Chandra X-ray Observatory Center

ACA Telemetry Products:
Level 0 to CXC Archive Interface Control Document

Rev. 1.1 — 2000 Aug 16

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Document and Change Control Log

Date	Version	Section	Status
1999 February 8	1.0	all	Updated file naming, content, type, and select keywords
		App. A	Added list of changes for header keywords
		all	Changed ASC to CXC
1998 December 21	0.5	all	Initial draft (based on SIM L0 ICD)

Unresolved issues

There are currently no unresolved issues, as of of 2000 Aug 16:

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Chapter 1

Introduction

This document describes the interface to be employed in transferring telemetry data from the *AXAF-I Aspect Camera Assembly* (*ACA*) between the CXC level 0 processing pipeline and the CXC data archive, according to the requirements stipulated in applicable document 1.

1.1 Purpose

ACA level 0 processing, described in applicable document 1, extracts the serial digital telemetry generated by the two *ACA Processing Electronics Assemblies* (*PEA-A* and *PEA-B*). This document describes the structure and content of the resulting data files that are produced from the telemetry during level 0 processing.

1.2 Scope

This interface shall apply to all *ACA* serial digital telemetry data products that are generated by CXC level 0 pipelines and distributed to the CXC data archive (see applicable documents 1 and 2) during the course of the *AXAF-I* mission.

1.3 Applicable Documents

	Document	Description
1	ASC AMO-2400	ASC Data System Requirements (ASC.302.93.0008)
2	ASC AMO-2401	ASC Data System Software Design (ASC.500.93.0006)
3	NOST 100-1.1	Definition of the Flexible Image Transport System (FITS) `http://www.cv.nrao.edu/fits/`
4	...	HEASARC FITS Standards `http://legacy.gsfc.nasa.gov/docs/heasarc/ofwg/docs/summary/ogip_93_001_summary.html`
5	...	Binary Table Extension to FITS `http://fits.cv.nrao.edu/documents/standards/bintable_aa.ps`
6	ACA DM05 Rev. H	Software Requirements Specification for AXAF-I Aspect Camera Assembly (ACA) Electronics Assembly (PEA)
7	IP&CL Version 6.0	AXAF-I Instrumentation Program & Command List
8	ASC-FITS-1.1	ASC FITS File Designers' Guide `http://hea-www.harvard.edu/~arots/asc/fits/ascfits.ps`
9	TRW EQ7-278 Rev. F	ACA Equipment Specification

1.4 Functional Description

1.4.1 Data Content Summary

All *ACA* data sets generated by the level 0 processing pipeline shall consist of data files conforming to the FITS standard (applicable document 3) and further conforming to HEASARC standards (applicable document 4). These files contain header keyword entries and binary table (BINTABLE) extensions conforming to applicable document 5.

Each entry in these files, apart from generic CXC header keywords, corresponds to an element in the *PEA* serial digital telemetry stream. The names of these keywords and table items are contained in a series of templates, listed in Appendices A–C.

All of the *PEA* serial digital telemetry referred to in this document is available in telemetry formats 1 through 5 (inclusive), and the data extraction and processing described herein applies equally to all five telemetry formats. The sampling of items depends on the image format: once per 1.025 s for 4×4 images, once per 2.050 s for 6×6 images, and once per 4.100 s for 8×8 images. There is no *PEA* serial digital telemetry in format 6 (STS).

The two *PEAs* (*PEA-A* and *PEA-B*) produce independent telemetry streams, although typically only one PEA is powered on. In format 4, data from each *PEA* are stored in distinct locations in each major frame, while in the remaining formats there is only one block of telemetry allocated for both PEAs. In these formats a switch from A to B side (or vice-versa) requires reprogramming of the CTU format. Since only one *PEA* can produce valid telemetry data at any given time, it is not required that the *ACA* data extractor be capable of processing telemetry data from both *PEA-A* and *PEA-B* simultaneously. Serial digital telemetry data from each *PEA* is written to a set of files that include a header keyword denoting the particular *PEA* reporting the telemetered values.

1.4.2 Timing and Sequencing Characteristics

Each merged telemetry dump from the OCC to the CXCDS will result in a sequence of strip files being created, from which the level 0 data products defined in this document are generated. The following strip file cutting criteria shall be implemented.

1. When an *ACA PEA* strip file exceeds the size of 806400 bytes it will be closed as soon as processing of the current atomic unit has been completed. The atomic unit for all *ACA PEA* serial digital telemetry, other than memory dump serial digital telemetry, is one complete image.

2. When a *ACA PEA* memory dump strip file exceeds the size of 100 KB it will be closed as soon as processing of the current atomic unit has been completed. The atomic unit for *ACA PEA* memory dump serial digital telemetry is the 24 bytes of memory plus 2 bytes of address which are telemetered in a single image slot each 1.025 s. The *PEA* memory dump data shall be written in increasing address order.

3. Upon detecting a timeout of the input telemetry stream, the strip file shall be closed after the last complete atomic unit. Any partially complete atomic units at the end of the input telemetry shall be held for processing when the input telemetry stream resumes. The timeout time shall be TBD.

4. The strip file shall be closed immediately whenever an unresolvable VCDU count anomaly occurs.

1.4.3 Recipients and Utilization

ACA level 0 data products will be stored in the CXC data archive, and the archived products subsequently will be accessed and utilized primarily for L1 aspect pipeline processing. Secondary uses include monitoring and trends analysis and for engineering diagnostic purposes. The data products are not intended to be a part of standard data distribution provided to the observers. However, observers may request, and be granted access to, level 0 data products. Identification of additional recipients of level 0 products, and the uses to which such recipients may wish to put them, are beyond the scope of this document.

1.4.4 Pertinent Relationships with Other Interfaces

Changes to the definition of *ACA PEA* serial digital telemetry and data fields as specified in applicable documents 6 and 9 may affect the level 0 data products described in the current document.

1.5 Assumptions and Constraints

Level 0 processing shall generate a set of *ACA PEA* serial digital telemetry data product files in FITS format, as shown in Table 2.1. While the data products files are being written, their contents may not conform to the FITS standard. Care must be taken not to read or copy these files until they are complete.

Chapter 2

Detailed Interface Specifications

2.1 Labeling and Identification

The data files generated by the level 0 processing pipeline shall be assigned external names as shown in Table 2.1. The names obey the following convention:

```
pcad<s><ttttttttt>N<vvv>_<f>_<content>0.fits

_<f>      =  _<slotnumber>TU        / raw image files
_<f>      =  _<slotnumber>          / calibrated image files
_<f>      =                         / omitted for memory dumps
<content> = adat                    / image files
<content> = mem                     / memory dumps
```

where <s> denotes the origin of the data (possible values: b = Ball Aerospace, c = other laboratory calibration, f = flight, s = simulation, t = TRW, u = unknown, x = XRCF), <ttttttttt> is a 9-digit time stamp that is the integer part of the FITS TSTART value, <vvv> is the processing run number (version), <content> specifies the contents of the file (see Table 2.1), and <slotnumber> specifies the ACA image slot (possible values: 0 to 7 inclusive).

Table 2.1: *ACA* level 0 data product files

Title	**<content>**	**Contents**
PEA telemetry (raw)	ACAIMG_TU	*PEA* raw telemetry images)
PEA telemetry (calibrated)	ACAIMG	*PEA* calibrated telemetry images)
PEA memory dump	ACAMEM	*PEA* memory dump data

The keyword HDUCLAS shall be "ASC". The remaining characteristics of the products are given in Table 2.2.

2.2 Substructure Definition and Format

The reader is referred to applicable document 8 for a detailed discussion of the components of the primary and all extension headers of the FITS files.

Table 2.2: *ACA* level 0 data product characteristics

Data product	HDU name	Type	HDUCLAS1	HDUCLAS2	HDUCLAS3
Raw ACA images	ACADATA	adat	TEMPORALDATA	ACADATA	RAW
Cal ACA images	ACADATA	adat	TEMPORALDATA	ACADATA	
ACA Memory Dump	MEMDUMP	mem	CONFIG	MEMDUMP	

2.2.1 Primary Header Keywords

This header contains mandatory, short configuration control, short timing, and short observation information components as defined in applicable document 8.

2.2.2 Principal HDU Header Keywords

The principal HDU is described by an extension header. The extension header contains mandatory, configuration control, timing, and observation information components as defined in applicable document 8.

2.3 *PEA* telemetry raw image files (`ACAIMG_TU`)

The *PEA* telemetry raw image file contains one extension, a principal HDU binary table containing all *PEA* image serial digital telemetry.

A list of all keywords required in a *PEA* telemetry image file is shown in appendix A.

2.3.1 Principal HDU: *PEA* telemetry raw image data

During level 0 processing, *PEA* serial telemetry, including *PEA* memory dump telemetry, is extracted from telemetry files, converted to standard formats, and output in the *PEA* telemetry files. Image raw data are output in `ACAIMG_TU` files. Telemetry for each image is assigned a time tag in Terrestial Time (TT).

The data extractor identification and version number, shall be included in the output FITS file header as the text value associated with the `CREATOR` keyword. The name of the input strip file, the strip file template, and the level 0 calibration template shall be provided in the form of `HISTORY` records in the configuration control component of the output FITS file header.

No other processing is performed.

Tables 2.3.1, 2.3.1, and 2.3.1 list the contents of the *PEA* telemetry (raw) data file principal HDU binary table. This HDU has the `EXTNAME` keyword set to `ACADATA` and `CONTENT` keyword set to `ACAIMG_TU`. The format and contents of the aspect image data stream, along with the correspondences between *PEA* serial digital telemetry identifiers and FITS `TTYPE` keywords are provided in Appendix D.

Table 2.3: Level 0 *PEA* telemetry HDU contents (Raw 4×4 images)

#	TTYPE	TUNIT	TFORM	TLMIN	TLMAX	Comment
1	TIME	s	1D			Time-tag of the data record
2	MRF		1J			Major frame roll ctr value
3	MJF		1J			Major frame ctr value
4	MNF		1J			Minor frame ctr value
5	END_INTEG_TIME	s	1D			End integration time
6	INTEG		1I			Integration time
7	QUALITY		1J			Data quality flag; 0 - good, 1 - bad
8	GLBSTAT		1B	0	255	Global status
9	COMMCNT		1B	0	63	Command count
10	COMMPROG		1B	0	63	Command progress
11	IMGFID1		1B	0	1	Image type
12	IMGNUM1		1B	0	7	Image number (of 8)
13	IMGFUNC1		1B	0	3	Image function
14	IMGSTAT		1B	0	255	Image status
15	IMGROW0	pixel	1I	-511	512	Row of lowerleft image pixel
16	IMGCOL0	pixel	1I	-511	512	Col of lowerleft image pixel
17	IMGSCALE		1I	0	1023	Pixel scaling factor
18	BGDAVG		1I			Average background
19	IMGRAW		16I			Aspect camera image

Table 2.4: Level 0 *PEA* telemetry HDU contents (Raw 6 × 6 images)

#	TTYPE	TUNIT	TFORM	TLMIN	TLMAX	Comment
1	TIME	s	1D			Time-tag of the data record
2	MRF		1J			Major frame roll ctr value
3	MJF		1J			Major frame ctr value
4	MNF		1J			Minor frame ctr value
5	END_INTEG_TIME	s	1D			End integration time
6	INTEG		1I			Integration time
7	QUALITY		1J			Data quality flag; 0 - good, 1 - bad
8	GLBSTAT		1B	0	255	Global status
9	COMMCNT		1B	0	63	Command count
10	COMMPROG		1B	0	63	Command progress
11	IMGFID1		1B	0	1	Image type
12	IMGNUM1		1B	0	7	Image number (of 8)
13	IMGFUNC1		1B	0	3	Image function
14	IMGSTAT		1B	0	255	Image status
15	IMGROW0		1I	-511	512	Row of lowerleft image pixel
16	IMGCOL0		1I	-511	512	Col of lowerleft image pixel
17	IMGSCALE		1I	0	1023	Pixel scaling factor
18	BGDAVG		1I			Average background
19	IMGRAW		36I			Aspect camera image
20	BGDRMS		1I			Background RMS
21	TEMPCCD		1B			Temp 1 - CCD
22	TEMPHOUS		1B			Temp 2 - AC housing
23	TEMPPRIM		1B			Temp 3 - lens cell
24	TEMPSEC		1B			Temp 4 - secondary mirror
25	BGDSTAT		1B	0	255	Bgd pixel status
26	IMGFID2		1B	0	1	Image type

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#	TTYPE	TUNIT	TFORM	TLMIN	TLMAX	Comment
27	IMGNUM2		1B	0	7	Image number (of 8)
28	IMGFUNC2		1B	0	3	Image function

Table 2.5: Level 0 *PEA* telemetry HDU contents (Raw 8 × 8 images)

#	TTYPE	TUNIT	TFORM	TLMIN	TLMAX	Comment
1	TIME	s	1D			Time-tag of the data record
2	MRF		1J			Major frame roll ctr value
3	MJF		1J			Major frame ctr value
4	MNF		1J			Minor frame ctr value
5	END_INTEG_TIME	s	1D			End integration time
6	INTEG		1I			Integration time
7	QUALITY		1J			Data quality flag; 0 - good, 1 - bad
8	GLBSTAT		1B	0	255	Global status
9	COMMCNT		1B	0	63	Command count
10	COMMPROG		1B	0	63	Command progress
11	IMGFID1		1B	0	1	Image type
12	IMGNUM1		1B	0	7	Image number (of 8)
13	IMGFUNC1		1B	0	3	Image function
14	IMGSTAT		1B	0	255	Image status
15	IMGROW0	pixel	1I	-511	512	Row of lowerleft image pixel
16	IMGCOL0	pixel	1I	-511	512	Col of lowerleft image pixel
17	IMGSCALE		1I	0	1023	Pixel scaling factor
18	BGDAVG		1I			Average background
19	IMGRAW		64I			Aspect camera image
20	BGDRMS		1I			Bacgkround RMS
21	TEMPCCD		1B			Temp 1 - CCD
22	TEMPHOUS		1B			Temp 2 - AC housing
23	TEMPPRIM		1B			Temp 3 - lens cell
24	TEMPSEC		1B			Temp 4 - secondary mirror
25	BGDSTAT		1B	0	255	Bgd pixel status
26	IMGFID2		1B	0	1	Image type

