limb Science	SS0 - SS3	SS0 – SS3						
SAS Image Science	SS0 – SS3	SS0 – SS3	SS0 – SS3					
SAS Image Diag.				SS0 – SS3	SS0 – SS3	SS0 – SS3	SS0 – SS3	SS0
1^{st} level RAS	FR0	FR1	FR2	FR3	FR4	FR5	FR6	FR7
RAS Event Science		SR1 – SR4						
RAS Image Diag.			SR1, SR4	SR1, SR4	SR1, SR4	SR1, SR4	SR1, SR4	SR1

Figure 5: ADP data format matrix. Note: The different shaded regions are corresponding to different source packet formats (see sect. ??)

1.1.3 Data Format without FPGA HW involvement

Type
Parameter file/ Pixel Mask for 3 SAS/RAS
RAS trigger levels
Memory dump (download)
ADP Housekeeping data

Figure 6: Data Format without FPGA HW involvement

1.1.4 Overview of SAS Operation

The science SAS limb mode will be the default mode at start-up. It is optimized for speed and minimal data rate. The parameters which are relevant for the operation are stored in the PF and are:

1.1.4.1.1 Fixed parameters for all 3 SAS CCD

- Cadency: Possible values 8, 16, 32, 64 128 Hz
- First H/W level: fixed to FS0 or FS7 (8 bit with subtraction of offset with or without running summation (see Figure 1)
- Second H/W level: SS0 to SS3 possible (see Figure 3)

- Number of pixels per limb:

  Since the limb record should be even byte long, only even number of pixels is allowed. Two parameters in the PF control the pixel distribution:

  i: number of pixel below threshold

  k: Number of pixels above or equal threshold

  i+k=2n=m, (n=0,1,...). Having k>i will allow to map the Solar limb for search of Sun spots near the limb, limb function determination etc.

A parameter of size s in the PF controls the minimum size of the separation of two limbs. Setting s> than about 4(TBD) will efficiently suppress hot pixels, without degrading the science.

1.1.4.1.2 Variable parameter for each SAS CCD

Integration time:

The integration time can be set to 256 predefined values. The minimum integration time is ~16us and can be set in steps of 16us which defines a maximum of ~4.0ms.

Trigger level:

This byte is the pixel number at which the level 2 HW limb detection is triggered.

1.1.5 Overview of RAS operation

1.1.5.1 RAS Cadency

The RAS cadency is programmable via the parameter file. The cadency can be varied from ~2.6 msec to ~53.6 msec in 255 steps of ~200 µsec. The star crossing time over the 500 µm wide CCD at 15 rpm is ~ 6.4 msec.

1.1.5.2 Earthshine

RAS events have to be taken with no Earthshine on the CCD. The ADP has to maintain an Earthshine detection procedure. Earthshine is defined when k pixels are n channels above threshold and a flag (Earthshine Flag ESF) is set. The event detection algorithms (see below) starts after m cycles are Earthshine free. The ESF is then cleared. (k, n and m are fixed and TBD)

1.1.5.3 Event detection (TBC)

To increase the S/N ratio pixel a running summation in spatial and time coordinates is introduced. The summed pixel is compared with a pixel dependent (summed) threshold. If an event (hopefully a star) is detected, the raw data pixels that contributed to the event trigger are transmitted including the corresponding pixels of the time frames before and after the triggering pixels. In addition p_o=1 (fixed) offset pixels on either spatial side of the triggering pixels are transmitted too. The following Figure 7 shows an example for 2 spatial and 2 timing summation. The shadowed pixels are summed and are contributing to the trigger. The hatched and the shadowed of the raw pixels are defining an event and are transmitted into the packet data. The summed images are available in the diagnostic mode (TBC).

