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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Manager, CXC Science Data Systems

Approved: Harvey Tananbaum
Director, CXC
## Document and Change Control Log

<table>
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<th>Date</th>
<th>Version</th>
<th>Section</th>
<th>Status</th>
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<td>1.0</td>
<td>all</td>
<td>Updated file naming, content, type, and select keywords</td>
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<td></td>
<td></td>
<td>App. A</td>
<td>Added list of changes for header keywords</td>
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<td></td>
<td></td>
<td>all</td>
<td>Changed ASC to CXC</td>
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<td>1998 December 21</td>
<td>0.5</td>
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<td>Initial draft (based on SIM L0 ICD)</td>
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Unresolved issues

There are currently no unresolved issues, as 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

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

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 1.025s for $4 \times 4$ images, once per 2.050 s for $6 \times 6$ images, and once per 4.100 s for $8 \times 8$ images. There is no PEA serial digital telemetry in format 6 (STS).

The two PEs (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 PEs. 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:

\[ \text{pcad<s><tttttttt><N<vvv>_<f>_<content>0.fits} \]

\[
\begin{align*}
_\text{<f>} & = _\text{<slotnumber>}_\text{TU} & / & \text{raw image files} \\
_\text{<f>} & = _\text{<slotnumber>}_\text{} & / & \text{calibrated image files} \\
_\text{<f>} & = & / & \text{omitted for memory dumps} \\
\text{<content>} & = \text{adat} & / & \text{image files} \\
\text{<content>} & = \text{mem} & / & \text{memory dumps}
\end{align*}
\]

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), \(<tttttttttt>\) is a 9-digit time stamp that is the integer part of the FITS TSTART value, \(<vvv>\) is the processing run number (version), \(<\text{content}>\) specifies the contents of the file (see Table 2.1), and \(<\text{slotnumber}>\) specifies the ACA image slot (possible values: 0 to 7 inclusive).

Table 2.1: ACA level 0 data product files

<table>
<thead>
<tr>
<th>Title</th>
<th>&lt;content&gt;</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>PEA telemetry (raw)</td>
<td>ACAIMG_TU</td>
<td>PEA raw telemetry images</td>
</tr>
<tr>
<td>PEA telemetry (calibrated)</td>
<td>ACAIMG</td>
<td>PEA calibrated telemetry images</td>
</tr>
<tr>
<td>PEA memory dump</td>
<td>ACAMEM</td>
<td>PEA memory dump data</td>
</tr>
</tbody>
</table>

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.
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 extractd 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 Terrestrial 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 EXTNNAME 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 x 4 images)

<table>
<thead>
<tr>
<th>#</th>
<th>TTYPE</th>
<th>TUNIT</th>
<th>TFORM</th>
<th>TMIN</th>
<th>TMAX</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>TIME</td>
<td>s</td>
<td>1D</td>
<td></td>
<td></td>
<td>Time-tag of the data record</td>
</tr>
<tr>
<td>2</td>
<td>MRF</td>
<td>1J</td>
<td></td>
<td></td>
<td></td>
<td>Major frame roll ctr value</td>
</tr>
<tr>
<td>3</td>
<td>MJF</td>
<td>1J</td>
<td></td>
<td></td>
<td></td>
<td>Major frame ctr value</td>
</tr>
<tr>
<td>4</td>
<td>MNF</td>
<td>1J</td>
<td></td>
<td></td>
<td></td>
<td>Minor frame ctr value</td>
</tr>
<tr>
<td>5</td>
<td>END_INTEG_TIME</td>
<td>s</td>
<td>1D</td>
<td></td>
<td></td>
<td>End integration time</td>
</tr>
<tr>
<td>6</td>
<td>INTEG</td>
<td>I</td>
<td></td>
<td></td>
<td></td>
<td>Integration time</td>
</tr>
<tr>
<td>7</td>
<td>QUALITY</td>
<td>1J</td>
<td></td>
<td></td>
<td></td>
<td>Data quality flag: 0 - good, 1 - bad</td>
</tr>
<tr>
<td>8</td>
<td>GLBSTAT</td>
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<td>255</td>
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<td>9</td>
<td>COMM_CNT</td>
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<td>Command progress</td>
</tr>
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<td>11</td>
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<td>0</td>
<td>1</td>
<td></td>
<td>Image type</td>
</tr>
<tr>
<td>12</td>
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<td>0</td>
<td>7</td>
<td></td>
<td>Image number (of 8)</td>
</tr>
<tr>
<td>13</td>
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<td>0</td>
<td>3</td>
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<td>Image function</td>
</tr>
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<td>255</td>
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</tr>
<tr>
<td>15</td>
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<td>512</td>
<td>Row of lowerleft image pixel</td>
</tr>
<tr>
<td>16</td>
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<td>512</td>
<td>Col of lowerleft image pixel</td>
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<td>17</td>
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<td>1023</td>
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<td>BGD AVG</td>
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<tr>
<td>19</td>
<td>IMGRAW</td>
<td>16I</td>
<td></td>
<td></td>
<td></td>
<td>Aspect camera image</td>
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</table>
Table 2.4: Level 0 PEA telemetry HDU contents (Raw 6 x 6 images)