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#	TTYPE	TUNIT	TFORM	TLMIN	TLMAX	Comment
27	IMGNUM2		1B	0	7	Image number (of 8)
28	IMGFUNC2		1B	0	3	Image function
29	IMGFID3		1B	0	1	Image type
30	IMGNUM3		1B	0	7	Image number (of 8)
31	IMGFUNC3		1B	0	3	Image function
32	IMGFID4		1B	0	1	Image type
33	IMGNUM4		1B	0	7	Image number (of 8)
34	IMGFUNC4		1B	0	3	Image function
35	HDR3TLM62		1B			Hdr 3 tlm. imgtype=6 word=2
36	HDR3TLM63		1B			Hdr 3 tlm. imgtype=6 word=3
37	HDR3TLM64		1B			Hdr 3 tlm. imgtype=6 word=4
38	HDR3TLM65		1B			Hdr 3 tlm. imgtype=6 word=5
39	HDR3TLM66		1B			Hdr 3 tlm. imgtype=6 word=6
40	HDR3TLM67		1B			Hdr 3 tlm. imgtype=6 word=7
41	HDR3TLM72		1B			Hdr 3 tlm. imgtype=7 word=2
42	HDR3TLM73		1B			Hdr 3 tlm. imgtype=7 word=3
43	HDR3TLM74		1B			Hdr 3 tlm. imgtype=7 word=4
44	HDR3TLM75		1B			Hdr 3 tlm. imgtype=7 word=5
45	HDR3TLM76		1B			Hdr 3 tlm. imgtype=7 word=6
46	HDR3TLM77		1B			Hdr 3 tlm. imgtype=7 word=7

2.4 *PEA* telemetry calibrated image files (`ACAIMG`)

The *PEA* telemetry calibrated image file contains one extension, a principal HDU binary table containing all *PEA* image serial digital telemetry.

A list of all keywords required in a *PEA* telemetry image file is shown in appendix B.

2.4.1 Principal HDU: *PEA* telemetry calibrated image data

During level 0 processing, *PEA* serial telemetry, including *PEA* memory dump telemetry, is extracted from telemetry files, converted to standard formats, and output in the *PEA* telemetry files. Image calibrated data are output in `ACAIMG` files. Telemetry for each image is assigned a time tag in Terrestial Time (TT).

The data extractor identification and version number, shall be included in the output FITS file header as the text value associated with the `CREATOR` keyword. The name of the input strip file, the strip file template, and the level 0 calibration template shall be provided in the form of `HISTORY` records in the configuration control component of the output FITS file header.

Telemetered quantities are calibrated according to the encodings specified in Appendix D.

Tables 2.4.1, 2.4.1, and 2.4.1 list the contents of the *PEA* telemetry calibrated data file principal HDU binary table. This HDU has the `EXTNAME` keyword set to `ACADATA` and `CONTENT` keyword set to `ACAIMG`. The format and contents of the aspect image data stream, along with the correspondences between *PEA* serial digital telemetry identifiers and FITS `TTYPE` keywords are provided in Appendix D.

Table 2.6: Level 0 *PEA* telemetry HDU contents (4×4 images)

#	TTYPE	TUNIT	TFORM	TLMIN	TLMAX	Comment
1	TIME	s	1D			Time-tag of the data record
2	MRF		1J			Major frame roll ctr value
3	MJF		1J			Major frame ctr value
4	MNF		1J			Minor frame ctr value
5	END_INTEG_TIME	s	1D			End integration time
6	INTEG	s	1E			Integration time
7	QUALITY		1J			Data quality flag; 0 - good, 1 - bad
8	GLBSTAT		1B	0	255	Global status
9	COMMCNT		1B	0	63	Command count
10	COMMPROG		1B	0	63	Command progress
11	IMGFID1		1B	0	1	Image type
12	IMGNUM1		1B	0	7	Image number (of 8)
13	IMGFUNC1		1B	0	3	Image function
14	IMGSTAT		1B	0	255	Image status
15	IMGROW0	pixel	1I	-511	512	Row of lowerleft image pixel
16	IMGCOL0	pixel	1I	-511	512	Col of lowerleft image pixel
17	IMGSCALE		1I	0	1023	Pixel scaling factor
18	BGDAVG	count	1E			Average background
19	IMGRAW	count	16E			Aspect camera image

Table 2.7: Level 0 *PEA* telemetry HDU contents (6×6 images)

#	TTYPE	TUNIT	TFORM	TLMIN	TLMAX	Comment
1	TIME	s	1D			Time-tag of the data record
2	MRF		1J			Major frame roll ctr value
3	MJF		1J			Major frame ctr value
4	MNF		1J			Minor frame ctr value
5	END_INTEG_TIME	s	1D			End integration time
6	INTEG	s	1E			Integration time
7	QUALITY		1J			Data quality flag; 0 - good, 1 - bad
8	GLBSTAT		1B	0	255	Global status
9	COMMCNT		1B	0	63	Command count
10	COMMPROG		1B	0	63	Command progress
11	IMGFID1		1B	0	1	Image type
12	IMGNUM1		1B	0	7	Image number (of 8)
13	IMGFUNC1		1B	0	3	Image function
14	IMGSTAT		1B	0	255	Image status
15	IMGROW0		1I	-511	512	Row of lowerleft image pixel
16	IMGCOL0		1I	-511	512	Col of lowerleft image pixel
17	IMGSCALE		1I	0	1023	Pixel scaling factor
18	BGDAVG	count	1E			Average background
19	IMGRAW	count	36E			Aspect camera image
20	BGDRMS	count	1E			Bacgkround RMS
21	TEMPCCD	K	1E			Temp 1 - CCD
22	TEMPHOUS	K	1E			Temp 2 - AC housing
23	TEMPPRIM	K	1E			Temp 3 - lens cell
24	TEMPSEC	K	1E			Temp 4 - secondary mirror
25	BGDSTAT		1B	0	255	Bgd pixel status
26	IMGFID2		1B	0	1	Image type

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#	TTYPE	TUNIT	TFORM	TLMIN	TLMAX	Comment
27	IMGNUM2		1B	0	7	Image number (of 8)
28	IMGFUNC2		1B	0	3	Image function

Table 2.8: Level 0 *PEA* telemetry HDU contents (8×8 images)

#	TTYPE	TUNIT	TFORM	TLMIN	TLMAX	Comment
1	TIME	s	1D			Time-tag of the data record
2	MRF		1J			Major frame roll ctr value
3	MJF		1J			Major frame ctr value
4	MNF		1J			Minor frame ctr value
5	END_INTEG_TIME	s	1D			End integration time
6	INTEG	s	1E			Integration time
7	QUALITY		1J			Data quality flag; 0 - good, 1 - bad
8	GLBSTAT		1B	0	255	Global status
9	COMMCNT		1B	0	63	Command count
10	COMMPROG		1B	0	63	Command progress
11	IMGFID1		1B	0	1	Image type
12	IMGNUM1		1B	0	7	Image number (of 8)
13	IMGFUNC1		1B	0	3	Image function
14	IMGSTAT		1B	0	255	Image status
15	IMGROW0	pixel	1I	-511	512	Row of lowerleft image pixel
16	IMGCOL0	pixel	1I	-511	512	Col of lowerleft image pixel
17	IMGSCALE		1I	0	1023	Pixel scaling factor
18	BGDAVG	count	1E			Average background
19	IMGRAW	count	64E			Aspect camera image
20	BGDRMS	count	1E			Bacgkround RMS
21	TEMPCCD	K	1E			Temp 1 - CCD
22	TEMPHOUS	K	1E			Temp 2 - AC housing
23	TEMPPRIM	K	1E			Temp 3 - lens cell
24	TEMPSEC	K	1E			Temp 4 - secondary mirror
25	BGDSTAT		1B	0	255	Bgd pixel status
26	IMGFID2		1B	0	1	Image type

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#	TTYPE	TUNIT	TFORM	TLMIN	TLMAX	Comment
27	IMGNUM2		1B	0	7	Image number (of 8)
28	IMGFUNC2		1B	0	3	Image function
29	IMGFID3		1B	0	1	Image type
30	IMGNUM3		1B	0	7	Image number (of 8)
31	IMGFUNC3		1B	0	3	Image function
32	IMGFID4		1B	0	1	Image type
33	IMGNUM4		1B	0	7	Image number (of 8)
34	IMGFUNC4		1B	0	3	Image function
35	HDR3TLM62		1B			Hdr 3 tlm. imgtype=6 word=2
36	HDR3TLM63		1B			Hdr 3 tlm. imgtype=6 word=3
37	HDR3TLM64		1B			Hdr 3 tlm. imgtype=6 word=4
38	HDR3TLM65		1B			Hdr 3 tlm. imgtype=6 word=5
39	HDR3TLM66		1B			Hdr 3 tlm. imgtype=6 word=6
40	HDR3TLM67		1B			Hdr 3 tlm. imgtype=6 word=7
41	HDR3TLM72		1B			Hdr 3 tlm. imgtype=7 word=2
42	HDR3TLM73		1B			Hdr 3 tlm. imgtype=7 word=3
43	HDR3TLM74		1B			Hdr 3 tlm. imgtype=7 word=4
44	HDR3TLM75		1B			Hdr 3 tlm. imgtype=7 word=5
45	HDR3TLM76		1B			Hdr 3 tlm. imgtype=7 word=6
46	HDR3TLM77		1B			Hdr 3 tlm. imgtype=7 word=7

2.5 *PEA* memory dump data files (MEMDUMP)

The *PEA* memory dump data file contains one extension, a principal HDU binary table containing *PEA* memory dump telemetry included in the *PEA* serial digital telemetry data stream.

A list of all keywords required in an *PEA* memory dump data file is shown in appendix C.

2.5.1 Principal HDU: *PEA* memory dump

During level 0 processing, *PEA* memory dump telemetry is decoded from telemetry files, converted to standard formats, and output in the *PEA* memory dump data file. Telemetry from each major frame is assigned a time tag in Terrestial Time (TT).

The data extractor identification and version number shall be included in the output FITS file header as the text value associated with the `CREATOR` keyword. The name of the input strip file, the strip file template, and the level 0 calibration template shall be provided in the form of `HISTORY` records in the configuration control component of the output FITS file header.

No other processing is performed.

Table 2.5.1 lists the contents of the *PEA* memory dump data file principal HDU binary table. This HDU has the `EXTNAME` keyword set to 'MEMDUMP' and `CONTENT` keyword set to `ACAMEM`.

Table 2.9: Level 0 *PEA* telemetry HDU contents (memory dump)

#	TTYPE	TUNIT	TFORM	TLMIN	TLMAX	Comment
1	TIME	s	1D			Time-tag of the data record
2	MRF		1J			Major frame roll ctr value
3	MJF		1J			Major frame ctr value
4	MNF		1J			Minor frame ctr value
5	ADDRESS		1J			Start address
6	MEMORY		24B			24 bytes of memory data
7	CHECKSUM		1I			Checksum

Table 2.10: ACA image data size and frequency

Content	Image size (pixels)	Record size (bytes)	Period (s)	Data rate bytes/s
ACAIMG	4	117	1.025	114.1
ACAIMG	6	221	2.050	107.8
ACAIMG	8	351	4.100	85.6
ACAIMG_TU	4	81	1.025	79.0
ACAIMG_TU	6	131	2.050	63.9
ACAIMG_TU	8	205	4.100	50.0

2.6 Volume, Size, and Frequency Estimates

The data rate for each of the image file types is listed in Table 2.10. This gives the rate for one of the eight ACA image slots.

