XMM

Interface Control Document: Observation and Slew Data Files (XSCS to SSC) (SciSIM to SOCSIM)

XMM-SOC-ICD-0004-SSD Issue 2.12

Written by: K. Galloway
Custodian: M. Guainazzi

June 11, 2002

Revision history

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Issue 1.0	October 9, 1997	K. Galloway	Updated with comments on Draft 2.0
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Agreed by R.Munoz (CCB chairman): ....

Agreed by G.Vacanti (SOC): ....

Agreed by J.Osborne (SSC): ....

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1 Introduction

1.1 Purpose

This document has 2 purposes:

1. To define the ODF/ SDF interface between the XSCS and the SSC.
2. To define the interface between SciSIM and SOCSIM.

Within the context of the XSCS to SSC interface the format and content of the ODF/ SDF component files are defined and the source of the stored data identified.

The files generated by SciSIM conform to the format defined for the relevant ODF/ SDF component file. This document identifies any differences in content between the SciSIM generated data files and the ODF/ SDF component files.

1.2 Scope

This document is principally concerned with the definition of the component files of an ODF/ SDF and the definition of the files generated by SciSIM.

This document defers the identification of the mechanisms involved in transferring the ODF/ SDF from the XSCS to the SSC to the relevant ICDs. The transfer of ODFs and SDFs from the SOC to the SSC are detailed in [1] while the transfer of the SciSIM output files to the SOCSIM is described in [2].

This document defines the component files which make up an ODF/ SDF and identifies the sources of the data which are to be stored in these files. This document does not detail the process by which this data can be extracted from its source. For example, it does not detail the decompression and reconstruction of data required to be performed on instrument science telemetry in order to retrieve the original on-board data values.

This document defines the data files generated by SciSIM in terms of their format and content differences from the corresponding ODF/ SDF component files. Additionally it identifies those records of each file which contain time information and which will need to be set by SOCSIM. This document does not describe the process by which the output files of SciSIM can be reverse engineered for inclusion in the SOCSIM telemetry stream. This process is detailed in [3].

The reader is assumed to be familiar with FITS and the details of the XMM telemetry stream. The user is also assumed to be familiar with the proposed method of partitioning the XMM data into ODFs and SDFs (detailed in [4]).

1.3 Documentation

From the following documents the applicable documents are: [5] [1] [2] [6] [7] [8] [9] [10] [11] [12] [13] [14] [15] [16] [17] [18].

From the following documents the reference documents are: [4] [19] [3] [20] [21] [22] [23] [24] [25] [26] [27] [28] [29] [30] [31] [32] [34] [35].

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1.4 Acronyms

AMS	Archive Management Subsystem
AO	Announcement Of Opportunity
AOCS	Attitude and Orbital Control System
APID	Application Identifier
CCD	Charge Coupled Device
CDMU	Control and Data Management Unit
CSG	Clock Sequence Generator
COBT	Central (CDMU) On-Board Time
CPU	Central processing Unit
DPP	Data Pre Processor
DPU	Data Processing Unit
EOL	End of Line
EPIC	European Photon Imaging Camera
EPDH	EPIC p-n Data Handler
ERMS	EPIC Radiation Monitor System
ERT	Earth Received Time
ESOC	European Satelitte Operation Center
FITS	Flexibel Image Transport System
FOV	Field of View
HBR	High Bit Rate (Interface)
h/k	Housekeeping
IA	Interactive Analysis
IAS	Interactive Analysis Subsystem
ID	Identifier
ITB	Image/ Timing/ Burst
JD	Julian Day
LEOP	Launch and Early Orbit Phase
LTMS	Local Time Management System
MMI	Man-Machine Interface
MOC	Mission Operation Center
MOS	Metal Oxide Semiconductor (EPIC)
MOUT	Message Out
MSB	Most Significant Bit
OBDH	Onboard Data Handler
OCB	On Chip Binning
ODF	Observation Data File
ODS	Observation Data Subsystem
OLA	Off-Line Analysis
OM	Optical Monitor
OTF	On-Target Flag
PCS	Payload Calibration Subsystem
PGO	Principal Guest Observer
PHS	Proposal Handling Subsystem
PI	Principle Investigator
POS	Preferred Observation Sequence
PMS	Payload Monitoring Subsystem
p-n	p-type/n-type semiconductor (EPIC)
PSF	Preferred Skeleton File
QLA	Quicklook Analysis
RBI	Remote Bus Interface
RGS	Reflection Grating Spectrometer
SCOS	Spacecraft Operation Control System