<table>
<thead>
<tr>
<th>#</th>
<th>TTYPE</th>
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<th>TFORM</th>
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<td>1</td>
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<td>Major frame roll ctr value</td>
</tr>
<tr>
<td>3</td>
<td>MJF</td>
<td>1J</td>
<td></td>
<td></td>
<td></td>
<td>Major frame ctr value</td>
</tr>
<tr>
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<td>1D</td>
<td></td>
<td></td>
<td>End integration time</td>
</tr>
<tr>
<td>6</td>
<td>INTEG</td>
<td>1H</td>
<td></td>
<td></td>
<td></td>
<td>Integration time</td>
</tr>
<tr>
<td>7</td>
<td>QUALITY</td>
<td>1J</td>
<td></td>
<td></td>
<td></td>
<td>Data quality flag: 0 - good, 1 - bad</td>
</tr>
<tr>
<td>8</td>
<td>GLBSTAT</td>
<td>1B</td>
<td>0</td>
<td>255</td>
<td></td>
<td>Global status</td>
</tr>
<tr>
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<td>COMMNT</td>
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<td>1B</td>
<td>0</td>
<td>1</td>
<td></td>
<td>Image type</td>
</tr>
<tr>
<td>12</td>
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<td></td>
<td>Image number (of 8)</td>
</tr>
<tr>
<td>13</td>
<td>IMGFUNC1</td>
<td>1B</td>
<td>0</td>
<td>3</td>
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<td>Image function</td>
</tr>
<tr>
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<td>1B</td>
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<td>Image status</td>
</tr>
<tr>
<td>15</td>
<td>IMGROW0</td>
<td>1H</td>
<td>-511</td>
<td>512</td>
<td></td>
<td>Row of lowerleft image pixel</td>
</tr>
<tr>
<td>16</td>
<td>IMGCOL0</td>
<td>1H</td>
<td>-511</td>
<td>512</td>
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<td>Col of lowerleft image pixel</td>
</tr>
<tr>
<td>17</td>
<td>IMGSCALE</td>
<td>1H</td>
<td>0</td>
<td>1023</td>
<td></td>
<td>Pixel scaling factor</td>
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<td>BGDAVG</td>
<td>1H</td>
<td></td>
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<td></td>
<td>Average background</td>
</tr>
<tr>
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<td>IMGRAW</td>
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<td></td>
<td>Aspect camera image</td>
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<td></td>
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<td>Background RMS</td>
</tr>
<tr>
<td>21</td>
<td>TEMPCCD</td>
<td>1B</td>
<td></td>
<td></td>
<td></td>
<td>Temp 1 - CCD</td>
</tr>
<tr>
<td>22</td>
<td>TEMPHOUS</td>
<td>1B</td>
<td></td>
<td></td>
<td></td>
<td>Temp 2 - AC housing</td>
</tr>
<tr>
<td>23</td>
<td>TEMPPRIM</td>
<td>1B</td>
<td></td>
<td></td>
<td></td>
<td>Temp 3 - lens cell</td>
</tr>
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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 Terrestrial 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.
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Table 2.6: Level 0 PEAD telemetry HDU contents (4 × 4 images)
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<th>#</th>
<th>TTYPE</th>
<th>TUNIT</th>
<th>TFORM</th>
<th>TMIN</th>
<th>TMAX</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>27</td>
<td>IMGNUM2</td>
<td>1B</td>
<td>0</td>
<td>7</td>
<td>3</td>
<td>Image number (of 8)</td>
</tr>
<tr>
<td>28</td>
<td>IMGFUNC2</td>
<td>1B</td>
<td>0</td>
<td>3</td>
<td></td>
<td>Image function</td>
</tr>
<tr>
<td>#</td>
<td>TTYPE</td>
<td>TUNIT</td>
<td>TFORM</td>
<td>TMIN</td>
<td>TMAX</td>
<td>Comment</td>
</tr>
<tr>
<td>----</td>
<td>-------------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>----------------------------------------------</td>
</tr>
<tr>
<td>1</td>
<td>TIME</td>
<td>s</td>
<td>1D</td>
<td></td>
<td></td>
<td>Time-tag of the data record</td>
</tr>
<tr>
<td>2</td>
<td>MRF</td>
<td></td>
<td>1J</td>
<td></td>
<td></td>
<td>Major frame roll ctr value</td>
</tr>
<tr>
<td>3</td>
<td>MJF</td>
<td></td>
<td>1J</td>
<td></td>
<td></td>
<td>Major frame ctr value</td>
</tr>
<tr>
<td>4</td>
<td>MNF</td>
<td></td>
<td>1J</td>
<td></td>
<td></td>
<td>Minor frame ctr value</td>
</tr>
<tr>
<td>5</td>
<td>END_INTEG_TIME</td>
<td>s</td>
<td>1D</td>
<td></td>
<td></td>
<td>End integration time</td>
</tr>
<tr>
<td>6</td>
<td>INTEG</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Integration time</td>
</tr>
<tr>
<td>7</td>
<td>QUALITY</td>
<td></td>
<td>1J</td>
<td></td>
<td></td>
<td>Data quality flag: 0 - good, 1 - bad</td>
</tr>
<tr>
<td>8</td>
<td>GLBSTAT</td>
<td>1B</td>
<td>0</td>
<td>255</td>
<td></td>
<td>Global status</td>
</tr>
<tr>
<td>9</td>
<td>COMM_CNT</td>
<td>1B</td>
<td>0</td>
<td>63</td>
<td></td>
<td>Command count</td>
</tr>
<tr>
<td>10</td>
<td>COMM_PROGRESS</td>
<td>1B</td>
<td>0</td>
<td>63</td>
<td></td>
<td>Command progress</td>
</tr>
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<td>11</td>
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<td>1</td>
<td></td>
<td>Image type</td>
</tr>
<tr>
<td>12</td>
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<td>0</td>
<td>7</td>
<td></td>
<td>Image number (of 8)</td>
</tr>
<tr>
<td>13</td>
<td>IMGFUNC1</td>
<td>1B</td>
<td>0</td>
<td>3</td>
<td></td>
<td>Image function</td>
</tr>
<tr>
<td>14</td>
<td>IMGSTAT</td>
<td>1B</td>
<td>0</td>
<td>255</td>
<td></td>
<td>Image status</td>
</tr>
<tr>
<td>15</td>
<td>IMGROW0</td>
<td>pixel</td>
<td>II</td>
<td>-511</td>
<td>512</td>
<td>Row of lowerleft image pixel</td>
</tr>
<tr>
<td>16</td>
<td>IMGCOL0</td>
<td>pixel</td>
<td>II</td>
<td>-511</td>
<td>512</td>
<td>Col of lowerleft image pixel</td>
</tr>
<tr>
<td>17</td>
<td>IMGSCL</td>
<td>I</td>
<td>0</td>
<td>1023</td>
<td></td>
<td>Pixel scaling factor</td>
</tr>
<tr>
<td>18</td>
<td>BGD_AVG</td>
<td>count</td>
<td>1E</td>
<td></td>
<td></td>
<td>Average background</td>
</tr>
<tr>
<td>19</td>
<td>IMGRAW</td>
<td>count</td>
<td>64E</td>
<td></td>
<td></td>
<td>Aspect camera image</td>
</tr>
<tr>
<td>20</td>
<td>BGD RMS</td>
<td>count</td>
<td>1E</td>
<td></td>
<td></td>
<td>Background RMS</td>
</tr>
<tr>
<td>21</td>
<td>TEMP_CCD</td>
<td>K</td>
<td>1E</td>
<td></td>
<td></td>
<td>Temp 1 - CCD</td>
</tr>
<tr>
<td>22</td>
<td>TEMP_HOUS</td>
<td>K</td>
<td>1E</td>
<td></td>
<td></td>
<td>Temp 2 - AC housing</td>
</tr>
<tr>
<td>23</td>
<td>TEMP_PRIM</td>
<td>K</td>
<td>1E</td>
<td></td>
<td></td>
<td>Temp 3 - lens cell</td>
</tr>
<tr>
<td>24</td>
<td>TEMP_SEC</td>
<td>K</td>
<td>1E</td>
<td></td>
<td></td>
<td>Temp 4 - secondary mirror</td>
</tr>
<tr>
<td>25</td>
<td>BGDSTAT</td>
<td>1B</td>
<td>0</td>
<td>255</td>
<td></td>
<td>Bgd pixel status</td>
</tr>
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<td>0</td>
<td>1</td>
<td></td>
<td>Image type</td>
</tr>
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</table>