Appendix A

List of all keywords in a *PEA* telemetry calibrated data file

The following sections list the primary and principal HDU header keywords for each file format. The values of certain keywords in these files need modification as follows:

- The double quotes around PCAD in INSTRUME should be removed
- All dates should conform to the standard described in ASC-FITS V1.3.
- ASCDSVER keyword, containing the current version of ASCDS, should be added
- Values of EXTNAME, HDUCLASS, HDUCLAS1, HDUCLAS2, HDUCLAS3 should be taken from Tables 2.1 and 2.2, instead of the values shown in the files
- ASC-FITS version (HDUDOC) should be 1.3.
- CREATOR should be set to the name of the aspect image data extractor

A.1 Primary header keywords (*PEA* telemetry) (4×4 images)

```
SIMPLE  =                    T / file does conform to FITS standard
BITPIX  =                   32 / number of bits per data pixel
NAXIS   =                    0 / number of data axes
EXTEND  =                    T / FITS dataset may contain extensions
COMMENT   FITS (Flexible Image Transport System) format defined in Astronomy and
COMMENT   Astrophysics Supplement Series v44/p363, v44/p371, v73/p359, v73/p365.
COMMENT   Contact the NASA Science Office of Standards and Technology for the
COMMENT   FITS Definition document #100 and other FITS information.
COMMENT
COMMENT   ########## Configuration control keywords ##########
COMMENT
ORIGIN  = 'ASC     '
CREATOR = 'xxx - Version 0.0'
CHECKSUM= '        '            / ASCII encoded HDU checksum
DATASUM = '        '            / Data unit checksum in ASCII
COMMENT
```

```
COMMENT   ########## Timing info keywords ##########
COMMENT
DATE    = '05/02/99'           / FITS file creation date (dd/mm/yy)
DATE-OBS= '        '           / TT, with clock correction if CLOCKAPP
DATE-END= '        '           / TT, with clock correction if CLOCKAPP
TIMESYS = 'TT      '           / AXAF time will be TT (Terrestrial Time)
MJDREF  = 5.0814000000000000E+04 / 1998-01-01T00:00:00 (TT) expressed in MJD
TIMEZERO= 0.0000000000000000E+00 / Cumulative clock correction
TIMEUNIT= 's       '
CLOCKAPP=                    T / Clock correction appllied
TSTART  = 0.0000000000000000E+00 / As in TIME column: raw S/C clock
TSTOP   = 0.0000000000000000E+00 /   add TIMEZERO and MJDREF for absolute TT
COMMENT
COMMENT   ########## Observation info keywords ##########
COMMENT
MISSION = 'AXAF    '           / Advanced X-Ray Astrophysics Facility
TELESCOP= 'AXAF    '           / Telescope used
INSTRUME= '"PCAD"  '
DETNAM  = 'ACA-P   '           / Detector
OBS_ID  = '        '           / Observation ID
END
```

A.2 Principal HDU (*PEA* telemetry) keywords (4×4 images)

```
XTENSION= 'BINTABLE'           / binary table extension
BITPIX  =                    8 / 8-bit bytes
NAXIS   =                    2 / 2-dimensional binary table
NAXIS1  =                   81 / width of table in bytes
NAXIS2  =                    1 / number of rows in table
PCOUNT  =                    0 / size of special data area
GCOUNT  =                    1 / one data group (required keyword)
TFIELDS =                   19 / number of fields in each row
TTYPE1  = 'time    '           / Time-tag of the data record
TFORM1  = '1D      '           / data format of field: 8-byte DOUBLE
TUNIT1  = 's       '           / physical unit of field
TTYPE2  = 'mrf     '           / Major frame roll ctr value
TFORM2  = '1J      '           / data format of field: 4-byte INTEGER
TTYPE3  = 'mjf     '           / Major frame ctr value
TFORM3  = '1J      '           / data format of field: 4-byte INTEGER
TTYPE4  = 'mnf     '           / Minor frame ctr value
TFORM4  = '1J      '           / data format of field: 4-byte INTEGER
TTYPE5  = 'end_integ_time'     / end integration time
TFORM5  = '1D      '           / data format of field: 8-byte DOUBLE
TUNIT5  = 's       '           / physical unit of field
TTYPE6  = 'integ   '           / integration time
TFORM6  = '1I      '           / data format of field: 2-byte INTEGER
TTYPE7  = 'quality '           / Data quality flag; 0 - good, 1 - bad
TFORM7  = '1J      '           / data format of field: 4-byte INTEGER
TTYPE8  = 'glbstat '           / global status
TFORM8  = '1B      '           / data format of field: BYTE
TTYPE9  = 'commcnt '           / command count
TFORM9  = '1B      '           / data format of field: BYTE
TTYPE10 = 'commprog'           / command progress
TFORM10 = '1B      '           / data format of field: BYTE
TTYPE11 = 'imgfid1 '           / image type
TFORM11 = '1B      '           / data format of field: BYTE
TTYPE12 = 'imgnum1 '           / image number (of 8)
TFORM12 = '1B      '           / data format of field: BYTE
TTYPE13 = 'imgfunc1'           / image function
TFORM13 = '1B      '           / data format of field: BYTE
TTYPE14 = 'imgstat '           / image status
TFORM14 = '1B      '           / data format of field: BYTE
TTYPE15 = 'imgrow0 '           / row of lowerleft image pixel
TFORM15 = '1I      '           / data format of field: 2-byte INTEGER
TUNIT15 = 'pixel   '           / physical unit of field
TTYPE16 = 'imgcol0 '           / col of lowerleft image pixel
TFORM16 = '1I      '           / data format of field: 2-byte INTEGER
TUNIT16 = 'pixel   '           / physical unit of field
TTYPE17 = 'imgscale'           / pixel scaling factor
```

```
TFORM17 = '1I      '           / data format of field: 2-byte INTEGER
TTYPE18 = 'bgdavg  '           / average background
TFORM18 = '1I      '           / data format of field: 2-byte INTEGER
TTYPE19 = 'imgraw  '           / aspect camera image
TFORM19 = '16I     '           / data format of field: 2-byte INTEGER
EXTNAME = 'ACA_TU_IMG4'        / name of this binary table extension
TDIM19  = '(4,4)   '           / size of the multidimensional array
COMMENT
COMMENT   ########## Configuration control keywords ##########
COMMENT
ORIGIN  = 'ASC     '
CREATOR = 'xxx - Version 0.0'
REVISION=                    0 / Processing system revision number
CHECKSUM= '        '           / ASCII encoded HDU checksum
DATASUM = '        '           / Data unit checksum in ASCII
CONTENT = '        '           / What data product
HDUNAME = '        '           /
HDUSPEC = '        '           /
HDUDOC  = 'ASC-FITS-1.1'       / ASC FITS Designers Guide
HDUVERS = '1.0.0   '           /
HDUCLASS= 'ASC     '
HDUCLAS1= '        '           /
HDUCLAS2= '        '           /
LONGSTRN= 'OGIP 1.0'           / The OGIP long string convention may be used.
COMMENT
COMMENT   ########## Timing info keywords ##########
COMMENT
DATE    = '05/02/99'           / FITS file creation date (dd/mm/yy)
DATE-OBS= '        '           / TT, with clock correction if CLOCKAPP
DATE-END= '        '           / TT, with clock correction if CLOCKAPP
TIMESYS = 'TT      '           / AXAF time will be TT (Terrestrial Time)
MJDREF  = 5.0814000000000000E+04 / 1998-01-01T00:00:00 (TT) expressed in MJD
TIMEZERO= 0.0000000000000000E+00 / Cumulative clock correction
TIMEUNIT= 's       '
CLOCKAPP=                    T / Clock correction appllied
TIERRELA= 1.0000000000000001E-09 / Short-term clock stability
TIERABSO= 1.0000000000000000E-04 / Absolute precision of clock correction
TIMVERSN= 'ASC-FITS-1.1'       / AXAF FITS design document
TSTART  = 0.0000000000000000E+00 / As in TIME column: raw S/C clock
TSTOP   = 0.0000000000000000E+00 /   add TIMEZERO and MJDREF for absolute TT
TIMEPIXR= 0.0000000000000000E+00 /
TIMEDEL = 0.0000000000000000E+00 / Time resolution of data ( in seconds )
COMMENT
COMMENT   ########## Observation info keywords ##########
COMMENT
MISSION = 'AXAF    '           / Advanced X-Ray Astrophysics Facility
TELESCOP= 'AXAF    '           / Telescope used
INSTRUME= 'PCAD    '
```

```
DETNAM  = 'ACA-P   '           / Detector
GRATING = 'NONE    '           / HETG, LETG, or NONE
OBJECT  = '        '           / Source name
TITLE   = '        '           / Title of Observaton
OBSERVER= '        '           / Observer or PI
OBS_ID  = '        '           / Observation ID
EQUINOX = 2.0000000000000000E+03 / J2000.0
RADECSYS= 'ICRS    '           / Julian coordinate reference frame
DATACLAS= 'OBSERVED'           / default is OBSERVED
ONTIME  = 0.0000000000000000E+00 / Ontime in seconds
LIVETIME= 0.0000000000000000E+00 / Livetime in seconds
EXPOSURE= 0.0000000000000000E+00
DTCOR   = 0.0000000000000000E+00
COMMENT
COMMENT   ########## Additional Principle Header keywords ##########
COMMENT
END
```

A.3 Primary header keywords (*PEA* telemetry) (6×6 images)

```
SIMPLE  =                    T / file does conform to FITS standard
BITPIX  =                   32 / number of bits per data pixel
NAXIS   =                    0 / number of data axes
EXTEND  =                    T / FITS dataset may contain extensions
COMMENT   FITS (Flexible Image Transport System) format defined in Astronomy and
COMMENT   Astrophysics Supplement Series v44/p363, v44/p371, v73/p359, v73/p365.
COMMENT   Contact the NASA Science Office of Standards and Technology for the
COMMENT   FITS Definition document #100 and other FITS information.
COMMENT
COMMENT   ########## Configuration control keywords ##########
COMMENT
ORIGIN  = 'ASC     '
CREATOR = 'xxx - Version 0.0'
CHECKSUM= '        '           / ASCII encoded HDU checksum
DATASUM = '        '           / Data unit checksum in ASCII
COMMENT
COMMENT   ########## Timing info keywords ##########
COMMENT
DATE    = '05/02/99'           / FITS file creation date (dd/mm/yy)
DATE-OBS= '        '           / TT, with clock correction if CLOCKAPP
DATE-END= '        '           / TT, with clock correction if CLOCKAPP
TIMESYS = 'TT      '           / AXAF time will be TT (Terrestrial Time)
MJDREF  = 5.0814000000000000E+04 / 1998-01-01T00:00:00 (TT) expressed in MJD
TIMEZERO= 0.0000000000000000E+00 / Cumulative clock correction
TIMEUNIT= 's       '
CLOCKAPP=                    T / Clock correction appllied
TSTART  = 0.0000000000000000E+00 / As in TIME column: raw S/C clock
TSTOP   = 0.0000000000000000E+00 /   add TIMEZERO and MJDREF for absolute TT
COMMENT
COMMENT   ########## Observation info keywords ##########
COMMENT
MISSION = 'AXAF    '           / Advanced X-Ray Astrophysics Facility
TELESCOP= 'AXAF    '           / Telescope used
INSTRUME= '"PCAD"  '
DETNAM  = 'ACA-P   '           / Detector
OBS_ID  = '        '           / Observation ID
END
```

A.4 Principal HDU (*PEA* telemetry) keywords (6×6 images)

```
XTENSION= 'BINTABLE'           / binary table extension
BITPIX  =                    8 / 8-bit bytes
NAXIS   =                    2 / 2-dimensional binary table
NAXIS1  =                  131 / width of table in bytes
NAXIS2  =                    1 / number of rows in table
PCOUNT  =                    0 / size of special data area
GCOUNT  =                    1 / one data group (required keyword)
TFIELDS =                   28 / number of fields in each row
TTYPE1  = 'time    '           / Time-tag of the data record
TFORM1  = '1D      '           / data format of field: 8-byte DOUBLE
TUNIT1  = 's       '           / physical unit of field
TTYPE2  = 'mrf     '           / Major frame roll ctr value
TFORM2  = '1J      '           / data format of field: 4-byte INTEGER
TTYPE3  = 'mjf     '           / Major frame ctr value
TFORM3  = '1J      '           / data format of field: 4-byte INTEGER
TTYPE4  = 'mnf     '           / Minor frame ctr value
TFORM4  = '1J      '           / data format of field: 4-byte INTEGER
TTYPE5  = 'end_integ_time'     / end integration time
TFORM5  = '1D      '           / data format of field: 8-byte DOUBLE
TUNIT5  = 's       '           / physical unit of field
TTYPE6  = 'integ   '           / integration time
TFORM6  = '1I      '           / data format of field: 2-byte INTEGER
TTYPE7  = 'quality '           / Data quality flag; 0 - good, 1 - bad
TFORM7  = '1J      '           / data format of field: 4-byte INTEGER
TTYPE8  = 'glbstat '           / global status
TFORM8  = '1B      '           / data format of field: BYTE
TTYPE9  = 'commcnt '           / command count
TFORM9  = '1B      '           / data format of field: BYTE
TTYPE10 = 'commprog'           / command progress
TFORM10 = '1B      '           / data format of field: BYTE
TTYPE11 = 'imgfid1 '           / image type
TFORM11 = '1B      '           / data format of field: BYTE
TTYPE12 = 'imgnum1 '           / image number (of 8)
TFORM12 = '1B      '           / data format of field: BYTE
TTYPE13 = 'imgfunc1'           / image function
TFORM13 = '1B      '           / data format of field: BYTE
TTYPE14 = 'imgstat '           / image status
TFORM14 = '1B      '           / data format of field: BYTE
TTYPE15 = 'imgrow0 '           / row of lowerleft image pixel
TFORM15 = '1I      '           / data format of field: 2-byte INTEGER
TTYPE16 = 'imgcol0 '           / col of lowerleft image pixel
TFORM16 = '1I      '           / data format of field: 2-byte INTEGER
TTYPE17 = 'imgscale'           / pixel scaling factor
TFORM17 = '1I      '           / data format of field: 2-byte INTEGER
TTYPE18 = 'bgdavg  '           / average background
```

```
TFORM18 = '1I      '           / data format of field: 2-byte INTEGER
TTYPE19 = 'imgraw  '           / aspect camera image
TFORM19 = '36I     '           / data format of field: 2-byte INTEGER
TTYPE20 = 'bgdrms  '           / background RMS
TFORM20 = '1I      '           / data format of field: 2-byte INTEGER
TTYPE21 = 'tempccd '           / temp 1 - CCD
TFORM21 = '1B      '           / data format of field: BYTE
TTYPE22 = 'temphous'           / temp 2 - AC housing
TFORM22 = '1B      '           / data format of field: BYTE
TTYPE23 = 'tempprim'           / temp 3 - lens cell
TFORM23 = '1B      '           / data format of field: BYTE
TTYPE24 = 'tempsec '           / temp 4 - secondary mirror
TFORM24 = '1B      '           / data format of field: BYTE
TTYPE25 = 'bgdstat '           / bgd pixel status
TFORM25 = '1B      '           / data format of field: BYTE
TTYPE26 = 'imgfid2 '           / image type
TFORM26 = '1B      '           / data format of field: BYTE
TTYPE27 = 'imgnum2 '           / image number (of 8)
TFORM27 = '1B      '           / data format of field: BYTE
TTYPE28 = 'imgfunc2'           / image function
TFORM28 = '1B      '           / data format of field: BYTE
EXTNAME = 'ACA_TU_IMG6'        / name of this binary table extension
TDIM19  = '(6,6)   '           / size of the multidimensional array
COMMENT
COMMENT   ########## Configuration control keywords ##########
COMMENT
ORIGIN  = 'ASC     '
CREATOR = 'xxx - Version 0.0'
REVISION=                    0 / Processing system revision number
CHECKSUM= '        '           / ASCII encoded HDU checksum
DATASUM = '        '           / Data unit checksum in ASCII
CONTENT = '        '           / What data product
HDUNAME = '        '           /
HDUSPEC = '        '           /
HDUDOC  = 'ASC-FITS-1.1'       / ASC FITS Designers Guide
HDUVERS = '1.0.0   '           /
HDUCLASS= 'ASC     '
HDUCLAS1= '        '           /
HDUCLAS2= '        '           /
LONGSTRN= 'OGIP 1.0'           / The OGIP long string convention may be used.
COMMENT
COMMENT   ########## Timing info keywords ##########
COMMENT
DATE    = '05/02/99'           / FITS file creation date (dd/mm/yy)
DATE-OBS= '        '           / TT, with clock correction if CLOCKAPP
DATE-END= '        '           / TT, with clock correction if CLOCKAPP
TIMESYS = 'TT      '           / AXAF time will be TT (Terrestrial Time)
MJDREF  = 5.0814000000000000E+04 / 1998-01-01T00:00:00 (TT) expressed in MJD
```

```
TIMEZERO= 0.0000000000000000E+00 / Cumulative clock correction
TIMEUNIT= 's       '
CLOCKAPP=                    T / Clock correction appllied
TIERRELA= 1.0000000000000001E-09 / Short-term clock stability
TIERABSO= 1.0000000000000000E-04 / Absolute precision of clock correction
TIMVERSN= 'ASC-FITS-1.1'       / AXAF FITS design document
TSTART  = 0.0000000000000000E+00 / As in TIME column: raw S/C clock
TSTOP   = 0.0000000000000000E+00 /   add TIMEZERO and MJDREF for absolute TT
TIMEPIXR= 0.0000000000000000E+00 /
TIMEDEL = 0.0000000000000000E+00 / Time resolution of data ( in seconds )
COMMENT
COMMENT   ########## Observation info keywords ##########
COMMENT
MISSION = 'AXAF    '           / Advanced X-Ray Astrophysics Facility
TELESCOP= 'AXAF    '           / Telescope used
INSTRUME= 'PCAD    '
DETNAM  = 'ACA-P   '           / Detector
GRATING = 'NONE    '           / HETG, LETG, or NONE
OBJECT  = '        '           / Source name
TITLE   = '        '           / Title of Observaton
OBSERVER= '        '           / Observer or PI
OBS_ID  = '        '           / Observation ID
EQUINOX = 2.0000000000000000E+03 / J2000.0
RADECSYS= 'ICRS    '           / Julian coordinate reference frame
DATACLAS= 'OBSERVED'           / default is OBSERVED
ONTIME  = 0.0000000000000000E+00 / Ontime in seconds
LIVETIME= 0.0000000000000000E+00 / Livetime in seconds
EXPOSURE= 0.0000000000000000E+00
DTCOR   = 0.0000000000000000E+00
COMMENT
COMMENT   ########## Additional Principle Header keywords ##########
COMMENT
END
```