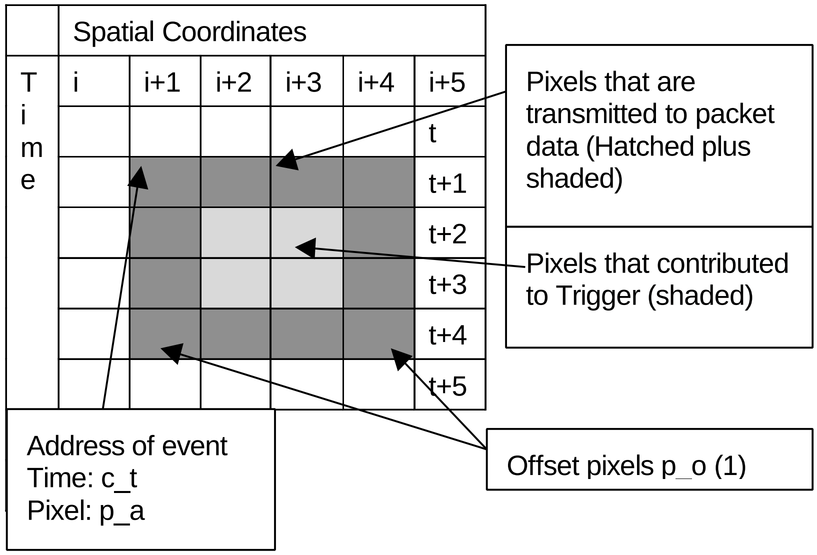

Figure 7: Scheme of spatial and time summation of RAS CCD cycles

The address for the RAS event is set by the first raw data pixel in the packet data followed by the raw data pixel for the same cadency cycle. In the example below the address would be (t+1,i+1). Since the number of spatial and time summed trigger pixel can be larger than 1, the number of raw data pixel send to ground is not fixed. Following the first cadency cycle, the next 3 (in case t_s=1) or 4 (in case t_s=2) cadency cycle are transmitted. Each cadency cycle starts with the address of the first pixel. The ADP S/W ensures that each pixel is sent only once in case of multiple triggering of adjacent pixels in time and space. If non-adjacent, but nearby pixels are triggering, the ADP treats it as two different events and then partly the same pixels can be transferred to the data buffer. Software on ground must handle this ambiguity.

The summation algorithms start newly after the ever Earthshine flag is cleared.

1.1.5.3.1 Spatial summation

The RAS CCD is split in five TBD region as shown in Figure 8. The region boundaries will be fixed before launch and can not be changed in orbit.

Pixel Number	0	TBD	TBD	TBD	TBD 2047
Name	Outer low	Middle low	Center	Middle Hi	Outer Hi
Range of summed pixels	1-4	1-4	1-4	1-4	1-4

Figure 8: Regions of spatial summation of RAS

The maximum number p_s of adjacent pixels that can be summed pixel is 4. Three p_s value for the five regions are programmable from ground and stored in the PF. They are:

1. center region with summing value p_s_c (defaut 2 TBD)
2. Middle region summing value p_s_m (default 3 TBD)
3. Outer region summing value p_s_o (default 4 TBD)

The p_s_i value is changed when the pixel address is above the lower boundary of the corresonding region i.

1.1.5.3.2 Time Summation (TBC)

The number of cadency cycles t_s that are summed up (running sum) is programmable from ground and stored in the PF. Its values is t_s =1 or 2.

If the running time summation mode is selected (RS?? and RS?? see Figure 3) four (TBD) raw RAS images corresponding to the last 4 cadency cycles are stored in the dual port memory. From those raw data a time and spatial summed pixel is computed and compared the summed threshold

1.1.5.4 Hot pixels

No trigger shall be issued if a hot pixel is in the summed pixel, which is above threshold. The RAS hot pixel mask is up-loaded from ground.

1.1.5.5 Adjustable Threshold (TBC)

For optimal triggering conditions and allowance for slow thermal drifts, the RAS threshold p_t_k is defined for each pixel k and can be up-loaded from ground. There are two modes of usage of the threshold:

1. Thresholds are pixel dependent but constant in time for the whole run.
2. Thresholds are formed by a running average algorithms using the j images (~500 TBD) of every m HESSI rotations (m~200 TBD). A new threshold N(k) for pixel k is derived after acquiring an RAS image by the following rules:

   N(p_t_k) = O(p_t_k) – O(p_t_k)/j + P(k)

   where: N(p_t_k) : new pixel threshold of pixel k
   O(p_t_k) = old threshold of pixel k (average of last j thresholds)
   and P(k) = last amplitude for pixel m

Care must be taken that the threshold reading is taken without Earthshine (see sect ??). During threshold updating no RAS events are acquired.