Continued on next page
<table>
<thead>
<tr>
<th>#</th>
<th>TTYPE</th>
<th>TUNIT</th>
<th>TFORM</th>
<th>TLMIN</th>
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<td>7</td>
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<td>Image number (of 8)</td>
</tr>
<tr>
<td>28</td>
<td>IMGFUNC2</td>
<td>1B</td>
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<td>3</td>
<td></td>
<td>Image function</td>
</tr>
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<td>29</td>
<td>IMGFD3</td>
<td>1B</td>
<td>0</td>
<td>1</td>
<td></td>
<td>Image type</td>
</tr>
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<td>IMGNUM3</td>
<td>1B</td>
<td>0</td>
<td>7</td>
<td></td>
<td>Image number (of 8)</td>
</tr>
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<td>31</td>
<td>IMGFUNC3</td>
<td>1B</td>
<td>0</td>
<td>3</td>
<td></td>
<td>Image function</td>
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<td>IMGFD4</td>
<td>1B</td>
<td>0</td>
<td>1</td>
<td></td>
<td>Image type</td>
</tr>
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<td>33</td>
<td>IMGNUM4</td>
<td>1B</td>
<td>0</td>
<td>7</td>
<td></td>
<td>Image number (of 8)</td>
</tr>
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<td>34</td>
<td>IMGFUNC4</td>
<td>1B</td>
<td>0</td>
<td>3</td>
<td></td>
<td>Image function</td>
</tr>
<tr>
<td>35</td>
<td>HDR3TLM62</td>
<td>1B</td>
<td></td>
<td></td>
<td></td>
<td>Hdr 3 thm. imgtype=6 word=2</td>
</tr>
<tr>
<td>36</td>
<td>HDR3TLM63</td>
<td>1B</td>
<td></td>
<td></td>
<td></td>
<td>Hdr 3 thm. imgtype=6 word=3</td>
</tr>
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<td>37</td>
<td>HDR3TLM64</td>
<td>1B</td>
<td></td>
<td></td>
<td></td>
<td>Hdr 3 thm. imgtype=6 word=4</td>
</tr>
<tr>
<td>38</td>
<td>HDR3TLM65</td>
<td>1B</td>
<td></td>
<td></td>
<td></td>
<td>Hdr 3 thm. imgtype=6 word=5</td>
</tr>
<tr>
<td>39</td>
<td>HDR3TLM66</td>
<td>1B</td>
<td></td>
<td></td>
<td></td>
<td>Hdr 3 thm. imgtype=6 word=6</td>
</tr>
<tr>
<td>40</td>
<td>HDR3TLM67</td>
<td>1B</td>
<td></td>
<td></td>
<td></td>
<td>Hdr 3 thm. imgtype=6 word=7</td>
</tr>
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<td>41</td>
<td>HDR3TLM72</td>
<td>1B</td>
<td></td>
<td></td>
<td></td>
<td>Hdr 3 thm. imgtype=7 word=2</td>
</tr>
<tr>
<td>42</td>
<td>HDR3TLM73</td>
<td>1B</td>
<td></td>
<td></td>
<td></td>
<td>Hdr 3 thm. imgtype=7 word=3</td>
</tr>
<tr>
<td>43</td>
<td>HDR3TLM74</td>
<td>1B</td>
<td></td>
<td></td>
<td></td>
<td>Hdr 3 thm. imgtype=7 word=4</td>
</tr>
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<td>44</td>
<td>HDR3TLM75</td>
<td>1B</td>
<td></td>
<td></td>
<td></td>
<td>Hdr 3 thm. imgtype=7 word=5</td>
</tr>
<tr>
<td>45</td>
<td>HDR3TLM76</td>
<td>1B</td>
<td></td>
<td></td>
<td></td>
<td>Hdr 3 thm. imgtype=7 word=6</td>
</tr>
<tr>
<td>46</td>
<td>HDR3TLM77</td>
<td>1B</td>
<td></td>
<td></td>
<td></td>
<td>Hdr 3 thm. imgtype=7 word=7</td>
</tr>
</tbody>
</table>
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 Terrestrial 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 EXTNAMES keyword set to 'MEMDUMP' and CONTENT keyword set to ACAMEM.
<table>
<thead>
<tr>
<th>#</th>
<th>TTYPE</th>
<th>UNIT</th>
<th>TFORM</th>
<th>TMIN</th>
<th>TMAX</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>TIME</td>
<td>8</td>
<td>1D</td>
<td></td>
<td></td>
<td>Time-tag of the data record</td>
</tr>
<tr>
<td>2</td>
<td>MRF</td>
<td></td>
<td>1J</td>
<td></td>
<td></td>
<td>Major frame ctt value</td>
</tr>
<tr>
<td>3</td>
<td>MNF</td>
<td></td>
<td>1J</td>
<td></td>
<td></td>
<td>Minor frame ctt value</td>
</tr>
<tr>
<td>4</td>
<td>ADDRESS</td>
<td></td>
<td>1J</td>
<td></td>
<td></td>
<td>Start address</td>
</tr>
<tr>
<td>5</td>
<td>MEMORY</td>
<td></td>
<td>24B</td>
<td></td>
<td></td>
<td>24 bytes of memory data</td>
</tr>
<tr>
<td>6</td>
<td>CHECKSUM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Checksum</td>
</tr>
<tr>
<td>Content</td>
<td>Image size</td>
<td>Record size</td>
<td>Period</td>
<td>Data rate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------</td>
<td>------------</td>
<td>-------------</td>
<td>--------</td>
<td>-----------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACAIMG</td>
<td>4</td>
<td>117</td>
<td>1.025</td>
<td>114.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACAIMG</td>
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<td>221</td>
<td>2.050</td>
<td>107.8</td>
<td></td>
<td></td>
</tr>
<tr>
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<td>351</td>
<td>4.100</td>
<td>85.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACAIMG_TU</td>
<td>4</td>
<td>81</td>
<td>1.025</td>
<td>79.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACAIMG_TU</td>
<td>6</td>
<td>131</td>
<td>2.050</td>
<td>63.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACAIMG_TU</td>
<td>8</td>
<td>205</td>
<td>4.100</td>
<td>50.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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, HDUCLASS1, HDUCLASS2, HDUCLASS3 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  Contact the NASA Science Office of Standards and Technology for the
          FITS Definition document #100 and other FITS information.
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 = 5.081400000000000E+04 / 1998-01-01T00:00:00 (TT) expressed in MJD
TIMEZERO= 0.000000000000000E+00 / Cumulative clock correction
TIMEUNIT= 's'             ,
CLOCKAPP= T / Clock correction applied
TSTART = 0.000000000000000E+00 / As in TIME column: raw S/C clock
TSTOP  = 0.000000000000000E+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   = ' '            ,