A.5 Primary header keywords (*PEA* telemetry) (8×8 images)

```
SIMPLE  =                    T / file does conform to FITS standard
BITPIX  =                   32 / number of bits per data pixel
NAXIS   =                    0 / number of data axes
EXTEND  =                    T / FITS dataset may contain extensions
COMMENT   FITS (Flexible Image Transport System) format defined in Astronomy and
COMMENT   Astrophysics Supplement Series v44/p363, v44/p371, v73/p359, v73/p365.
COMMENT   Contact the NASA Science Office of Standards and Technology for the
COMMENT   FITS Definition document #100 and other FITS information.
COMMENT
COMMENT   ########## Configuration control keywords ##########
COMMENT
ORIGIN  = 'ASC     '
CREATOR = 'xxx - Version 0.0'
CHECKSUM= '        '           / ASCII encoded HDU checksum
DATASUM = '        '           / Data unit checksum in ASCII
COMMENT
COMMENT   ########## Timing info keywords ##########
COMMENT
DATE    = '05/02/99'           / FITS file creation date (dd/mm/yy)
DATE-OBS= '        '           / TT, with clock correction if CLOCKAPP
DATE-END= '        '           / TT, with clock correction if CLOCKAPP
TIMESYS = 'TT      '           / AXAF time will be TT (Terrestrial Time)
MJDREF  = 5.0814000000000000E+04 / 1998-01-01T00:00:00 (TT) expressed in MJD
TIMEZERO= 0.0000000000000000E+00 / Cumulative clock correction
TIMEUNIT= 's       '
CLOCKAPP=                    T / Clock correction appllied
TSTART  = 0.0000000000000000E+00 / As in TIME column: raw S/C clock
TSTOP   = 0.0000000000000000E+00 /   add TIMEZERO and MJDREF for absolute TT
COMMENT
COMMENT   ########## Observation info keywords ##########
COMMENT
MISSION = 'AXAF    '           / Advanced X-Ray Astrophysics Facility
TELESCOP= 'AXAF    '           / Telescope used
INSTRUME= '"PCAD"  '
DETNAM  = 'ACA-P   '           / Detector
OBS_ID  = '        '           / Observation ID
END
```

A.6 Principal HDU (*PEA* telemetry) keywords (8×8 images)

```
XTENSION= 'BINTABLE'           / binary table extension
BITPIX  =                    8 / 8-bit bytes
NAXIS   =                    2 / 2-dimensional binary table
NAXIS1  =                  205 / width of table in bytes
NAXIS2  =                    1 / number of rows in table
PCOUNT  =                    0 / size of special data area
GCOUNT  =                    1 / one data group (required keyword)
TFIELDS =                   46 / number of fields in each row
TTYPE1  = 'time    '           / Time-tag of the data record
TFORM1  = '1D      '           / data format of field: 8-byte DOUBLE
TUNIT1  = 's       '           / physical unit of field
TTYPE2  = 'mrf     '           / Major frame roll ctr value
TFORM2  = '1J      '           / data format of field: 4-byte INTEGER
TTYPE3  = 'mjf     '           / Major frame ctr value
TFORM3  = '1J      '           / data format of field: 4-byte INTEGER
TTYPE4  = 'mnf     '           / Minor frame ctr value
TFORM4  = '1J      '           / data format of field: 4-byte INTEGER
TTYPE5  = 'end_integ_time'     / end integration time
TFORM5  = '1D      '           / data format of field: 8-byte DOUBLE
TUNIT5  = 's       '           / physical unit of field
TTYPE6  = 'integ   '           / integration time
TFORM6  = '1I      '           / data format of field: 2-byte INTEGER
TTYPE7  = 'quality '           / Data quality flag; 0 - good, 1 - bad
TFORM7  = '1J      '           / data format of field: 4-byte INTEGER
TTYPE8  = 'glbstat '           / global status
TFORM8  = '1B      '           / data format of field: BYTE
TTYPE9  = 'commcnt '           / command count
TFORM9  = '1B      '           / data format of field: BYTE
TTYPE10 = 'commprog'           / command progress
TFORM10 = '1B      '           / data format of field: BYTE
TTYPE11 = 'imgfid1 '           / image type
TFORM11 = '1B      '           / data format of field: BYTE
TTYPE12 = 'imgnum1 '           / image number (of 8)
TFORM12 = '1B      '           / data format of field: BYTE
TTYPE13 = 'imgfunc1'           / image function
TFORM13 = '1B      '           / data format of field: BYTE
TTYPE14 = 'imgstat '           / image status
TFORM14 = '1B      '           / data format of field: BYTE
TTYPE15 = 'imgrow0 '           / row of lowerleft image pixel
TFORM15 = '1I      '           / data format of field: 2-byte INTEGER
TUNIT15 = 'pixel   '           / physical unit of field
TTYPE16 = 'imgcol0 '           / col of lowerleft image pixel
TFORM16 = '1I      '           / data format of field: 2-byte INTEGER
TUNIT16 = 'pixel   '           / physical unit of field
TTYPE17 = 'imgscale'           / pixel scaling factor
```

```
TFORM17 = '1I      '           / data format of field: 2-byte INTEGER
TTYPE18 = 'bgdavg  '           / average background
TFORM18 = '1I      '           / data format of field: 2-byte INTEGER
TTYPE19 = 'imgraw  '           / aspect camera image
TFORM19 = '64I     '           / data format of field: 2-byte INTEGER
TTYPE20 = 'bgdrms  '           / bacgkround RMS
TFORM20 = '1I      '           / data format of field: 2-byte INTEGER
TTYPE21 = 'tempccd '           / temp 1 - CCD
TFORM21 = '1B      '           / data format of field: BYTE
TTYPE22 = 'temphous'           / temp 2 - AC housing
TFORM22 = '1B      '           / data format of field: BYTE
TTYPE23 = 'tempprim'           / temp 3 - lens cell
TFORM23 = '1B      '           / data format of field: BYTE
TTYPE24 = 'tempsec '           / temp 4 - secondary mirror
TFORM24 = '1B      '           / data format of field: BYTE
TTYPE25 = 'bgdstat '           / bgd pixel status
TFORM25 = '1B      '           / data format of field: BYTE
TTYPE26 = 'imgfid2 '           / image type
TFORM26 = '1B      '           / data format of field: BYTE
TTYPE27 = 'imgnum2 '           / image number (of 8)
TFORM27 = '1B      '           / data format of field: BYTE
TTYPE28 = 'imgfunc2'           / image function
TFORM28 = '1B      '           / data format of field: BYTE
TTYPE29 = 'imgfid3 '           / image type
TFORM29 = '1B      '           / data format of field: BYTE
TTYPE30 = 'imgnum3 '           / image number (of 8)
TFORM30 = '1B      '           / data format of field: BYTE
TTYPE31 = 'imgfunc3'           / image function
TFORM31 = '1B      '           / data format of field: BYTE
TTYPE32 = 'imgfid4 '           / image type
TFORM32 = '1B      '           / data format of field: BYTE
TTYPE33 = 'imgnum4 '           / image number (of 8)
TFORM33 = '1B      '           / data format of field: BYTE
TTYPE34 = 'imgfunc4'           / image function
TFORM34 = '1B      '           / data format of field: BYTE
TTYPE35 = 'hdr3tlm62'          / Hdr 3 tlm. imgtype=6 word=2
TFORM35 = '1B      '           / data format of field: BYTE
TTYPE36 = 'hdr3tlm63'          / Hdr 3 tlm. imgtype=6 word=3
TFORM36 = '1B      '           / data format of field: BYTE
TTYPE37 = 'hdr3tlm64'          / Hdr 3 tlm. imgtype=6 word=4
TFORM37 = '1B      '           / data format of field: BYTE
TTYPE38 = 'hdr3tlm65'          / Hdr 3 tlm. imgtype=6 word=5
TFORM38 = '1B      '           / data format of field: BYTE
TTYPE39 = 'hdr3tlm66'          / Hdr 3 tlm. imgtype=6 word=6
TFORM39 = '1B      '           / data format of field: BYTE
TTYPE40 = 'hdr3tlm67'          / Hdr 3 tlm. imgtype=6 word=7
TFORM40 = '1B      '           / data format of field: BYTE
TTYPE41 = 'hdr3tlm72'          / Hdr 3 tlm. imgtype=7 word=2
```

```
TFORM41 = '1B      '           / data format of field: BYTE
TTYPE42 = 'hdr3tlm73'          / Hdr 3 tlm. imgtype=7 word=3
TFORM42 = '1B      '           / data format of field: BYTE
TTYPE43 = 'hdr3tlm74'          / Hdr 3 tlm. imgtype=7 word=4
TFORM43 = '1B      '           / data format of field: BYTE
TTYPE44 = 'hdr3tlm75'          / Hdr 3 tlm. imgtype=7 word=5
TFORM44 = '1B      '           / data format of field: BYTE
TTYPE45 = 'hdr3tlm76'          / Hdr 3 tlm. imgtype=7 word=6
TFORM45 = '1B      '           / data format of field: BYTE
TTYPE46 = 'hdr3tlm77'          / Hdr 3 tlm. imgtype=7 word=7
TFORM46 = '1B      '           / data format of field: BYTE
EXTNAME = 'ACA_TU_IMG8'        / name of this binary table extension
TDIM19  = '(8,8)   '           / size of the multidimensional array
COMMENT
COMMENT   ########## Configuration control keywords ##########
COMMENT
ORIGIN  = 'ASC     '
CREATOR = 'xxx - Version 0.0'
REVISION=                    0 / Processing system revision number
CHECKSUM= '        '           / ASCII encoded HDU checksum
DATASUM = '        '           / Data unit checksum in ASCII
CONTENT = '        '           / What data product
HDUNAME = '        '           /
HDUSPEC = '        '           /
HDUDOC  = 'ASC-FITS-1.1'       / ASC FITS Designers Guide
HDUVERS = '1.0.0   '           /
HDUCLASS= 'ASC     '
HDUCLAS1= '        '           /
HDUCLAS2= '        '           /
LONGSTRN= 'OGIP 1.0'           / The OGIP long string convention may be used.
COMMENT
COMMENT   ########## Timing info keywords ##########
COMMENT
DATE    = '05/02/99'           / FITS file creation date (dd/mm/yy)
DATE-OBS= '        '           / TT, with clock correction if CLOCKAPP
DATE-END= '        '           / TT, with clock correction if CLOCKAPP
TIMESYS = 'TT      '           / AXAF time will be TT (Terrestrial Time)
MJDREF  = 5.0814000000000000E+04 / 1998-01-01T00:00:00 (TT) expressed in MJD
TIMEZERO= 0.0000000000000000E+00 / Cumulative clock correction
TIMEUNIT= 's       '
CLOCKAPP=                    T / Clock correction appllied
TIERRELA= 1.0000000000000001E-09 / Short-term clock stability
TIERABSO= 1.0000000000000000E-04 / Absolute precision of clock correction
TIMVERSN= 'ASC-FITS-1.1'       / AXAF FITS design document
TSTART  = 0.0000000000000000E+00 / As in TIME column: raw S/C clock
TSTOP   = 0.0000000000000000E+00 /   add TIMEZERO and MJDREF for absolute TT
TIMEPIXR= 0.0000000000000000E+00 /
TIMEDEL = 0.0000000000000000E+00 / Time resolution of data ( in seconds )
```

```
COMMENT
COMMENT   ########## Observation info keywords ##########
COMMENT
MISSION = 'AXAF    '           / Advanced X-Ray Astrophysics Facility
TELESCOP= 'AXAF    '           / Telescope used
INSTRUME= 'PCAD    '
DETNAM  = 'ACA-P   '           / Detector
GRATING = 'NONE    '           / HETG, LETG, or NONE
OBJECT  = '        '           / Source name
TITLE   = '        '           / Title of Observaton
OBSERVER= '        '           / Observer or PI
OBS_ID  = '        '           / Observation ID
EQUINOX = 2.0000000000000000E+03 / J2000.0
RADECSYS= 'ICRS    '           / Julian coordinate reference frame
DATACLAS= 'OBSERVED'           / default is OBSERVED
ONTIME  = 0.0000000000000000E+00 / Ontime in seconds
LIVETIME= 0.0000000000000000E+00 / Livetime in seconds
EXPOSURE= 0.0000000000000000E+00
DTCOR   = 0.0000000000000000E+00
COMMENT
COMMENT   ########## Additional Principle Header keywords ##########
COMMENT
END
```