1.1.5.6 Summary of Parameters related to the RAS event

For description see sect ?? to ?? and for an example see Fig ??.

Parameter	Mem.	Typical value (TBD)	Range	Stored
Spatial summation for the 3 region c,m,o	p_s_i, (i=c,m,o)	1,3,4	1 to 4	PF
Cadency cycle summation (time)	t_s	2	1 or 2	PF
Spatial Region boundaries (k=1 to 5)	p_r_k	0, 410, 820, 1230, 1640		fixed
Spatial offset pixels	p_o	1		fixed
Time offset	t_o	1		fixed
Threshold for pixel k	p_t_k	0 to 100		PF or variable

Table 1: Definition of variables of RAS event triggering

2 Source Packet Format for ADP

2.1 General remarks

The HESSI Telemetry Formats is described in HSI_SYS_007D.doc, (section 2.3.3. Source Packet Format, 2.3.3.1.1. Packet ID). It consist of a source packet header of 6 word length and the packet data of 543 word lengths (see Fig. ??). The source packet header is defined in HSI_SYS_007D.doc; the packet data format is defined by this document. The packet data structure is the same for all AP-ID, namely it consists of a 4 word long header, a 536 word long packet data and a 1 word check sum. The contents of the packet date is different for the different AP-ID, but 2 major groups can be identified, namely event related data (SAS and RAS science events, ADP HK data) and block related data (SAS RAS images and file and/or memory dumps). The following sections describe each AP-ID in detail, starting with event related AP-IDs and followed by block related AP-IDs.

2.2 Source Packet Header

Since the source packet header has to be formatted by the ADP, a summary of the ADP relevant parameters is given below.

Bytes	2	2	2	6	1086
Name	Pkt ID	Pkt Control	Pkt Length	Pkt. Time	Packet Data

Bytes	8	1076	2
Name	Packet Data Header	Packet Data	Check Sum

Figure 9: Source Packet Format. The source packet header, upper figure, is defined by HSI_SYS_007D. The Packet Data, lower figure, is defined by the present document and described in detail below.

2.2.1 Identifier Description

2.2.1.1 Packet ID

The Packet ID field contains a number of sub-fields as shown in Figure ??.

Bits	(3)	(1)	(1)	(11)
Name	Version #	Type	SecHdrFlag	AP ID
Value	000	0	1	See Tab. ??

Figure 10: Source packet ID Format

2.2.1.2 Application Process Identifier AP-IID

This field contains the identifier indicating the process that collects the data (e.g. the format of the Packet Data Field). Table 2 lists the AD-ID for ADP

AP. ID #	Name	Contents
200	SASLimbSci	SAS Limb Data Science
210	SAS0ImgSci	SAS Image Science CCD0
211	SAS1ImgSci	SAS Image Science CCD1
212	SAS2ImgSci	SAS Image Science CCD2
220	RASEvtSci	RAS Event Science
230	SAS0DiaSci	SAS Diagnostic Science CCD0
231	SAS1DiaSci	SAS Diagnostic Science CCD1
232	SAS2DiaSci	SAS Diagnostic Science CCD2
240	RASDiaSci	RAS Diagnostic Science
250	SAS0ImgDia	SAS Image Diagnostic CCD0
251	SAS1ImgDia	SAS Image Diagnostic CCD1
252	SAS2ImgDia	SAS Image Diagnostic CCD2
260	RASImgDia	RAS Image Diagnostic
270	HKADP	ADP Housekeeping Data
272	ParADP	Parameters, Hot pixel addresses
274	RASTrg	RAS Thresholds
280	MEMDump	Memory Dump

Table 2: AP-ID table for ADP.