END
A.2 Principal HDU (PEA telemetry) keywords (4 x 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
TUNIT2 = '/s' / Major frame roll unit
TTYPE3 = 'mjf' / data format of field: 4-byte INTEGER
TFORM3 = '1J' / Minor frame ctr value
TUNIT3 = '/s' / Minor frame unit
TTYPE4 = 'mnf' / data format of field: 4-byte INTEGER
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
TUNIT6 = '/s' / physical unit of field
TTYPE7 = 'quality' / Data quality flag; 0 - good, 1 - bad
TFORM7 = '1J' / data format of field: 4-byte INTEGER
TUNIT7 = '/s' / data unit
TTYPE8 = 'glbstat' / global status
TFORM8 = '1B' / data format of field: BYTE
TUNIT8 = '/s' / data unit
TTYPE9 = 'commcnt' / command count
TFORM9 = '1B' / data format of field: BYTE
TUNIT9 = '/s' / data unit
TTYPE10 = 'commprog' / command progress
TFORM10 = '1B' / data format of field: BYTE
TUNIT10 = '/s' / data unit
TTYPE11 = 'imgfid1' / image type
TFORM11 = '1B' / data format of field: BYTE
TUNIT11 = '/s' / data unit
TTYPE12 = 'imgnum1' / image number (of 8)
TFORM12 = '1B' / data format of field: BYTE
TUNIT12 = '/s' / data unit
TTYPE13 = 'imgfunc1' / image function
TFORM13 = '1B' / data format of field: BYTE
TUNIT13 = '/s' / data unit
TTYPE14 = 'imgstat' / image status
TFORM14 = '1B' / data format of field: BYTE
TUNIT14 = '/s' / data unit
TTYPE15 = 'imgrow0' / row of lowerleft image pixel
TFORM15 = '1I' / data format of field: 2-byte INTEGER
TUNIT15 = '/s' / physical unit of field
TTYPE16 = 'imgcol0' / col of lowerleft image pixel
TFORM16 = '1I' / data format of field: 2-byte INTEGER
TUNIT16 = '/s' / physical unit of field
TTYPE17 = 'imgscale' / pixel scaling factor
TFORM17 = '1I'   / data format of field: 2-byte INTEGER
TFORM18 = 'bgdavg'   / average background
TFORM18 = '1I'   / data format of field: 2-byte INTEGER
TFORM19 = '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=   ,
DATE-END=   ,
TIMEYS = 'TT'   ,
TIMEYS= 'TT'   / TT, with clock correction if CLOCKAPP
MJDREF = 5.081400000000000E+04 / 1998-01-01T00:00:00 (TT) expressed in MJD
TIMEZERO= 0.000000000000000E+00 / Cumulative clock correction
TIMEUNIT= 's'   ,
CLOCKAPP= T   / Clock correction applied
TIERREL= 1.000000000000001E-09 / Short-term clock stability
TIERABS= 1.000000000000000E-04 / Absolute precision of clock correction
TIMVERSION= 'ASC-FITS-1.1'   / AXAF FITS design document
TSTART = 0.000000000000000E+00 / As in TIME column: raw S/C clock
TSTOP = 0.000000000000000E+00 / add TIMEZERO and MJDREF for absolute TT
TIMEPIXR= 0.000000000000000E+00 /
TIMEDEL = 0.000000000000000E+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'   ,
DET Nam = 'ACA-P' / Detector
Grating = 'NONE' / HETG, LETG, or NONE
Object = '' / Source name
Title = '' / Title of Observation
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
On Time = 0.0000000000000000E+00 / On time in seconds
Livel time = 0.0000000000000000E+00 / Live time in seconds
Exposure = 0.0000000000000000E+00
Dtcor = 0.0000000000000000E+00
Comment
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 Contact the NASA Science Office of Standards and Technology for the
COMMENT FITS Definition document #100 and other FITS information.