Appendix B

List of all keywords in a *PEA* telemetry calibrated data file

B.1 Primary header keywords (*PEA* telemetry) (4×4 images)

```
SIMPLE  =                    T / file does conform to FITS standard
BITPIX  =                   32 / number of bits per data pixel
NAXIS   =                    0 / number of data axes
EXTEND  =                    T / FITS dataset may contain extensions
COMMENT   FITS (Flexible Image Transport System) format defined in Astronomy and
COMMENT   Astrophysics Supplement Series v44/p363, v44/p371, v73/p359, v73/p365.
COMMENT   Contact the NASA Science Office of Standards and Technology for the
COMMENT   FITS Definition document #100 and other FITS information.
COMMENT
COMMENT   ########## Configuration control keywords ##########
COMMENT
ORIGIN  = 'ASC     '
CREATOR = 'xxx - Version 0.0'
CHECKSUM= '        '             / ASCII encoded HDU checksum
DATASUM = '        '             / Data unit checksum in ASCII
COMMENT
COMMENT   ########## Timing info keywords ##########
COMMENT
DATE    = '05/02/99'             / FITS file creation date (dd/mm/yy)
DATE-OBS= '        '             / TT, with clock correction if CLOCKAPP
DATE-END= '        '             / TT, with clock correction if CLOCKAPP
TIMESYS = 'TT      '             / AXAF time will be TT (Terrestrial Time)
MJDREF  = 5.0814000000000000E+04 / 1998-01-01T00:00:00 (TT) expressed in MJD
TIMEZERO= 0.0000000000000000E+00 / Cumulative clock correction
TIMEUNIT= 's       '
CLOCKAPP=                    T / Clock correction appllied
TSTART  = 0.0000000000000000E+00 / As in TIME column: raw S/C clock
TSTOP   = 0.0000000000000000E+00 /   add TIMEZERO and MJDREF for absolute TT
COMMENT
COMMENT   ########## Observation info keywords ##########
```

```
COMMENT
MISSION = 'AXAF    '           / Advanced X-Ray Astrophysics Facility
TELESCOP= 'AXAF    '           / Telescope used
INSTRUME= '"PCAD"  '
DETNAM  = 'ACA-P   '           / Detector
OBS_ID  = '        '           / Observation ID
END
```

B.2 Principal HDU (*PEA* telemetry) keywords (4×4 images)

```
XTENSION= 'BINTABLE'           / binary table extension
BITPIX  =                    8 / 8-bit bytes
NAXIS   =                    2 / 2-dimensional binary table
NAXIS1  =                  117 / width of table in bytes
NAXIS2  =                    1 / number of rows in table
PCOUNT  =                    0 / size of special data area
GCOUNT  =                    1 / one data group (required keyword)
TFIELDS =                   19 / number of fields in each row
TTYPE1  = 'time    '           / Time-tag of the data record
TFORM1  = '1D      '           / data format of field: 8-byte DOUBLE
TUNIT1  = 's       '           / physical unit of field
TTYPE2  = 'mrf     '           / Major frame roll ctr value
TFORM2  = '1J      '           / data format of field: 4-byte INTEGER
TTYPE3  = 'mjf     '           / Major frame ctr value
TFORM3  = '1J      '           / data format of field: 4-byte INTEGER
TTYPE4  = 'mnf     '           / Minor frame ctr value
TFORM4  = '1J      '           / data format of field: 4-byte INTEGER
TTYPE5  = 'end_integ_time'     / end integration time
TFORM5  = '1D      '           / data format of field: 8-byte DOUBLE
TUNIT5  = 's       '           / physical unit of field
TTYPE6  = 'integ   '           / integration time
TFORM6  = '1E      '           / data format of field: 4-byte REAL
TUNIT6  = 's       '           / physical unit of field
TTYPE7  = 'quality '           / Data quality flag; 0 - good, 1 - bad
TFORM7  = '1J      '           / data format of field: 4-byte INTEGER
TTYPE8  = 'glbstat '           / global status
TFORM8  = '1B      '           / data format of field: BYTE
TTYPE9  = 'commcnt '           / command count
TFORM9  = '1B      '           / data format of field: BYTE
TTYPE10 = 'commprog'           / command progress
TFORM10 = '1B      '           / data format of field: BYTE
TTYPE11 = 'imgfid1 '           / image type
TFORM11 = '1B      '           / data format of field: BYTE
TTYPE12 = 'imgnum1 '           / image number (of 8)
TFORM12 = '1B      '           / data format of field: BYTE
TTYPE13 = 'imgfunc1'           / image function
TFORM13 = '1B      '           / data format of field: BYTE
TTYPE14 = 'imgstat '           / image status
TFORM14 = '1B      '           / data format of field: BYTE
TTYPE15 = 'imgrow0 '           / row of lowerleft image pixel
TFORM15 = '1I      '           / data format of field: 2-byte INTEGER
TUNIT15 = 'pixel   '           / physical unit of field
TTYPE16 = 'imgcol0 '           / col of lowerleft image pixel
TFORM16 = '1I      '           / data format of field: 2-byte INTEGER
TUNIT16 = 'pixel   '           / physical unit of field
```

```
TTYPE17 = 'imgscale'           / pixel scaling factor
TFORM17 = '1I      '           / data format of field: 2-byte INTEGER
TTYPE18 = 'bgdavg  '           / average background
TFORM18 = '1E      '           / data format of field: 4-byte REAL
TUNIT18 = 'count   '           / physical unit of field
TTYPE19 = 'imgraw  '           / aspect camera image
TFORM19 = '16E     '           / data format of field: 4-byte REAL
TUNIT19 = 'count   '           / physical unit of field
EXTNAME = 'ACA_IMG4'           / name of this binary table extension
TDIM19  = '(4,4)   '           / size of the multidimensional array
COMMENT
COMMENT   ########## Configuration control keywords ##########
COMMENT
ORIGIN  = 'ASC     '
CREATOR = 'xxx - Version 0.0'
REVISION=                    0 / Processing system revision number
CHECKSUM= '        '           / ASCII encoded HDU checksum
DATASUM = '        '           / Data unit checksum in ASCII
CONTENT = '        '           / What data product
HDUNAME = '        '           /
HDUSPEC = '        '           /
HDUDOC  = 'ASC-FITS-1.1'       / ASC FITS Designers Guide
HDUVERS = '1.0.0   '           /
HDUCLASS= 'ASC     '
HDUCLAS1= '        '           /
HDUCLAS2= '        '           /
LONGSTRN= 'OGIP 1.0'           / The OGIP long string convention may be used.
COMMENT
COMMENT   ########## Timing info keywords ##########
COMMENT
DATE    = '05/02/99'           / FITS file creation date (dd/mm/yy)
DATE-OBS= '        '           / TT, with clock correction if CLOCKAPP
DATE-END= '        '           / TT, with clock correction if CLOCKAPP
TIMESYS = 'TT      '           / AXAF time will be TT (Terrestrial Time)
MJDREF  = 5.0814000000000000E+04 / 1998-01-01T00:00:00 (TT) expressed in MJD
TIMEZERO= 0.0000000000000000E+00 / Cumulative clock correction
TIMEUNIT= 's       '
CLOCKAPP=                    T / Clock correction appllied
TIERRELA= 1.0000000000000001E-09 / Short-term clock stability
TIERABSO= 1.0000000000000000E-04 / Absolute precision of clock correction
TIMVERSN= 'ASC-FITS-1.1'       / AXAF FITS design document
TSTART  = 0.0000000000000000E+00 / As in TIME column: raw S/C clock
TSTOP   = 0.0000000000000000E+00 /   add TIMEZERO and MJDREF for absolute TT
TIMEPIXR= 0.0000000000000000E+00 /
TIMEDEL = 0.0000000000000000E+00 / Time resolution of data ( in seconds )
COMMENT
COMMENT   ########## Observation info keywords ##########
COMMENT
```

```
MISSION = 'AXAF    '           / Advanced X-Ray Astrophysics Facility
TELESCOP= 'AXAF    '           / Telescope used
INSTRUME= 'PCAD    '
DETNAM  = 'ACA-P   '           / Detector
GRATING = 'NONE    '           / HETG, LETG, or NONE
OBJECT  = '        '           / Source name
TITLE   = '        '           / Title of Observaton
OBSERVER= '        '           / Observer or PI
OBS_ID  = '        '           / Observation ID
EQUINOX = 2.0000000000000000E+03 / J2000.0
RADECSYS= 'ICRS    '           / Julian coordinate reference frame
DATACLAS= 'OBSERVED'           / default is OBSERVED
ONTIME  = 0.0000000000000000E+00 / Ontime in seconds
LIVETIME= 0.0000000000000000E+00 / Livetime in seconds
EXPOSURE= 0.0000000000000000E+00
DTCOR   = 0.0000000000000000E+00
COMMENT
COMMENT   ########## Additional Principle Header keywords ##########
COMMENT
END
```

B.3 Primary header keywords (*PEA* telemetry) (6×6 images)

```
SIMPLE  =                    T / file does conform to FITS standard
BITPIX  =                   32 / number of bits per data pixel
NAXIS   =                    0 / number of data axes
EXTEND  =                    T / FITS dataset may contain extensions
COMMENT   FITS (Flexible Image Transport System) format defined in Astronomy and
COMMENT   Astrophysics Supplement Series v44/p363, v44/p371, v73/p359, v73/p365.
COMMENT   Contact the NASA Science Office of Standards and Technology for the
COMMENT   FITS Definition document #100 and other FITS information.
COMMENT
COMMENT   ########## Configuration control keywords ##########
COMMENT
ORIGIN  = 'ASC     '
CREATOR = 'xxx - Version 0.0'
CHECKSUM= '        '           / ASCII encoded HDU checksum
DATASUM = '        '           / Data unit checksum in ASCII
COMMENT
COMMENT   ########## Timing info keywords ##########
COMMENT
DATE    = '05/02/99'           / FITS file creation date (dd/mm/yy)
DATE-OBS= '        '           / TT, with clock correction if CLOCKAPP
DATE-END= '        '           / TT, with clock correction if CLOCKAPP
TIMESYS = 'TT      '           / AXAF time will be TT (Terrestrial Time)
MJDREF  = 5.0814000000000000E+04 / 1998-01-01T00:00:00 (TT) expressed in MJD
TIMEZERO= 0.0000000000000000E+00 / Cumulative clock correction
TIMEUNIT= 's       '
CLOCKAPP=                    T / Clock correction appllied
TSTART  = 0.0000000000000000E+00 / As in TIME column: raw S/C clock
TSTOP   = 0.0000000000000000E+00 /   add TIMEZERO and MJDREF for absolute TT
COMMENT
COMMENT   ########## Observation info keywords ##########
COMMENT
MISSION = 'AXAF    '           / Advanced X-Ray Astrophysics Facility
TELESCOP= 'AXAF    '           / Telescope used
INSTRUME= '"PCAD"  '
DETNAM  = 'ACA-P   '           / Detector
OBS_ID  = '        '           / Observation ID
END
```