2.2.1.3 Packet Sequence Control (*Packet Control*)

The Packet Sequence Control field contains two sub-fields as shown in Figure 11

Bits	2	14
Name	Grouping Flag	Source Sequence Count
Value	11	Binary count (modulo 16384) of the number of Source Packets generated for the Application ID indicated in the AP ID field for this Source

Figure 11: Packet Sequence Control

2.2.1.4 Packet Length

This field shall contain the value 1091 (decimal, Most Significant Byte first), indicating 1092 bytes in the Source Packet Data Field (including Packet Secondary header).

2.2.1.5 Source Packet Time

Source packets will be marked with the packet opening time in the Packet Secondary header Packet Time (Collect Time) field. The ADP has no means to know the collect time, instead the packet time is defined as follows:

For RAS events and SAS limb data the time of the first RAS event or the first SAS limb in packet data will be stored, respectively.

For RAS and SAS image data the time of the image collection is stored.

For non-SAS/RAS data the time of the last RAS time counter is stored

The timing of data collection for all data in the source packet should be reconstructible from this time tag. The format of the time tag will be the same as the Transmit Time in the Transfer Frame secondary header (see section 2.3.2.1.6 of HSI_SYS_007D), and shall be based on the same stable clock and epoch. The Time format is as follows

Bits	32	16
Name, / [units]	Seconds / [1]	Sub-Seconds/ [1/65536 sec]

Figure 12: Source Packet Time

2.2.1.6 ADP Packet Data

The Packet Data field shall contain data formatted as specified for the AP-ID indicated in the Source Packet Header. The ADP Packet Data has the same format given in Fig. ?? for all AP-ID's, namely a header of 4 words length, a 536 word long packet data and a 1 word long check sum.

2.2.2 ADP Packet Data Formats

Bytes	8	1076	2
Name	Packet Data Header	Packet Data	Check Sum

Figure 13: ADP Packet Data Format

2.2.2.1 Identifier Description of ADP Packet Data

2.2.2.1.1 Packet Data Header (8 bytes)

The structure of the packet Data Header is given in Figure 14. The same header applies for all ADP AP-Ids.

Bits	1	1	1	1	1	1	10	48
Name	CF	EF1	EF2	S	S	S	Data Word Number	ADP Data Base Version

Figure 14: Packet Data Header

2.2.2.1.2 Continuation flag (CF):

If the CF is set it indicates that the following packet data belongs to packet data of the the previous source packet. This flag is need for all data with more than 1080 bytes continues data, like RAS/SAS images, memory dump, ADP data base etc.

2.2.2.1.3 Error Flags (EF1,EF2)

Set if an recoverable error occurred in the following packet data block

2.2.2.1.4 Data Word Number (DWN)

Since the ADP-DSP does not clear the packet data blocks before filling, any unused portion of it will contain meaningless data from the previous packed data. Therefore, the Data Word Number gives the number of usable words in the following data block.

Note: the packet data block will be addressed, written in words not bytes, therefore DWN is a word counter with its max. value of 540 (10 bits)

S: Spare bits

2.2.2.1.5 ADP Data Base Version

Figure 15 shows the 3 entities that describe the ADP data under which the data are taken

16	16	16
Version Parameter File	Version Hot Pixel File	Version RAS Threshold

Figure 15: ADP Data Base Version

2.2.2.1.5.1 Version Parameter File

This word holds the version number of the parameter file. In case of no-use of this word it shall be cleared

2.2.2.1.5.2 Version Hot Pixel File

This word holds the version number of the hot pixel file, which is used for the data of the RAS or SAS CCDs . In case of no-use of this word it shall be cleared

2.2.2.1.5.3 Version RAS Threshold

This word holds the version number of the RAS threshold file used for the RAS event trigger. In case of non RAS data this word is not used and shall be cleared.

2.2.2.1.6 Check Sum

The Check Sum is the longitudinal 16 bit sum of the whole source packet without carry bits.