COMMENT ####### Configuration control keywords #######
ORIGIN = 'ASC',
CREATOR = 'xxx - Version 0.0'
CHECKSUM = / ASCII encoded HDU checksum
DATASUM = / Data unit checksum in ASCII

COMMENT ####### Timing info keywords #######
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
TIME-REF = 5.08140000000000E+04 / 1998-01-01T00:00:00 (TT) expressed in MJD
TIMEZERO = 0.0000000000000000E+00 / Cumulative clock correction
TIMEUNIT = 's',
CLOCKAPP = T / Clock correction applied
TSTART = 0.0000000000000000E+00 / As in TIME column: raw S/C clock
TSTOP = 0.0000000000000000E+00 / add TIMEZERO and MJDREF for absolute TT

COMMENT ####### Observation info keywords #######
MISSION = 'AXAF', / Advanced X-Ray Astrophysics Facility
TELESCOPE = '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 = 'gblstat' / global status
TFORM8 = '1B' / data format of field: BYTE
TTYPE9 = 'comment' / 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
TFORM19 = 'imgraw', / aspect camera image
TFORM19 = '36I', / data format of field: 2-byte INTEGER
TFORM20 = 'bgdrms', / background RMS
TFORM21 = '1I', / data format of field: 2-byte INTEGER
TFORM21 = 'tempccd', / temp 1 - CCD
TFORM21 = '1B', / data format of field: BYTE
TFORM22 = 'temphousing', / temp 2 - AC housing
TFORM22 = '1B', / data format of field: BYTE
TFORM23 = 'tempprim', / temp 3 - lens cell
TFORM23 = '1B', / data format of field: BYTE
TFORM24 = 'temps', / temp 4 - secondary mirror
TFORM24 = '1B', / data format of field: BYTE
TFORM25 = 'bgdstat', / bgd pixel status
TFORM25 = '1B', / data format of field: BYTE
TFORM26 = 'imgfid2', / image type
TFORM26 = '1B', / data format of field: BYTE
TFORM27 = 'imgnum2', / image number (of 8)
TFORM27 = '1B', / data format of field: BYTE
TFORM28 = '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',
HDUCLASS1= ',
HDUCLASS2= ',
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

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TIMEZERO= 0.0000000000000000E+00 / Cumulative clock correction
TIMEUNIT= 's  
CLOCKAPP= T / Clock correction applied
TIERRELA= 1.0000000000000001E-09 / Short-term clock stability
TIERABSO= 1.0000000000000000E-04 / Absolute precision of clock correction
TIMVERS= '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' / Detector
DETNAME = '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 / Onetime 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 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 = 5.08140000000000000E+04 / 1998-01-01T00:00:00 (TT) expressed in MJD
TIMEZERO= 0.0000000000000000E+00 / Cumulative clock correction
TIMEUNIT= 's ',
CLOCKAPP= T / Clock correction applied
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 ctrl value
TFORM2 = '1J' / data format of field: 4-byte INTEGER
TTYPE3 = 'mjf' / Major frame ctrl value
TFORM3 = '1J' / data format of field: 4-byte INTEGER
TTYPE4 = 'mmf' / Minor frame ctrl 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
TFORM18 = 'bgdavg',      / average background
TFORM18 = '1I',          / data format of field: 2-byte INTEGER
TFORM19 = 'imgraw',      / aspect camera image
TFORM19 = '+64I',        / data format of field: 2-byte INTEGER
TFORM20 = 'bgdrms',      / background RMS
TFORM20 = '1I',          / data format of field: 2-byte INTEGER
TFORM21 = 'tempccd',     / temp 1 - CCD
TFORM21 = '1B',          / data format of field: BYTE
TFORM22 = 'tempous',     / temp 2 - AC housing
TFORM22 = '1B',          / data format of field: BYTE
TFORM23 = 'tempprime',   / temp 3 - lens cell
TFORM23 = '1B',          / data format of field: BYTE
TFORM24 = 'tempsec',     / temp 4 - secondary mirror
TFORM24 = '1B',          / data format of field: BYTE
TFORM25 = 'bgdstat',     / bgd pixel status
TFORM25 = '1B',          / data format of field: BYTE
TFORM26 = 'imgfid2',     / image type
TFORM26 = '1B',          / data format of field: BYTE
TFORM27 = 'imgnum2',     / image number (of 8)
TFORM27 = '1B',          / data format of field: BYTE
TFORM28 = 'imgfunc2',    / image function
TFORM28 = '1B',          / data format of field: BYTE
TFORM29 = 'imgfid3',     / image type
TFORM29 = '1B',          / data format of field: BYTE
TFORM30 = 'imgnum3',     / image number (of 8)
TFORM30 = '1B',          / data format of field: BYTE
TFORM31 = 'imgfunc3',    / image function
TFORM31 = '1B',          / data format of field: BYTE
TFORM32 = 'imgfid4',     / image type
TFORM32 = '1B',          / data format of field: BYTE
TFORM33 = 'imgnum4',     / image number (of 8)
TFORM33 = '1B',          / data format of field: BYTE
TFORM34 = 'imgfunc4',    / image function
TFORM34 = '1B',          / data format of field: BYTE
TFORM35 = 'hdr3tlm62',   / Hdr 3 tlm. imgtype=6 word=2
TFORM35 = '1B',          / data format of field: BYTE
TFORM36 = 'hdr3tlm63',   / Hdr 3 tlm. imgtype=6 word=3
TFORM36 = '1B',          / data format of field: BYTE
TFORM37 = 'hdr3tlm64',   / Hdr 3 tlm. imgtype=6 word=4
TFORM37 = '1B',          / data format of field: BYTE
TFORM38 = 'hdr3tlm65',   / Hdr 3 tlm. imgtype=6 word=5
TFORM38 = '1B',          / data format of field: BYTE
TFORM39 = 'hdr3tlm66',   / Hdr 3 tlm. imgtype=6 word=6
TFORM39 = '1B',          / data format of field: BYTE
TFORM40 = 'hdr3tlm67',   / Hdr 3 tlm. imgtype=6 word=7
TFORM40 = '1B',          / data format of field: BYTE
TFORM41 = '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'   /
HDUCLS= = 'ASC'   
HDUCLS1=   
HDUCLS2=   
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 = 5.0814000000000000+04 / 1998-01-01T00:00:00 (TT) expressed in MJD
TIMEZERO= 0.0000000000000000+00 / Cumulative clock correction
TIMEUNIT= 's'   
CLOCKAPP= T / Clock correction applied
TIERRA= 1.0000000000000001E-09 / Short-term clock stability
TIERABS= 1.0000000000000000E-04 / Absolute precision of clock correction
TIMVERS= = 'ASC-FITS-1.1'   / AXAF FITS design document
TSTART = 0.0000000000000000E+00 / As in TIME column: raw S/C clock
STOP = 0.0000000000000000E+00 / add TIMEZERO and MJ DREF for absolute TT
TEMPX= 0.0000000000000000E+00 / 
TIMEDEL = 0.0000000000000000E+00 / Time resolution of data ( in seconds )