B.4 Principal HDU (*PEA* telemetry) keywords (6×6 images)

```
XTENSION= 'BINTABLE'           / binary table extension
BITPIX  =                    8 / 8-bit bytes
NAXIS   =                    2 / 2-dimensional binary table
NAXIS1  =                  221 / width of table in bytes
NAXIS2  =                    1 / number of rows in table
PCOUNT  =                    0 / size of special data area
GCOUNT  =                    1 / one data group (required keyword)
TFIELDS =                   28 / number of fields in each row
TTYPE1  = 'time    '           / Time-tag of the data record
TFORM1  = '1D      '           / data format of field: 8-byte DOUBLE
TUNIT1  = 's       '           / physical unit of field
TTYPE2  = 'mrf     '           / Major frame roll ctr value
TFORM2  = '1J      '           / data format of field: 4-byte INTEGER
TTYPE3  = 'mjf     '           / Major frame ctr value
TFORM3  = '1J      '           / data format of field: 4-byte INTEGER
TTYPE4  = 'mnf     '           / Minor frame ctr value
TFORM4  = '1J      '           / data format of field: 4-byte INTEGER
TTYPE5  = 'end_integ_time'     / end integration time
TFORM5  = '1D      '           / data format of field: 8-byte DOUBLE
TUNIT5  = 's       '           / physical unit of field
TTYPE6  = 'integ   '           / integration time
TFORM6  = '1E      '           / data format of field: 4-byte REAL
TUNIT6  = 's       '           / physical unit of field
TTYPE7  = 'quality '           / Data quality flag; 0 - good, 1 - bad
TFORM7  = '1J      '           / data format of field: 4-byte INTEGER
TTYPE8  = 'glbstat '           / global status
TFORM8  = '1B      '           / data format of field: BYTE
TTYPE9  = 'commcnt '           / command count
TFORM9  = '1B      '           / data format of field: BYTE
TTYPE10 = 'commprog'           / command progress
TFORM10 = '1B      '           / data format of field: BYTE
TTYPE11 = 'imgfid1 '           / image type
TFORM11 = '1B      '           / data format of field: BYTE
TTYPE12 = 'imgnum1 '           / image number (of 8)
TFORM12 = '1B      '           / data format of field: BYTE
TTYPE13 = 'imgfunc1'           / image function
TFORM13 = '1B      '           / data format of field: BYTE
TTYPE14 = 'imgstat '           / image status
TFORM14 = '1B      '           / data format of field: BYTE
TTYPE15 = 'imgrow0 '           / row of lowerleft image pixel
TFORM15 = '1I      '           / data format of field: 2-byte INTEGER
TTYPE16 = 'imgcol0 '           / col of lowerleft image pixel
TFORM16 = '1I      '           / data format of field: 2-byte INTEGER
TTYPE17 = 'imgscale'           / pixel scaling factor
TFORM17 = '1I      '           / data format of field: 2-byte INTEGER
```

```
TTYPE18 = 'bgdavg  '           / average background
TFORM18 = '1E      '           / data format of field: 4-byte REAL
TUNIT18 = 'count   '           / physical unit of field
TTYPE19 = 'imgraw  '           / aspect camera image
TFORM19 = '36E     '           / data format of field: 4-byte REAL
TUNIT19 = 'count   '           / physical unit of field
TTYPE20 = 'bgdrms  '           / bacgkround RMS
TFORM20 = '1E      '           / data format of field: 4-byte REAL
TUNIT20 = 'count   '           / physical unit of field
TTYPE21 = 'tempccd '           / temp 1 - CCD
TFORM21 = '1E      '           / data format of field: 4-byte REAL
TUNIT21 = 'K       '           / physical unit of field
TTYPE22 = 'temphous'           / temp 2 - AC housing
TFORM22 = '1E      '           / data format of field: 4-byte REAL
TUNIT22 = 'K       '           / physical unit of field
TTYPE23 = 'tempprim'           / temp 3 - lens cell
TFORM23 = '1E      '           / data format of field: 4-byte REAL
TUNIT23 = 'K       '           / physical unit of field
TTYPE24 = 'tempsec '           / temp 4 - secondary mirror
TFORM24 = '1E      '           / data format of field: 4-byte REAL
TUNIT24 = 'K       '           / physical unit of field
TTYPE25 = 'bgdstat '           / bgd pixel status
TFORM25 = '1B      '           / data format of field: BYTE
TTYPE26 = 'imgfid2 '           / image type
TFORM26 = '1B      '           / data format of field: BYTE
TTYPE27 = 'imgnum2 '           / image number (of 8)
TFORM27 = '1B      '           / data format of field: BYTE
TTYPE28 = 'imgfunc2'           / image function
TFORM28 = '1B      '           / data format of field: BYTE
EXTNAME = 'ACA_IMG6'           / name of this binary table extension
TDIM19  = '(6,6)   '           / size of the multidimensional array
COMMENT
COMMENT   ########## Configuration control keywords ##########
COMMENT
ORIGIN  = 'ASC     '
CREATOR = 'xxx - Version 0.0'
REVISION=                    0 / Processing system revision number
CHECKSUM= '        '           / ASCII encoded HDU checksum
DATASUM = '        '           / Data unit checksum in ASCII
CONTENT = '        '           / What data product
HDUNAME = '        '           /
HDUSPEC = '        '           /
HDUDOC  = 'ASC-FITS-1.1'       / ASC FITS Designers Guide
HDUVERS = '1.0.0   '           /
HDUCLASS= 'ASC     '
HDUCLAS1= '        '           /
HDUCLAS2= '        '           /
LONGSTRN= 'OGIP 1.0'           / The OGIP long string convention may be used.
```

```
COMMENT
COMMENT   ########## Timing info keywords ##########
COMMENT
DATE    = '05/02/99'           / FITS file creation date (dd/mm/yy)
DATE-OBS= '        '           / TT, with clock correction if CLOCKAPP
DATE-END= '        '           / TT, with clock correction if CLOCKAPP
TIMESYS = 'TT      '           / AXAF time will be TT (Terrestrial Time)
MJDREF  = 5.0814000000000000E+04 / 1998-01-01T00:00:00 (TT) expressed in MJD
TIMEZERO= 0.0000000000000000E+00 / Cumulative clock correction
TIMEUNIT= 's       '
CLOCKAPP=                    T / Clock correction appllied
TIERRELA= 1.0000000000000001E-09 / Short-term clock stability
TIERABSO= 1.0000000000000000E-04 / Absolute precision of clock correction
TIMVERSN= 'ASC-FITS-1.1'       / AXAF FITS design document
TSTART  = 0.0000000000000000E+00 / As in TIME column: raw S/C clock
TSTOP   = 0.0000000000000000E+00 /   add TIMEZERO and MJDREF for absolute TT
TIMEPIXR= 0.0000000000000000E+00 /
TIMEDEL = 0.0000000000000000E+00 / Time resolution of data ( in seconds )
COMMENT
COMMENT   ########## Observation info keywords ##########
COMMENT
MISSION = 'AXAF    '           / Advanced X-Ray Astrophysics Facility
TELESCOP= 'AXAF    '           / Telescope used
INSTRUME= 'PCAD    '
DETNAM  = 'ACA-P   '           / Detector
GRATING = 'NONE    '           / HETG, LETG, or NONE
OBJECT  = '        '           / Source name
TITLE   = '        '           / Title of Observaton
OBSERVER= '        '           / Observer or PI
OBS_ID  = '        '           / Observation ID
EQUINOX = 2.0000000000000000E+03 / J2000.0
RADECSYS= 'ICRS    '           / Julian coordinate reference frame
DATACLAS= 'OBSERVED'           / default is OBSERVED
ONTIME  = 0.0000000000000000E+00 / Ontime in seconds
LIVETIME= 0.0000000000000000E+00 / Livetime in seconds
EXPOSURE= 0.0000000000000000E+00
DTCOR   = 0.0000000000000000E+00
COMMENT
COMMENT   ########## Additional Principle Header keywords ##########
COMMENT
END
```

B.5 Primary header keywords (*PEA* telemetry) (8×8 images)

```
SIMPLE  =                    T / file does conform to FITS standard
BITPIX  =                   32 / number of bits per data pixel
NAXIS   =                    0 / number of data axes
EXTEND  =                    T / FITS dataset may contain extensions
COMMENT   FITS (Flexible Image Transport System) format defined in Astronomy and
COMMENT   Astrophysics Supplement Series v44/p363, v44/p371, v73/p359, v73/p365.
COMMENT   Contact the NASA Science Office of Standards and Technology for the
COMMENT   FITS Definition document #100 and other FITS information.
COMMENT
COMMENT   ########## Configuration control keywords ##########
COMMENT
ORIGIN  = 'ASC     '
CREATOR = 'xxx - Version 0.0'
CHECKSUM= '        '           / ASCII encoded HDU checksum
DATASUM = '        '           / Data unit checksum in ASCII
COMMENT
COMMENT   ########## Timing info keywords ##########
COMMENT
DATE    = '05/02/99'           / FITS file creation date (dd/mm/yy)
DATE-OBS= '        '           / TT, with clock correction if CLOCKAPP
DATE-END= '        '           / TT, with clock correction if CLOCKAPP
TIMESYS = 'TT      '           / AXAF time will be TT (Terrestrial Time)
MJDREF  = 5.0814000000000000E+04 / 1998-01-01T00:00:00 (TT) expressed in MJD
TIMEZERO= 0.0000000000000000E+00 / Cumulative clock correction
TIMEUNIT= 's       '
CLOCKAPP=                    T / Clock correction appllied
TSTART  = 0.0000000000000000E+00 / As in TIME column: raw S/C clock
TSTOP   = 0.0000000000000000E+00 /   add TIMEZERO and MJDREF for absolute TT
COMMENT
COMMENT   ########## Observation info keywords ##########
COMMENT
MISSION = 'AXAF    '           / Advanced X-Ray Astrophysics Facility
TELESCOP= 'AXAF    '           / Telescope used
INSTRUME= '"PCAD"  '
DETNAM  = 'ACA-P   '           / Detector
OBS_ID  = '        '           / Observation ID
END
```

B.6 Principal HDU (*PEA* telemetry) keywords (8×8 images)

```
XTENSION= 'BINTABLE'           / binary table extension
BITPIX  =                    8 / 8-bit bytes
NAXIS   =                    2 / 2-dimensional binary table
NAXIS1  =                  351 / width of table in bytes
NAXIS2  =                    1 / number of rows in table
PCOUNT  =                    0 / size of special data area
GCOUNT  =                    1 / one data group (required keyword)
TFIELDS =                   46 / number of fields in each row
TTYPE1  = 'time    '           / Time-tag of the data record
TFORM1  = '1D      '           / data format of field: 8-byte DOUBLE
TUNIT1  = 's       '           / physical unit of field
TTYPE2  = 'mrf     '           / Major frame roll ctr value
TFORM2  = '1J      '           / data format of field: 4-byte INTEGER
TTYPE3  = 'mjf     '           / Major frame ctr value
TFORM3  = '1J      '           / data format of field: 4-byte INTEGER
TTYPE4  = 'mnf     '           / Minor frame ctr value
TFORM4  = '1J      '           / data format of field: 4-byte INTEGER
TTYPE5  = 'end_integ_time'     / end integration time
TFORM5  = '1D      '           / data format of field: 8-byte DOUBLE
TUNIT5  = 's       '           / physical unit of field
TTYPE6  = 'integ   '           / integration time
TFORM6  = '1E      '           / data format of field: 4-byte REAL
TUNIT6  = 's       '           / physical unit of field
TTYPE7  = 'quality '           / Data quality flag; 0 - good, 1 - bad
TFORM7  = '1J      '           / data format of field: 4-byte INTEGER
TTYPE8  = 'glbstat '           / global status
TFORM8  = '1B      '           / data format of field: BYTE
TTYPE9  = 'commcnt '           / command count
TFORM9  = '1B      '           / data format of field: BYTE
TTYPE10 = 'commprog'           / command progress
TFORM10 = '1B      '           / data format of field: BYTE
TTYPE11 = 'imgfid1 '           / image type
TFORM11 = '1B      '           / data format of field: BYTE
TTYPE12 = 'imgnum1 '           / image number (of 8)
TFORM12 = '1B      '           / data format of field: BYTE
TTYPE13 = 'imgfunc1'           / image function
TFORM13 = '1B      '           / data format of field: BYTE
TTYPE14 = 'imgstat '           / image status
TFORM14 = '1B      '           / data format of field: BYTE
TTYPE15 = 'imgrow0 '           / row of lowerleft image pixel
TFORM15 = '1I      '           / data format of field: 2-byte INTEGER
TUNIT15 = 'pixel   '           / physical unit of field
TTYPE16 = 'imgcol0 '           / col of lowerleft image pixel
TFORM16 = '1I      '           / data format of field: 2-byte INTEGER
TUNIT16 = 'pixel   '           / physical unit of field
```

```
TTYPE17 = 'imgscale'           / pixel scaling factor
TFORM17 = '1I      '           / data format of field: 2-byte INTEGER
TTYPE18 = 'bgdavg  '           / average background
TFORM18 = '1E      '           / data format of field: 4-byte REAL
TUNIT18 = 'count   '           / physical unit of field
TTYPE19 = 'imgraw  '           / aspect camera image
TFORM19 = '64E     '           / data format of field: 4-byte REAL
TUNIT19 = 'count   '           / physical unit of field
TTYPE20 = 'bgdrms  '           / bacgkround RMS
TFORM20 = '1E      '           / data format of field: 4-byte REAL
TUNIT20 = 'count   '           / physical unit of field
TTYPE21 = 'tempccd '           / temp 1 - CCD
TFORM21 = '1E      '           / data format of field: 4-byte REAL
TUNIT21 = 'K       '           / physical unit of field
TTYPE22 = 'temphous'           / temp 2 - AC housing
TFORM22 = '1E      '           / data format of field: 4-byte REAL
TUNIT22 = 'K       '           / physical unit of field
TTYPE23 = 'tempprim'           / temp 3 - lens cell
TFORM23 = '1E      '           / data format of field: 4-byte REAL
TUNIT23 = 'K       '           / physical unit of field
TTYPE24 = 'tempsec '           / temp 4 - secondary mirror
TFORM24 = '1E      '           / data format of field: 4-byte REAL
TUNIT24 = 'K       '           / physical unit of field
TTYPE25 = 'bgdstat '           / bgd pixel status
TFORM25 = '1B      '           / data format of field: BYTE
TTYPE26 = 'imgfid2 '           / image type
TFORM26 = '1B      '           / data format of field: BYTE
TTYPE27 = 'imgnum2 '           / image number (of 8)
TFORM27 = '1B      '           / data format of field: BYTE
TTYPE28 = 'imgfunc2'           / image function
TFORM28 = '1B      '           / data format of field: BYTE
TTYPE29 = 'imgfid3 '           / image type
TFORM29 = '1B      '           / data format of field: BYTE
TTYPE30 = 'imgnum3 '           / image number (of 8)
TFORM30 = '1B      '           / data format of field: BYTE
TTYPE31 = 'imgfunc3'           / image function
TFORM31 = '1B      '           / data format of field: BYTE
TTYPE32 = 'imgfid4 '           / image type
TFORM32 = '1B      '           / data format of field: BYTE
TTYPE33 = 'imgnum4 '           / image number (of 8)
TFORM33 = '1B      '           / data format of field: BYTE
TTYPE34 = 'imgfunc4'           / image function
TFORM34 = '1B      '           / data format of field: BYTE
TTYPE35 = 'hdr3tlm62'          / Hdr 3 tlm. imgtype=6 word=2
TFORM35 = '1B      '           / data format of field: BYTE
TTYPE36 = 'hdr3tlm63'          / Hdr 3 tlm. imgtype=6 word=3
TFORM36 = '1B      '           / data format of field: BYTE
TTYPE37 = 'hdr3tlm64'          / Hdr 3 tlm. imgtype=6 word=4
```

```
TFORM37 = '1B      '           / data format of field: BYTE
TTYPE38 = 'hdr3tlm65'          / Hdr 3 tlm. imgtype=6 word=5
TFORM38 = '1B      '           / data format of field: BYTE
TTYPE39 = 'hdr3tlm66'          / Hdr 3 tlm. imgtype=6 word=6
TFORM39 = '1B      '           / data format of field: BYTE
TTYPE40 = 'hdr3tlm67'          / Hdr 3 tlm. imgtype=6 word=7
TFORM40 = '1B      '           / data format of field: BYTE
TTYPE41 = 'hdr3tlm72'          / Hdr 3 tlm. imgtype=7 word=2
TFORM41 = '1B      '           / data format of field: BYTE
TTYPE42 = 'hdr3tlm73'          / Hdr 3 tlm. imgtype=7 word=3
TFORM42 = '1B      '           / data format of field: BYTE
TTYPE43 = 'hdr3tlm74'          / Hdr 3 tlm. imgtype=7 word=4
TFORM43 = '1B      '           / data format of field: BYTE
TTYPE44 = 'hdr3tlm75'          / Hdr 3 tlm. imgtype=7 word=5
TFORM44 = '1B      '           / data format of field: BYTE
TTYPE45 = 'hdr3tlm76'          / Hdr 3 tlm. imgtype=7 word=6
TFORM45 = '1B      '           / data format of field: BYTE
TTYPE46 = 'hdr3tlm77'          / Hdr 3 tlm. imgtype=7 word=7
TFORM46 = '1B      '           / data format of field: BYTE
EXTNAME = 'ACA_IMG8'           / name of this binary table extension
TDIM19  = '(8,8)   '           / size of the multidimensional array
COMMENT
COMMENT   ########## Configuration control keywords ##########
COMMENT
ORIGIN  = 'ASC     '
CREATOR = 'xxx - Version 0.0'
REVISION=                    0 / Processing system revision number
CHECKSUM= '        '           / ASCII encoded HDU checksum
DATASUM = '        '           / Data unit checksum in ASCII
CONTENT = '        '           / What data product
HDUNAME = '        '           /
HDUSPEC = '        '           /
HDUDOC  = 'ASC-FITS-1.1'       / ASC FITS Designers Guide
HDUVERS = '1.0.0   '           /
HDUCLASS= 'ASC     '
HDUCLAS1= '        '           /
HDUCLAS2= '        '           /
LONGSTRN= 'OGIP 1.0'           / The OGIP long string convention may be used.
COMMENT
COMMENT   ########## Timing info keywords ##########
COMMENT
DATE    = '05/02/99'           / FITS file creation date (dd/mm/yy)
DATE-OBS= '        '           / TT, with clock correction if CLOCKAPP
DATE-END= '        '           / TT, with clock correction if CLOCKAPP
TIMESYS = 'TT      '           / AXAF time will be TT (Terrestrial Time)
MJDREF  = 5.0814000000000000E+04 / 1998-01-01T00:00:00 (TT) expressed in MJD
TIMEZERO= 0.0000000000000000E+00 / Cumulative clock correction
TIMEUNIT= 's       '
```

```
CLOCKAPP=                    T / Clock correction appllied
TIERRELA= 1.0000000000000001E-09 / Short-term clock stability
TIERABSO= 1.0000000000000000E-04 / Absolute precision of clock correction
TIMVERSN= 'ASC-FITS-1.1'       / AXAF FITS design document
TSTART  = 0.0000000000000000E+00 / As in TIME column: raw S/C clock
TSTOP   = 0.0000000000000000E+00 /   add TIMEZERO and MJDREF for absolute TT
TIMEPIXR= 0.0000000000000000E+00 /
TIMEDEL = 0.0000000000000000E+00 / Time resolution of data ( in seconds )
COMMENT
COMMENT   ########## Observation info keywords ##########
COMMENT
MISSION = 'AXAF    '           / Advanced X-Ray Astrophysics Facility
TELESCOP= 'AXAF    '           / Telescope used
INSTRUME= 'PCAD    '
DETNAM  = 'ACA-P   '           / Detector
GRATING = 'NONE    '           / HETG, LETG, or NONE
OBJECT  = '        '           / Source name
TITLE   = '        '           / Title of Observaton
OBSERVER= '        '           / Observer or PI
OBS_ID  = '        '           / Observation ID
EQUINOX = 2.0000000000000000E+03 / J2000.0
RADECSYS= 'ICRS    '           / Julian coordinate reference frame
DATACLAS= 'OBSERVED'           / default is OBSERVED
ONTIME  = 0.0000000000000000E+00 / Ontime in seconds
LIVETIME= 0.0000000000000000E+00 / Livetime in seconds
EXPOSURE= 0.0000000000000000E+00
DTCOR   = 0.0000000000000000E+00
COMMENT
COMMENT   ########## Additional Principle Header keywords ##########
COMMENT
END
```