2.3 Source Packet Data in Event Mode

2.3.1 AP ID 200: SAS Event Packet Data

2.3.1.1 Packet Data Format

The AP-ID 200 PD packet data format is given by Figure 16.

Bytes	m+2	m+2	m+2	m+2
Name	limb rec. 0	limb rec. 1		limb rec. n

Figure 16: SAS event packet data, note m = number of pixels/limb must be even

2.3.1.1.1 Limb Record

The structure of the limb record is shown in Figure 17

Bits	5	11	8	8		8
Name	ID	Pixel address	pixel 1	pixel 2		pixel m

Figure 17: SAS Limb Record

2.3.1.1.1.1 ID/pixel address:

The ID pixel address is hardware encoded and stored w/o further processing and shown in Figure 18

Bits	1	3	1	11
Name	Not used	CCD#	up/down	address

Figure 18: ID / pixel address

2.3.1.1.1.1.1 CCD Number:

The CCD Number is given in Figure 19

001	CCD 0
01X	CCD 1
1XX	CCD 2

Figure 19: CCD assignment for SAS limb events. x is not controlled

2.3.1.1.1.1.2 up/down bit:

0: means up going limb from lower to higher addresses

1: means down going limb from lower to higher addresses

2.3.1.1.1.1.3 Pixel Address

Address of the pixel, which triggered.

2.3.1.1.1.1.4 Pixel k (k=0,1..m):

The pixel amplitude of the pixel with the address = lowest address + k.

2.3.1.2 Comments to the AP-ID 200 Packet Data

2.3.1.2.1 Timing of the first limb record

The time in the source packet header corresponds to the end of integration time equal start of read-out time of the first limb record cycle.

2.3.1.2.2 Data integrity

The data is written in fixed order CCD0, CCD1, CCD2.

Missing limbs recovery procedure:

In case a CCD shows no limbs, a limb record with XFFFF FF (Hex), where X is the CCD number (4bits), with same length as a valid limb record is entered into the data block. At the same time the error flag (EF1) in the packet header is set

Missing cadency cycle:

The ADP checks that for each cadency cycle at least one limb record is written. In case k (k>=1) cycles are missed a limb k limb records with 555 55 (Hex) with same length than a valid record is entered into the data block. At the same time the error flag (EF2) in the packet header is set.

2.3.1.2.3 "Last limb record" (TB Discussed)

In normal mode (number of pixels/limb = 4) a limb records is 3 words long and with 2 limbs/CCD a cadency cycle is 18 words long. There are two possibilities if there is not enough space for writing the full cycle at the end of the data block

1. Leave the space empty and start a new source packet.
   Disadvantage: about 1% of telemetry is spoiled (3Mb/day)
   Advantage: Simple

2. Fill up data block and carry limbs over to new source packet data; set the continuation flag in packet data header. Time in source packet header corresponds to the split cycle event (time of last cadency cycle in pervious source packet).
   Advantage: Allows m>>4 pixel/limb without excess degradation of filling factor data block.

Note: A limb record will not be split over two source packets

2.3.1.2.4 Number of limbs per data block

Table 3 gives the number of limbs / data block for m pixels per limb for version 2 from above:

Number of limb record/data block = 1080/(1+m/2)

m	Number of limb record/data block	Number of "6 limb" cycles/DB
0	540	90
2	270	45
4	180	30
6	135	22.5
32	31	5.16

Table 3: Number of limb records as a function of limb pixels and estimate of number of events per packet data block

2.3.2 AP ID 204: RAS event data

2.3.2.1 Packet Data Format

For one RAS event the number of pixels stored in the packet data buffer is variable depending of the number of adjacent pixel in space and time that triggered the event. The distinction of the different RAS events is made by the MSB of the address word, which is always set. The MSB of neither the time nor the pixel word are set. Therefore checking of the MSB of all words does the separation of the different events. The data buffer is shown in Figure 1

Bytes					
Name	RAS event 0	RAS event 1			RAS event n

Figure 20: RAS packet data format.