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 COMMENT
COMMENT  ################ Observation info keywords ##############
COMMENT
MISSION = 'AXAF' / Advanced X-Ray Astrophysics Facility
TELESCOPE= '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 / On-time 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 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################ 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 = 5.081400000000000E+04 / 1998-01-01T00:00:00 (TT) expressed in MJD
TIMEZERO= 0.000000000000000E+00 / Cumulative clock correction
TIMEUNIT= 's ',
CLOCKAPP= T / Clock correction applied
TSTART = 0.000000000000000E+00 / As in TIME column: raw S/C clock
TSTOP = 0.000000000000000E+00 / add TIMEZERO and MJDREF for absolute TT

COMMENT################ Observation info keywords ################

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COMMENT
MISSION = 'AXAF ' / Advanced X-Ray Astrophysics Facility
TELESCOPE = 'AXAF ' / Telescope used
INSTRUMENT = '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 = 'comcnt' / 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 = 'imgray' / 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  #--------------- 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' /
HDCLASS= 'ASC'
HDCLASS1= /
HDCLASS2= /
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 = 5.081400000000000E+04 / 1998-01-01T00:00:00 (TT) expressed in MJD
TIMEZERO= 0.000000000000000E+00 / Cumulative clock correction
TIMEUNIT= 's' / T / Clock correction applied
CLOCKAPP= 1.000000000000000E-09 / Short-term clock stability
TIERABL= 1.000000000000000E-04 / Absolute precision of clock correction
TIMVERS= 'ASC-FITS-1.1' / AXAF FITS design document
TSTART = 0.000000000000000E+00 / As in TIME column: raw S/C clock
STOP = 0.000000000000000E+00 / add TIMEZERO and MJDREF for absolute TT
TIMEPIXR= 0.000000000000000E+00 / Time resolution of data (in seconds)
TIMEDEL = 0.000000000000000E+00 / Time resolution of data (in seconds)

COMMENT
COMMENT  #--------------- Observation info keywords -------------------#
COMMENT

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MISSION = 'AXAF', / Advanced X-Ray Astrophysics Facility
TELESCOPE = 'AXAF', / Telescope used
INSTRUMENT = 'PCAD',
DETNAM = 'ACA-P', / Detector
GRATING = 'NONE', / HETG, LETG, or NONE
OBJECT = '', / Source name
TITLE = '', / Title of Observation
OBSERVER = '', / Observer or PI
OBS_ID = '', / Observation ID
EQUINOX = 2.000000000000000E+03 / J2000.0
RADECSYS = 'ICRS', / Julian coordinate reference frame
DATACLAS = 'OBSERVED', / default is OBSERVED
ONTIME = 0.000000000000000E+00 / Onetime in seconds
LIVETIME = 0.000000000000000E+00 / Livetime in seconds
EXPOSURE = 0.000000000000000E+00
DTCOR = 0.000000000000000E+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 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' / ASCII encoded HDU checksum
CHECKSUM = , / ASCII encoded data unit checksum in ASCII
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 applied
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
UNIT1 = 's' / physical unit of field
TTYPE2 = 'mrf' / Major frame roll ctr value
TFORM2 = '1J' / data format of field: 4-byte INTEGER
TTYPE3 = 'mjr' / 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
UNIT5 = 's' / physical unit of field
TTYPE6 = 'integ' / integration time
TFORM6 = '1E' / data format of field: 4-byte REAL
UNIT6 = '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 = 'comcnt' / 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 = 'imgstat1' / 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
UNIT18 = 'count' / physical unit of field
TTYPE19 = 'imgraw' / aspect camera image
TFORM19 = '36E' / data format of field: 4-byte REAL
UNIT19 = 'count' / physical unit of field
TTYPE20 = 'bgdrms' / background RMS
TFORM20 = '1E' / data format of field: 4-byte REAL
UNIT20 = 'count' / physical unit of field
TTYPE21 = 'tempccd' / temp 1 - OCD
TFORM21 = '1E' / data format of field: 4-byte REAL
UNIT21 = 'K' / physical unit of field
TTYPE22 = 'temphtous' / temp 2 - AC housing
TFORM22 = '1E' / data format of field: 4-byte REAL
UNIT22 = 'K' / physical unit of field
TTYPE23 = 'tempprim' / temp 3 - lens cell
TFORM23 = '1E' / data format of field: 4-byte REAL
UNIT23 = 'K' / physical unit of field
TTYPE24 = 'tempsec' / temp 4 - secondary mirror
TFORM24 = '1E' / data format of field: 4-byte REAL
UNIT24 = '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
TDM19 = '(6,6)' / size of the multidimensional array