Appendix C

List of all keywords in a *PEA* memory dump data file

C.1 Primary header keywords

```
SIMPLE  =                    T / file does conform to FITS standard
BITPIX  =                   32 / number of bits per data pixel
NAXIS   =                    0 / number of data axes
EXTEND  =                    T / FITS dataset may contain extensions
COMMENT   FITS (Flexible Image Transport System) format defined in Astronomy and
COMMENT   Astrophysics Supplement Series v44/p363, v44/p371, v73/p359, v73/p365.
COMMENT   Contact the NASA Science Office of Standards and Technology for the
COMMENT   FITS Definition document #100 and other FITS information.
COMMENT
COMMENT   ########## Configuration control keywords ##########
COMMENT
ORIGIN  = 'ASC     '
CREATOR = 'xxx - Version 0.0'
CHECKSUM= '        '             / ASCII encoded HDU checksum
DATASUM = '        '             / Data unit checksum in ASCII
COMMENT
COMMENT   ########## Timing info keywords ##########
COMMENT
DATE    = '05/02/99'             / FITS file creation date (dd/mm/yy)
DATE-OBS= '        '             / TT, with clock correction if CLOCKAPP
DATE-END= '        '             / TT, with clock correction if CLOCKAPP
TIMESYS = 'TT      '             / AXAF time will be TT (Terrestrial Time)
MJDREF  = 5.0814000000000000E+04 / 1998-01-01T00:00:00 (TT) expressed in MJD
TIMEZERO= 0.0000000000000000E+00 / Cumulative clock correction
TIMEUNIT= 's       '
CLOCKAPP=                    T / Clock correction appllied
TSTART  = 0.0000000000000000E+00 / As in TIME column: raw S/C clock
TSTOP   = 0.0000000000000000E+00 /   add TIMEZERO and MJDREF for absolute TT
COMMENT
COMMENT   ########## Observation info keywords ##########
```

```
COMMENT
MISSION = 'AXAF    '            / Advanced X-Ray Astrophysics Facility
TELESCOP= 'AXAF    '            / Telescope used
INSTRUME= '"PCAD"  '
DETNAM  = 'ACA-P   '            / Detector
OBS_ID  = '        '            / Observation ID
END
```

```
XTENSION= 'BINTABLE'           / binary table extension
BITPIX  =                    8 / 8-bit bytes
NAXIS   =                    2 / 2-dimensional binary table
NAXIS1  =                   50 / width of table in bytes
NAXIS2  =                    1 / number of rows in table
PCOUNT  =                    0 / size of special data area
GCOUNT  =                    1 / one data group (required keyword)
TFIELDS =                    7 / number of fields in each row
TTYPE1  = 'time    '           / Time-tag of the data record
TFORM1  = '1D      '           / data format of field: 8-byte DOUBLE
TUNIT1  = 's       '           / physical unit of field
TTYPE2  = 'mrf     '           / Major frame roll ctr value
TFORM2  = '1J      '           / data format of field: 4-byte INTEGER
TTYPE3  = 'mjf     '           / Major frame ctr value
TFORM3  = '1J      '           / data format of field: 4-byte INTEGER
TTYPE4  = 'mnf     '           / Minor frame ctr value
TFORM4  = '1J      '           / data format of field: 4-byte INTEGER
TTYPE5  = 'address '           / start address
TFORM5  = '1J      '           / data format of field: 4-byte INTEGER
TTYPE6  = 'memory  '           / 24 bytes of memory data
TFORM6  = '24B     '           / data format of field: BYTE
TTYPE7  = 'checksum'           / checksum
TFORM7  = '1I      '           / data format of field: 2-byte INTEGER
EXTNAME = 'MEM_DUMP'           / name of this binary table extension
COMMENT
COMMENT   ########## Configuration control keywords ##########
COMMENT
ORIGIN  = 'ASC     '
CREATOR = 'xxx - Version 0.0'
REVISION=                    0 / Processing system revision number
CHECKSUM= '        '           / ASCII encoded HDU checksum
DATASUM = '        '           / Data unit checksum in ASCII
CONTENT = '        '           / What data product
HDUNAME = '        '           /
HDUSPEC = '        '           /
HDUDOC  = 'ASC-FITS-1.1'       / ASC FITS Designers Guide
HDUVERS = '1.0.0   '           /
HDUCLASS= 'ASC     '
HDUCLAS1= '        '           /
HDUCLAS2= '        '           /
LONGSTRN= 'OGIP 1.0'           / The OGIP long string convention may be used.
COMMENT
COMMENT   ########## Timing info keywords ##########
COMMENT
DATE    = '05/02/99'           / FITS file creation date (dd/mm/yy)
DATE-OBS= '        '           / TT, with clock correction if CLOCKAPP
DATE-END= '        '           / TT, with clock correction if CLOCKAPP
```

```
TIMESYS = 'TT      '           / AXAF time will be TT (Terrestrial Time)
MJDREF  = 5.0814000000000000E+04 / 1998-01-01T00:00:00 (TT) expressed in MJD
TIMEZERO= 0.0000000000000000E+00 / Cumulative clock correction
TIMEUNIT= 's       '
CLOCKAPP=                    T / Clock correction appllied
TIERRELA= 1.0000000000000001E-09 / Short-term clock stability
TIERABSO= 1.0000000000000000E-04 / Absolute precision of clock correction
TIMVERSN= 'ASC-FITS-1.1'       / AXAF FITS design document
TSTART  = 0.0000000000000000E+00 / As in TIME column: raw S/C clock
TSTOP   = 0.0000000000000000E+00 /   add TIMEZERO and MJDREF for absolute TT
TIMEPIXR= 0.0000000000000000E+00 /
TIMEDEL = 0.0000000000000000E+00 / Time resolution of data ( in seconds )
COMMENT
COMMENT   ########## Observation info keywords ##########
COMMENT
MISSION = 'AXAF    '           / Advanced X-Ray Astrophysics Facility
TELESCOP= 'AXAF    '           / Telescope used
INSTRUME= 'PCAD    '
DETNAM  = 'ACA-P   '           / Detector
GRATING = 'NONE    '           / HETG, LETG, or NONE
OBJECT  = '        '           / Source name
TITLE   = '        '           / Title of Observaton
OBSERVER= '        '           / Observer or PI
OBS_ID  = '        '           / Observation ID
EQUINOX = 2.0000000000000000E+03 / J2000.0
RADECSYS= 'ICRS    '           / Julian coordinate reference frame
DATACLAS= 'OBSERVED'           / default is OBSERVED
ONTIME  = 0.0000000000000000E+00 / Ontime in seconds
LIVETIME= 0.0000000000000000E+00 / Livetime in seconds
EXPOSURE= 0.0000000000000000E+00
DTCOR   = 0.0000000000000000E+00
COMMENT
COMMENT   ########## Additional Principle Header keywords ##########
COMMENT
END
```

Appendix D

PEA telemetry decommutation, calibration, and encoding

The image pixel data of the aspect camera assembly (ACA) are transfered to the OBC and telemetered in the "Aspect Data" stream. This is distinct from the "OBC Data" stream, which contains ACA star centroids and magnitudes and is used by the OBC for spacecraft pointing and control. The Aspect Data stream has a fundamental unit size of 224 bytes each 4 minor frames (1.025 sec). The beginning or end of set of 4 frames is coincident with the RCTU science header pulse each 2.050 sec.

The 224 byte ACA data packet consists of 8 bytes of header information, followed by 27 bytes of image data for each of 8 image slots ($8 + 27 \times 8 = 224$). For 4×4 pixel images (specified by the Image Type), one 27-byte image data packet is needed to specify an image. For 6×6 pixel images, two 27-byte image data packets (requiring 2.050 sec) are needed to specify an image. For 8×8 pixel images, four 27-byte image data packets (requiring 4.100 sec) are needed to specify an image. The contents of the 224-byte data packet therefore depend of the image sizes and the current image segment (e.g. third out of four 27-byte packets for an 8×8 image).

D.1 Decommutation

The Aspect Data are decommutated as follows. Note that each of the eight image slots are essentially independent (they can have different sizes), and so the following process takes place for each slot.

- For 4×4 image data, create a 32 byte buffer consisting of (in this order):

Segment	Contents
1	Bytes 0 - 4 (header info)
1	27 bytes of image data

- For 6×6 image data, create a 59 byte buffer consisting of (in this order):

Segment	Contents
1	Bytes 0 - 4 (header info)
1	27 bytes of image data
2	27 bytes of image data

- For 8×8 image data, create a 113 byte buffer consisting of (in this order):

Segment	Contents
1	Bytes 0 - 4 (header info)
1	27 bytes of image data
2	27 bytes of image data
3	27 bytes of image data
4	27 bytes of image data

- Decommutate the buffer using the appropriate one of the following three tables, which specify a mnemonic name, start byte (from 0), start bit, length (bits) and data type (uncalibrated).