2.3.2.1.1 RAS Event Record

A RAS event is defined in Figure 21. For the definition of the addresses see sect ?? and Figure 1 below

Bytes	2	2	2	2	2	2	2	2	2
Name	Address A0	Cycle #	pixel 0,0	...	pixel 0,n	Address A1	pixel 1,0	.....	pixel 1,n
	Address A2	pixel 2,0	...		pixel 2,n	Address Ai	pixel i,0	....	pixel i,1

Figure 21: RAS Event structure for single event, allowing for multiple triggering

where

2.3.2.1.1.1 *Pixel Addresses (2 bytes)*

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
FA	NA	S	S	S	Address 11 bits										

Figure 22: RAS Pixel address

The pixel address A0 is the address of the first pixel (pixel 0,0). For bit 15 and 14 of the address word the following rules apply:

- FA: First Address Flag: If set a new event starts. The next words will be the "number of cycle" word (see below) followed by all pixels belonging to the same time cycle. NA must be 0.
- NA: Next Address Flag: If set a new cycle of the same event starts. The next words are all the pixels belobnging to the same cadency cycle. FA must be 0.

2.3.2.1.1.2 *Cadency Cycle Number*

The Cadency cycle number word (2byte) counts the number of cycles since the time word in the source packet was written. The cadency cycle is defined as the cycle of the triggering event.

2.3.2.1.1.3 *Pixel n (2 bytes)*

Pixels are stored consecutively for a cadency cycle, starting with the lowest address.

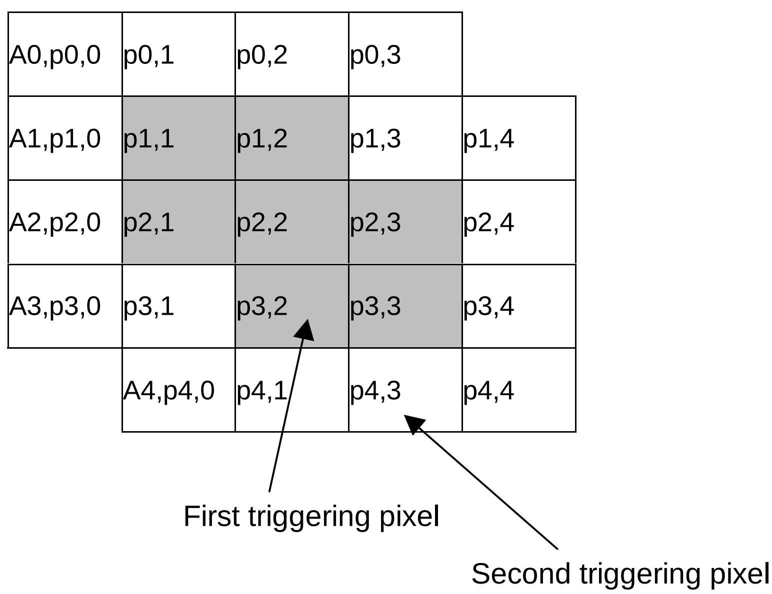

Figure 23: Example of a RAS event with 2 pixel spatial and 2 cycle timing sum. The event triggered twice, the first trigger for pixels; p1,1, p1,2, p2,1 and p2,2. the second trigger corresponds to ; p2,2, p2,3, p3,2 and p3,3. The time of the event corresponds to the cadency cycle of the first trigger, which is the cadency cycle 3.

2.3.2.1.1.3.1 Comments

For a cadency cycle time of 3msec (smallest time) the cadency cycle counter overflows after about 200 sec. A minimum event size (time and spatial sum = 1) is equal to 3 Addresses + 1 Cycle + 9 Pixels = 13 words. Therefore a packet data block holds maximal 536/13=41 events/block corresponding to 0.2 events/sec. In case the block is not filled before the cycle counter overflows, the block as to be closed.

In case the last event is larger than the remaining block size, the same procedure as discussed in sect. ?? applies (SAS events)

2.3.3 AP-ID 270 ADP Housekeeping Data

2.3.3.1 Packet Data Format

Bytes	TBD	TBD	TBD	TBD
Name	HK 0	HK 1	....	HK n

Figure 24: HK packet data format

The HK data is transferred to packet data every n_hk (TBD) RAS cycles. The n_hk parameter is stored in the actual parameter file. The contents and lenght of a HK event will be defined in a next version of this document.