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 =  /
HDSPEC =  /
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'   / Clock correction applied
CLOCKAPP=       T / Clock correction applied
TIERELA= 1.000000000000001E-09 / Short-term clock stability
TIERABSO= 1.000000000000000E-04 / Absolute precision of clock correction
TIMVERSNC= 'ASC-FITS-1.1' / AXAF FITS design document
TSTART = 0.0000000000000000E+00 / As in TIME column: raw S/C clock
STOP = 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= 'PCA'  / Detector
DETNUM = 'ACA-P' / Detector
GRATING = 'NONE' / HETG, LETG, or NONE
OBJECT = ' '  / Source name
TITLE = ' '  / Title of Observation
OBSEVER= ' '  / Observer or PI
OBS_ID = ' '  / Observation ID
EQUINOX = 2.0000000000000000E+03 / J2000.0
RADECYS= 'ICRS' / Julian coordinate reference frame
DATACLASS= 'OBSERVED' / default is OBSERVED
ONTIME = 0.0000000000000000E+00 / On-time in seconds
LIVETIME = 0.0000000000000000E+00 / Livetime in seconds
EXPOSURE= 0.0000000000000000E+00
DCOR = 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 Contact the NASA Science Office of Standards and Technology for the
       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 = 5.08140000000000000E+04 / 1998-01-01T00:00:00 (TT) expressed in MJD
TIMEZERO = 0.0000000000000000E+00 / Cumulative clock correction
TIMEUNIT = 's',
CLOCKAPP= T / Clock correction applied
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 ctrl value
TFORM2 = '1J'           / data format of field: 4-byte INTEGER
TTYPE3 = 'mjf'          / Major frame ctrl value
TFORM3 = '1J'           / data format of field: 4-byte INTEGER
TTYPE4 = 'mnf'          / Minor frame ctrl 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 = 'globstat'     / 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 = 'imgsclae' / 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 = 'imgray' / aspect camera image
TFORM19 = '64E' / data format of field: 4-byte REAL
TUNIT19 = 'count' / physical unit of field
TTYPE20 = 'bgdms' / background 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 = 'tempsel' / 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 = 'hdr3tmpl62' / Hdr 3 tlm. imgtype=6 word=2
TFORM35 = '1B' / data format of field: BYTE
TTYPE36 = 'hdr3tmpl63' / Hdr 3 tlm. imgtype=6 word=3
TFORM36 = '1B' / data format of field: BYTE
TTYPE37 = 'hdr3tmpl64' / Hdr 3 tlm. imgtype=6 word=4
TFORM37 = '1B'   
/ data format of field: BYTE
TTYPE38 = 'hdr3tlm65'   
/ Hdr 3 tlm. imgtpe=6 word=5
TFORM38 = '1B'   
/ data format of field: BYTE
TTYPE39 = 'hdr3tlm66'   
/ Hdr 3 tlm. imgtpe=6 word=6
TFORM39 = '1B'   
/ data format of field: BYTE
TTYPE40 = 'hdr3tlm67'   
/ Hdr 3 tlm. imgtpe=6 word=7
TFORM40 = '1B'   
/ data format of field: BYTE
TTYPE41 = 'hdr3tlm72'   
/ Hdr 3 tlm. imgtpe=7 word=2
TFORM41 = '1B'   
/ data format of field: BYTE
TTYPE42 = 'hdr3tlm73'   
/ Hdr 3 tlm. imgtpe=7 word=3
TFORM42 = '1B'   
/ data format of field: BYTE
TTYPE43 = 'hdr3tlm74'   
/ Hdr 3 tlm. imgtpe=7 word=4
TFORM43 = '1B'   
/ data format of field: BYTE
TTYPE44 = 'hdr3tlm75'   
/ Hdr 3 tlm. imgtpe=7 word=5
TFORM44 = '1B'   
/ data format of field: BYTE
TTYPE45 = 'hdr3tlm76'   
/ Hdr 3 tlm. imgtpe=7 word=6
TFORM45 = '1B'   
/ data format of field: BYTE
TTYPE46 = 'hdr3tlm77'   
/ Hdr 3 tlm. imgtpe=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'   
/      
HDUCLASS1= '    '   
/      
HDUCLASS2= '    '   
/      
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 = 5.08140000000000000E+04 / 1998-01-01T00:00:00 (TT) expressed in MJD
TIMEZERO= 0.00000000000000000E+00 / Cumulative clock correction
TIMEUNIT= 's'   
/
CLOCKAPP= T / Clock correction applied
TIERELA= 1.00000000000001E-09 / Short-term clock stability
TIERABSO= 1.00000000000001E-04 / Absolute precision of clock correction
TIMVERSN= 'ASC-FITS-1.1' / AXAF FITS design document
TSTART = 0.000000000000000E+00 / As in TIME column: raw S/C clock
TSTOP = 0.000000000000000E+00 / add TIMEZERO and MJDREF for absolute TT
TIMEPIXR= 0.000000000000000E+00 /
TIMEDEL = 0.000000000000000E+00 / Time resolution of data ( in seconds )
COMMENT
COMMENT  ############# Observation info keywords #############
COMMENT
MISSION = 'AXAF' / Advanced X-Ray Astrophysics Facility
TELESCOPE = '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 = 2.000000000000000E+03 / J2000.0
FRAME = 'ICRS' / Julian coordinate reference frame
DATACLASS= 'OBSERVED' / default is OBSERVED
ONTIME = 0.000000000000000E+00 / On time in seconds
LIVETIME= 0.000000000000000E+00 / Livetime in seconds
EXPOSURE= 0.000000000000000E+00
DTCOR = 0.000000000000000E+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 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 = 5.08140000000000000E+04 / 1998-01-01T00:00:00 (TT) expressed in MJD
TIMEZERO = 0.0000000000000000E+00 / Cumulative clock correction
TIMEUNIT = 's',
CLOCKAPP = T / Clock correction applied
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 ###################

48
COMMENT
MISSION = 'AXAF',  / Advanced X-Ray Astrophysics Facility
TELESCOP = 'AXAF',  / Telescope used
INSTRUM = '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
TTYTE1 = 'time' / Time-tag of the data record
TTYTE2 = 'mrf' / Major frame roll ctr value
TTYTE3 = 'mjf' / Major frame ctr value
TTYTE4 = 'mnf' / Minor frame ctr value
TTYTE5 = 'address' / start address
TTYTE6 = 'memory' / 24 bytes of memory data
TTYTE7 = '24B' / data format of field: BYTE
TTYTE8 = 'checksum' / checksum
TTYTE9 = '1I' / data format of field: 2-byte INTEGER
EXTNAME = 'MEM_DUMP' / name of this binary table extension

COMMENT

COMMENT

COMMENT # Configuration control keywords #
COMMENT ORIGIN = 'ASC'
CREATOR = 'xxx - Version 0.0'

COMMENT

COMMENT # Processing system revision number
REVISION= 0 / Processing system revision number

COMMENT

COMMENT

COMMENT # ASC FITS Designers Guide
HDUDOC = 'ASC-FITS-1.1'

COMMENT

COMMENT # The OGIP long string convention may be used.
LONGSTRN = 'OGIP 1.0'

COMMENT

COMMENT # Timing info keywords #
COMMENT

COMMENT

COMMENT # FITS file creation date (dd/mm/yy)
DATE = '05/02/99'