4×4 Aspect Data

Name	Start byte	Start bit	Length	Type
INTEG	0	0	16	USHORT
GLBSTAT	2	0	8	UBYTE
COMMCNT	3	0	8	UBYTE
COMMPROG	4	0	8	UBYTE
IMGFID1	5	0	1	UBYTE
IMGNUM1	5	1	3	UBYTE
IMGFUNC1	5	4	2	UBYTE
IMGSTAT	5	6	6	UBYTE
IMGROWA1	6	4	10	SSHORT
IMGCOLA1	7	6	10	SSHORT
IMGSCALE	9	0	14	USHORT
BGDAVG	10	6	10	USHORT
SIGPIXA1	12	0	10	USHORT
SIGPIXB1	13	2	10	USHORT
SIGPIXC1	14	4	10	USHORT
SIGPIXD1	15	6	10	USHORT
SIGPIXE1	17	0	10	USHORT
SIGPIXF1	18	2	10	USHORT
SIGPIXG1	19	4	10	USHORT
SIGPIXH1	20	6	10	USHORT
SIGPIXI1	22	0	10	USHORT
SIGPIXJ1	23	2	10	USHORT
SIGPIXK1	24	4	10	USHORT
SIGPIXL1	25	6	10	USHORT
SIGPIXM1	27	0	10	USHORT
SIGPIXN1	28	2	10	USHORT
SIGPIXO1	29	4	10	USHORT
SIGPIXP1	30	6	10	USHORT

6×6 Aspect Data

Name	Start byte	Start bit	Length	Type
INTEG	0	0	16	USHORT
GLBSTAT	2	0	8	UBYTE
COMMCNT	3	0	8	UBYTE
COMMPROG	4	0	8	UBYTE
IMGFID1	5	0	1	UBYTE
IMGNUM1	5	1	3	UBYTE
IMGFUNC1	5	4	2	UBYTE
IMGSTAT	5	6	6	UBYTE
IMGROWA1	6	4	10	SSHORT
IMGCOLA1	7	6	10	SSHORT
IMGSCALE	9	0	14	USHORT
BGDAVG	10	6	10	USHORT
SIGPIXA1	12	0	10	USHORT
SIGPIXB1	13	2	10	USHORT
SIGPIXC1	14	4	10	USHORT
SIGPIXD1	15	6	10	USHORT
SIGPIXE1	17	0	10	USHORT
SIGPIXF1	18	2	10	USHORT
SIGPIXG1	19	4	10	USHORT
SIGPIXH1	20	6	10	USHORT
SIGPIXI1	22	0	10	USHORT
SIGPIXJ1	23	2	10	USHORT
SIGPIXK1	24	4	10	USHORT
SIGPIXL1	25	6	10	USHORT
SIGPIXM1	27	0	10	USHORT
SIGPIXN1	28	2	10	USHORT
SIGPIXO1	29	4	10	USHORT
SIGPIXP1	30	6	10	USHORT
IMGFID2	32	0	1	UBYTE
IMGNUM2	32	1	3	UBYTE
IMGFUNC2	32	4	2	UBYTE
BGDRMS	32	6	10	USHORT
TEMPCCD	34	0	8	SSHORT
TEMPHOUS	35	0	8	SSHORT
TEMPPRIM	36	0	8	SSHORT
TEMPSEC	37	0	8	SSHORT
BGDSTAT	38	0	8	UBYTE
SIGPIXA2	39	0	10	USHORT
SIGPIXB2	40	2	10	USHORT
SIGPIXC2	41	4	10	USHORT
SIGPIXD2	42	6	10	USHORT
SIGPIXE2	44	0	10	USHORT
SIGPIXF2	45	2	10	USHORT
SIGPIXG2	46	4	10	USHORT
SIGPIXH2	47	6	10	USHORT
SIGPIXI2	49	0	10	USHORT
SIGPIXJ2	50	2	10	USHORT
SIGPIXK2	51	4	10	USHORT
SIGPIXL2	52	6	10	USHORT
SIGPIXM2	54	0	10	USHORT
SIGPIXN2	55	2	10	USHORT
SIGPIXO2	56	4	10	USHORT
SIGPIXP2	57	6	10	USHORT

8×8 Aspect Data

Name	Start byte	Start bit	Length	Type
INTEG	0	0	16	USHORT
GLBSTAT	2	0	8	UBYTE
COMMCNT	3	0	8	UBYTE
COMMPROG	4	0	8	UBYTE
IMGFID1	5	0	1	UBYTE
IMGNUM1	5	1	3	UBYTE
IMGFUNC1	5	4	2	UBYTE
IMGSTAT	5	6	6	UBYTE
IMGROWA1	6	4	10	SSHORT
IMGCOLA1	7	6	10	SSHORT
IMGSCALE	9	0	14	USHORT
BGDAVG	10	6	10	USHORT
SIGPIXA1	12	0	10	USHORT
SIGPIXB1	13	2	10	USHORT
SIGPIXC1	14	4	10	USHORT
SIGPIXD1	15	6	10	USHORT
SIGPIXE1	17	0	10	USHORT
SIGPIXF1	18	2	10	USHORT
SIGPIXG1	19	4	10	USHORT
SIGPIXH1	20	6	10	USHORT
SIGPIXI1	22	0	10	USHORT
SIGPIXJ1	23	2	10	USHORT
SIGPIXK1	24	4	10	USHORT
SIGPIXL1	25	6	10	USHORT
SIGPIXM1	27	0	10	USHORT
SIGPIXN1	28	2	10	USHORT
SIGPIXO1	29	4	10	USHORT
SIGPIXP1	30	6	10	USHORT
IMGFID2	32	0	1	UBYTE
IMGNUM2	32	1	3	UBYTE
IMGFUNC2	32	4	2	UBYTE
BGDRMS	32	6	10	USHORT
TEMPCCD	34	0	8	SSHORT
TEMPHOUS	35	0	8	SSHORT
TEMPPRIM	36	0	8	SSHORT
TEMPSEC	37	0	8	SSHORT
BGDSTAT	38	0	8	UBYTE
SIGPIXA2	39	0	10	USHORT
SIGPIXB2	40	2	10	USHORT
SIGPIXC2	41	4	10	USHORT
SIGPIXD2	42	6	10	USHORT
SIGPIXE2	44	0	10	USHORT
SIGPIXF2	45	2	10	USHORT
SIGPIXG2	46	4	10	USHORT
SIGPIXH2	47	6	10	USHORT
SIGPIXI2	49	0	10	USHORT
SIGPIXJ2	50	2	10	USHORT
SIGPIXK2	51	4	10	USHORT
SIGPIXL2	52	6	10	USHORT
SIGPIXM2	54	0	10	USHORT
SIGPIXN2	55	2	10	USHORT
SIGPIXO2	56	4	10	USHORT
SIGPIXP2	57	6	10	USHORT

8×8 Aspect Data (*continued*)

Name	Start byte	Start bit	Length	Type
IMGFID3	59	0	1	UBYTE
IMGNUM3	59	1	3	UBYTE
IMGFUNC3	59	4	2	UBYTE
HDR3TLM62	60	0	8	UBYTE
HDR3TLM63	61	0	8	UBYTE
HDR3TLM64	62	0	8	UBYTE
HDR3TLM65	63	0	8	UBYTE
HDR3TLM66	64	0	8	UBYTE
HDR3TLM67	65	0	8	UBYTE
SIGPIXA3	66	0	10	USHORT
SIGPIXB3	67	2	10	USHORT
SIGPIXC3	68	4	10	USHORT
SIGPIXD3	69	6	10	USHORT
SIGPIXE3	71	0	10	USHORT
SIGPIXF3	72	2	10	USHORT
SIGPIXG3	73	4	10	USHORT
SIGPIXH3	74	6	10	USHORT
SIGPIXI3	76	0	10	USHORT
SIGPIXJ3	77	2	10	USHORT
SIGPIXK3	78	4	10	USHORT
SIGPIXL3	79	6	10	USHORT
SIGPIXM3	81	0	10	USHORT
SIGPIXN3	82	2	10	USHORT
SIGPIXO3	83	4	10	USHORT
SIGPIXP3	84	6	10	USHORT
IMGFID4	86	0	1	UBYTE
IMGNUM4	86	1	3	UBYTE
IMGFUNC4	86	4	2	UBYTE
HDR3TLM72	87	0	8	UBYTE
HDR3TLM73	88	0	8	UBYTE
HDR3TLM74	89	0	8	UBYTE
HDR3TLM75	90	0	8	UBYTE
HDR3TLM76	91	0	8	UBYTE
HDR3TLM77	92	0	8	UBYTE
SIGPIXA4	93	0	10	USHORT
SIGPIXB4	94	2	10	USHORT
SIGPIXC4	95	4	10	USHORT
SIGPIXD4	96	6	10	USHORT
SIGPIXE4	98	0	10	USHORT
SIGPIXF4	99	2	10	USHORT
SIGPIXG4	100	4	10	USHORT
SIGPIXH4	101	6	10	USHORT
SIGPIXI4	103	0	10	USHORT
SIGPIXJ4	104	2	10	USHORT
SIGPIXK4	105	4	10	USHORT
SIGPIXL4	106	6	10	USHORT
SIGPIXM4	108	0	10	USHORT
SIGPIXN4	109	2	10	USHORT
SIGPIXO4	110	4	10	USHORT
SIGPIXP4	111	6	10	USHORT

D.2 Calibration and encoding

D.2.1 Temperatures

The output product columns `tempccd, temphous, tempprim, tempsec` are converted from uncalibrated to a calibrated float (degrees C) using the equation

```
temp<*> = 0.4 * raw<*>
```

where `raw<*>` are the uncalibrated 8-bit values interpreted as signed chars.

D.2.2 Pixel values

Each element of the `imgraw` array is converted from an uncalibrated value (10 bit unsigned integer) to calibrated (A/D counts) as follows:

```
imgraw[*] = imgraw[*] * imgscale / 32.0 - 50.0
```

D.2.3 Background average and background RMS

It should be noted that the BGDAVG and BGDRMS in raw telemetry are *not* scaled like the pixel values, as is indicated in versions of the ACA software specification DM05 before Rev. H.

D.2.4 Time tags

The output product columns `time` and `end_integ_time` are defined as follows:

```
end_integ_time = AXAF_TIME(VCDU_CTR) - 1.025    (sec)
time = end_integ_time - integ / 2.0             (sec)
```

Here `AXAF_TIME(VCDU_CTR)` is the clock correlation time for the first minor frame of the 224 byte ACA data packet which contains segment 1 of data for that image.

D.2.5 Image row, column, and pixel values

The output product columns `imgrow0, imgcol0` and `imgraw` are built from the Aspect Data decom mnemonics in the following way. For 4×4 and 8×8 images,

```
imgrow0 = IMGROWA1
imgcol0 = IMGCOLA1
```

For 6×6 images,

```
imgrow0 = IMGROWA1 - 1
imgcol0 = IMGCOLA1 - 1
```

The `imgraw` array is interpreted in processing as a two-dimensional image array. However, in L0 decom it is built and output as a linear list in the following order:

```
   (4 x 4)
SIGPIXA1, SIGPIXB1, SIGPIXC1, SIGPIXD1,
SIGPIXE1, SIGPIXF1, SIGPIXG1, SIGPIXH1,
SIGPIXI1, SIGPIXJ1, SIGPIXK1, SIGPIXL1,
SIGPIXM1, SIGPIXN1, SIGPIXO1, SIGPIXP1
```

```
   (6 x 6)
0.0, SIGPIXA2, SIGPIXB2, SIGPIXC2, SIGPIXD2, 0.0,
SIGPIXP2, SIGPIXA1, SIGPIXB1, SIGPIXC1, SIGPIXD1, SIGPIXE2,
SIGPIXO2, SIGPIXE1, SIGPIXF1, SIGPIXG1, SIGPIXH1, SIGPIXF2,
SIGPIXN2, SIGPIXI1, SIGPIXJ1, SIGPIXK1, SIGPIXL1, SIGPIXG2,
SIGPIXM2, SIGPIXM1, SIGPIXN1, SIGPIXO1, SIGPIXP1, SIGPIXH2,
0.0, SIGPIXL2, SIGPIXK2, SIGPIXJ2, SIGPIXI2, 0.0

   (8 x 8)
SIGPIXA1, SIGPIXB1, SIGPIXC1, SIGPIXD1, SIGPIXE1, SIGPIXF1, SIGPIXG1, SIGPIXH1,
SIGPIXI1, SIGPIXJ1, SIGPIXK1, SIGPIXL1, SIGPIXM1, SIGPIXN1, SIGPIXO1, SIGPIXP1,
SIGPIXA2, SIGPIXB2, SIGPIXC2, SIGPIXD2, SIGPIXE2, SIGPIXF2, SIGPIXG2, SIGPIXH2,
SIGPIXI2, SIGPIXJ2, SIGPIXK2, SIGPIXL2, SIGPIXM2, SIGPIXN2, SIGPIXO2, SIGPIXP2,
SIGPIXA3, SIGPIXB3, SIGPIXC3, SIGPIXD3, SIGPIXE3, SIGPIXF3, SIGPIXG3, SIGPIXH3,
SIGPIXI3, SIGPIXJ3, SIGPIXK3, SIGPIXL3, SIGPIXM3, SIGPIXN3, SIGPIXO3, SIGPIXP3,
SIGPIXA4, SIGPIXB4, SIGPIXC4, SIGPIXD4, SIGPIXE4, SIGPIXF4, SIGPIXG4, SIGPIXH4,
SIGPIXI4, SIGPIXJ4, SIGPIXK4, SIGPIXL4, SIGPIXM4, SIGPIXN4, SIGPIXO4, SIGPIXP4
```