2.4 Source Packet Data in Block Mode

2.4.1 AP ID 210-212 and 250-252: SAS Image Science and Diagnostic Packet Data

2.4.1.1 Packet Data Format

2.4.1.1.1 SAS Science Image (1076 bytes)

Bytes	1	1	1	1
Name	pixel 0	pixel 1		pixel n

Figure 25: SAS science image packet data format

The SAS science image is collected in the first HW level mode F0 or F7 (8 MSB) and has two second level hardware modes namely:

1. mode SS0 (all pixels) corresponding to 2048 bytes/CCD image, or 2 packet data blocks, respectively

mode SS1, SS2, or SS3 (odd, even, average. pixels) corresponding to 1024 bytes/CCD image , or 1 packet data block, respectively

In the first case the data is written in 2 source packets, using the continuation flag (CF) in the packet data header.

In the second case the data is written in 1 source packet.

In both cases the unused data in the data block is not cleared and must be discarded.

2.4.1.1.2 SAS Diagnostic Image (1076 bytes)

Bytes	2	2		2
Name	pixel 0	pixel 1		pixel n

Figure 26: SAS/RAS Diagnostic image format

The SAS diagnostic image is collected in the first HW level mode in the 10 bit/pixel modes, and has two second level hardware modes, namely:

1. mode SS0 (all pixels) corresponding to 2048 words/CCD image , or 4 packet data blocks, respectively
2. mode SS1, SS2,or SS3 (odd, even, averaged pixels) corresponding to 1024 words/CCD image, or 2 packet data blocks, respectively

In the first case the data is written in 4 source packets. In the second case the data is written in 2 source packets. In both cases the continuation flag of the packet data header must be used.

In both cases the unused data in the data block is not cleared and must be discarded.

2.4.1.2 Comments on SAS Images

As can be seen from Figure 5 the difference of the science and diagnostic modes is in the first level hardware mode and in the number of bits transferred. Science data allows only data taking in the FS0 and FS7 mode and 8 bit data/pixel, whereas the diagnostic mode uses the FS1, FS2 or FS3 modes with fixed 10 bit data/pixel.

2.4.1.2.1 SAS Science Image:

The science image is taken simultaneously with the limb data, with a parameter in the PF that defines the ratio of limb data/image data in units of 1024 (typically 10 to 100). The limb and the image data must correspond to the same cadency cycle for all 3 CCDs. If a timing conflict with RAS occurs, then RAS data acquisition cycle has lower priority, viz. is lost.

2.4.1.2.2 SAS Diagnostic Image

Diagnostic RAS images are used to control the offset and signal levels of each pixel, the to perform functional tests using built in LEDs and to test the communication line. They are commanded from ground, parameters in the PF control the number of cycles to be taken, the cadency, and the first and second level hardware modes. No scientific data are taken during this time. Since the diagnostic mode is DSP time consuming, it must be run with low cadency. No checking on "lost cadency cycles are made.

2.4.1.2.3 Timing

The source packet header time corresponds to the SAS time as defined in SAS limb event mode of operation (see sect. ??).

2.4.2 AP ID 240 and 260: RAS Image Science and Diagnostic Packet Data

2.4.2.1 Packet Data Format

2.4.2.1.1 RAS Science Image (1076 bytes)

Bytes	1	1	1	1
Name	pixel 0	pixel 1		pixel n

Figure 27: SAS science image packet data format

The RAS science image is collected in the first HW level mode FR?? 10 LSB and has two second level hardware modes namely:

1. mode SR1 (all pixels) corresponding to 4096 bytes/CCD image, or 4 packet data blocks, respectively