COMMENT

COMMENT

COMMENT # TT, with clock correction if CLOCKAPP
DATE- OBS= 

COMMENT

COMMENT # TT, with clock correction if CLOCKAPP
DATE-END= 

50
TIMESYS = 'TT' / AXAF time will be TT (Terrestrial Time)
MJDREF = 5.081400000000000E+04 / 1998-01-01T00:00:00 (TT) expressed in MJD
TIMEZERO = 0.000000000000000E+00 / Cumulative clock correction
TIMEUNIT = 's' / Clock correction applied
TIERELA= 1.000000000000000E-09 / Short-term clock stability
TIERABSO 1.000000000000000E-04 / Absolute precision of clock correction
TIMVERS = 'ASC-FITS-1.1' / AXAF FITS design document
TSTART = 0.000000000000000E+00 / As in TIME column: raw S/C clock
TSTOP = 0.000000000000000E+00 / add TIMEZERO and MJDREF for absolute TT
TIMEPIXR = 0.000000000000000E+00 / TIMEDEL = 0.000000000000000E+00 / Time resolution of data (in seconds)
COMMENT
COMMENT  #Observation info keywords###########
COMMENT
MISSION = 'AXAF' / Advanced X-Ray Astrophysics Facility
TELESCOPE = 'AXAF' / Telescope used
INSTRUME = 'PCAD' / Detector
DETNAM = 'ACA-P' / Detector
GRATING = 'NONE' / HETG, LETG, or NONE
OBJECT = ' ' / Source name
TITLE = ' ' / Title of Observation
OBSERVER = ' ' / Observer or PI
OBS_ID = ' ' / Observation ID
EQUINOX = 2.000000000000000E+03 / J2000.0
RADECSYS = 'ICRS' / Julian coordinate reference frame
DATACLASS = 'OBSERVED' / default is OBSERVED
ONTIME = 0.000000000000000E+00 / On-time in seconds
LIVETIME = 0.000000000000000E+00 / Livetime in seconds
EXPOSURE = 0.000000000000000E+00
DTCOR = 0.000000000000000E+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 transferred 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 + 27×8 = 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 on 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):

<table>
<thead>
<tr>
<th>Segment</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bytes 0 - 4 (header info)</td>
</tr>
<tr>
<td>1</td>
<td>27 bytes of image data</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Segment</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bytes 0 - 4 (header info)</td>
</tr>
<tr>
<td>1</td>
<td>27 bytes of image data</td>
</tr>
<tr>
<td>2</td>
<td>27 bytes of image data</td>
</tr>
</tbody>
</table>

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

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<th>Type</th>
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### 8×8 Aspect Data

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D.2 Calibration and encoding

D.2.1 Temperatures

The output product columns tempccd, tempshous, tempprim, tempsec are converted from un-calibrated to a calibrated float (degrees C) using the equation

\[ \text{temp<<} = 0.4 \times \text{raw<<} \]

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:

\[ \text{imgraw[*]} = \text{imgraw[*]} \times \text{imgscale} / 32.0 - 50.0 \]

D.2.3 Background average and background RMS

It should be noted that the BGDAVG and BGRMS 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:

\[
\begin{align*}
\text{end_integ_time} &= \text{AXAF\_TIME(VCDU\_CTR)} - 1.025 \text{ (sec)} \\
\text{time} &= \text{end_integ_time} - \text{integ} / 2.0 \text{ (sec)}
\end{align*}
\]

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 decommemories in the following way. For 4 x 4 and 8 x 8 images,

\[
\begin{align*}
\text{imgrow0} &= \text{IMGROWA1} \\
\text{imgcol0} &= \text{IMGCOLA1}
\end{align*}
\]

For 6 x 6 images,

\[
\begin{align*}
\text{imgrow0} &= \text{IMGROWA1} - 1 \\
\text{imgcol0} &= \text{IMGCOLA1} - 1
\end{align*}
\]

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:

\[(4 \times 4)\]

SIGPIXI1, SIGPIXI2, SIGPIXI3, SIGPIXI4,
SIGPIXI5, SIGPIXI6, SIGPIXI7, SIGPIXI8,
SIGPIXI9, SIGPIXI10, SIGPIXI11, SIGPIXI12,
SIGPIXI13, SIGPIXI14, SIGPIXI15, SIGPIXI16,
SIGPIXI17, SIGPIXI18, SIGPIXI19, SIGPIXI20
(6 x 6)
0.0, SIGPIXA2, SIGPIXB2, SIGPIXC2, SIGPIXD2, 0.0,
SIGPIXP2, SIGPIXA1, SIGPIXB1, SIGPIXC1, SIGPIXD1, SIGPIXE2,
SIGPIX02, SIGPIXE1, SIGPIXF1, SIGPIXG1, SIGPIXH1, SIGPIXF2,
SIGPIXN2, SIGPIXI1, SIGPIXJ1, SIGPIXK1, SIGPIXL1, SIGPIXG2,
SIGPIXM2, SIGPIXM1, SIGPIXN1, SIGPIX01, SIGPIXP1, SIGPIXH2,
0.0, SIGPIXL2, SIGPIXK2, SIGPIXJ2, SIGPIXI2, 0.0

(8 x 8)
SIGPIXI1, SIGPIXJ1, SIGPIXK1, SIGPIXL1, SIGPIXM1, SIGPIXN1, SIGPIX01, SIGPIXP1,
SIGPIXA2, SIGPIXB2, SIGPIXC2, SIGPIXD2, SIGPIXE2, SIGPIXF2, SIGPIXG2, SIGPIXH2,
SIGPIXI2, SIGPIXJ2, SIGPIXK2, SIGPIXL2, SIGPIXM2, SIGPIXN2, SIGPIX02, SIGPIXP2,
SIGPIXA3, SIGPIXB3, SIGPIXC3, SIGPIXD3, SIGPIXE3, SIGPIXF3, SIGPIXG3, SIGPIXH3,
SIGPIXI3, SIGPIXJ3, SIGPIXK3, SIGPIXL3, SIGPIXM3, SIGPIXN3, SIGPIX03, SIGPIXP3,
SIGPIXA4, SIGPIXB4, SIGPIXC4, SIGPIXD4, SIGPIXE4, SIGPIXF4, SIGPIXG4, SIGPIXH4,
SIGPIXI4, SIGPIXJ4, SIGPIXK4, SIGPIXL4, SIGPIXM4, SIGPIXN4, SIGPIX04, SIGPIXP4