2. Spatial summed image corresponding to a variable amount of pixels depending of the spatial summation pattern.

2.4.2.1.2 RAS Diagnostic Image (1076 bytes)

Bytes	2	2		2
Name	pixel 0	pixel 1		pixel n

Figure 28: RAS Diagnostic image format

The SAS diagnostic image is collected in the first HW level mode in the 10 bit MSB (level checking) or 10 bit LSB (threshold checking, LED) modes, and has two second level hardware modes, namely:

1. mode SR1 (all pixels) corresponding to 4096 bytes/CCD image, or 4 packet data blocks, respectively

2. Spatial summed image corresponding to a variable amount of pixels depending of the spatial summation pattern.

2.4.2.2 Comments on RAS Images

As can be seen from Figure 5 the difference of the science and diagnostic modes is in the first level hardware mode and in the number of bits transferred. RAS science data is taken in the FR? mode using the 10 LSB bit data/pixel, whereas the diagnostic mode uses the FR?? to FR ?? modes with either 10 LSB or 10 MSB bits data/pixel.

2.4.2.2.1 RAS Science Image:

The science image is taken simultaneously with the star event data after a successful trigger, with a parameter in the PF that defines the ratio of event data/image data in units of 1024 (typically 10 to 100). The event and the image data must correspond to the same cadency cycle and is used on ground to verify threshold settings and pixel summation.

2.4.2.2.2 RAS Diagnostic Image

Diagnostic RAS images are used to control the offset and signal levels of each pixel, the to perform functional tests using built in LEDs and to test the communication line. They are commanded from ground, parameters in the PF control the number of cycles to be taken, the cadency, and the first and second level hardware modes. No scientific data are taken during this time.

2.4.2.2.3 Timing

The source packet header time corresponds to the RAS time as defined in RAS event mode of operation (see sect. ??).

2.4.3 AP-ID 272 Parameter File and Hotspot Map

2.4.3.1 Packet Data Format

Figure 29 shows the packet data format for AP-ID 272

Byte	250	2	2	2
Name	PF	Hotspot Address 1	....	Hotspot Address n

Figure 29: AP-ID272 Packet data format

The parameter file PF contains the actually used parameters. The length of PF is 250 bytes. Following the PF a list of the n hot spot addresses actually used follows. The format of the hot spot address is shown in Figure 30

Bit	15	14 –11	10-0
Name	0	CCD #	Hotspot pixel address i

Figure 30: Hotspot address

The CCD number is given in Figure 31 (TBC)

Bit	14	13	12	11
CCD 0 SAS	0	0	0	1
CCD 1 SAS	0	0	1	0
CCD 2 SAS	0	1	0	0
CCD 3 RAS	1	0	0	0

Figure 31: CCD assignment for hotspot address

The hot spot addresses are converted by the ADP in a 8192 bit data block (hot spot mask) and an version number is assigned to it from ground. The packet data header shall include the actually used version number for the parameter file and hot spot mask

2.4.4 AP-ID 274 RAS Threshold file

2.4.4.1 Packet Data Format

Figure 32 shows the packet data format for AP-ID 274.

Byte	2	2	2	2
Name	Thres. pixel 0	Thres. pixel 1	.....	Thres. pixel 1076

Figure 32: AP-ID 274 packet data format

The next packet data block header has its continuation flag set and the remaining thresholds from pixel 1077 to 2047 are written.

2.4.5 AP-ID 280 Memory Dump

2.4.5.1 Packet Data Header Format

In the memory dump AP-ID mode the packet data header has a different word assignment than the RAS/SAS related data. Figure 33 shows the packet data header format for AP-ID 280

Byte	2	2	2	2
Name	Number of words in packet data	Start Address of Memory Dump	Number of Words in Memory Dump	Memory Identification Number

Figure 33: AP-ID 280 Packet data header format

2.4.5.2 Packet Data Format

Figure 34 shows the packet data format for AP-ID 280

Byte	2	2	2	2
Name	Memory loc. 0	Memory loc. 1	....	Memory loc. 1076

Figure 34: AP-ID 280 packet data format

The next packet data block headers have their continuation flag set and the remaining memory locations are written. The maximum number of source packet data blocks is 32 for a full memory dump.