SDF	Slew Data File
SGS	Sequence Generation Subsystem
SHF	Short History File
SID	Structure Identifier
SOC	Science Operation Center
SSC	survey Science Centre
SSRD	Specific Science Requirement Document
S/C	Spacecraft
TBC	To be confirmed
TBD	To be defined
TC	Telecommand
TM	Telemetry
URD	User Requirement Document
UT	Universal Time
UTC	Universal Time (Coordinated)
XMM	X-ray Multi Mirror Mission
XFTS	XMM File Transfer System
XSCS	XMM SOC Control System

1.5 Glossary of Terms

- **Configuration:** For each instrument a fixed set of commandable conditions which are set up in order to take science and/ or calibration or engineering data.
- **Exposure:** The time during which science data is generated by an instrument when held in a fixed configuration. By implication, all data from one exposure will be in the same format.

  For the X-ray instruments an exposure comprises many CCD frames which are assembled on ground. For the OM an exposure is accumulated in memory before telemetering. More than one subsequent exposures can be made and telemetered under the same OM instrument fixed configuration period.
- **Exposure Period:** The period of time from the start of configuring an X-ray instrument for an exposure until the end of the exposure itself.
- **Fixed Configuration Period:** The time period in which an instrument is held in a fixed configuration. For the X-ray instruments this is an Exposure Period. For the OM instrument this is the period of time from the start of configuring the instrument until the start of the next configuring of the instrument.

  Note: It is currently envisaged that each instrument will initially go to a default mode to reconfigure and then go to the required mode. In this document the fixed configuration period includes this set-up period.
- **Frame:** A data set generated by a detector during a quantised period, such as a single CCD readout or an interim photon-counting image accumulated in a memory. For the X-ray cameras the frames will be identified by a changing time stamp associated with a CCD readout. OM has blue tracking frames, which are accumulated in memory. These are not telemetered as individual data units. The OM defines a separate temporal unit in timing mode as a TIME SLICE, in order to reduce confusion in nomencalture.
- **Frame Time:** The time for collection of photons within one CCD or other (eg. tracking) FRAME.
- **Instrument Slew Period:** The period of time from the start of configuring an instruments for a slew until the instrument is reconfigured at the end of the slew. The instrument slew period consists of an integer number (nominally 1) of fixed configuration periods. The time period covered by all the Instrument Slew Periods for a slew constitutes a Slew Period.
- **Observation:** An observation by definition has an entry in the Proposal Information Database.
- **Observation Data File:** The files created by the ODS from the data corresponding to an observation period.
- **Observation Period:** The period of time from the start of configuring the spacecraft and instruments for an observation until the end of the actual observation itself. Please note that, in order to archive all data, the end of observation is extended until the start of the next slew (or observation) for housekeeping telemetry and auxiliary files.
- **Slew:** The movement of the spacecraft from one attitude to another. Please note that, in order to archive all data, the end of slew is extended until the start of the next observation (or slew) for housekeeping telemetry and auxiliary files
- **Slew Data File:** The files created by the ODS from the data corresponding to a slew period.

- **Slew Period:** The period of time from the start of configuring the spacecraft and instruments for a slew until the end of the actual slew itself. A slew period will in all likelihood consist of a single fixed configuration period for each instrument but it could be more.

2 Operational Assumptions and Constraints

All XMM instruments (including the AOCS) maintain a copy of XMM S/C time using the so-called RBI chip. The RBI chip however has one minor flaw; the copy it maintains has 3 bytes for the seconds increment counter, whereas the S/C uses 4 bytes. The instruments thus have a 3 byte copy of the S/C clock in their RBI chip, and the MSB byte in their memory. There is however, NO provision for a carry bit between these two sets of bytes. This means that every 2^{24} seconds, the instrument clocks wrap around to 0, except for the most significant byte of the S/C clock copy, this does not change.

Assumption 1: A reset of the EPIC instrument clock will nominally be performed before the wrap-around occurs.

Assumption 2: For the RGS instruments the instrument and spacecraft clocks are synchronized at least every time the RGS is rebooted, and as a minimum approximately every 6 months (to avoid counter overflow) [24].

The generic solution foreseen is to have all ODF reading S/W replace the MSB's of the instruments copy of the S/C clock replaced by the 4th byte of the actual S/C clock.

3 Requirements

3.1 Functional Requirements

None.

3.2 On-line Data Delivery Requirements

None.

3.3 Off-line Data Delivery Requirements

None.

4 Interface Characteristics

4.1 Interface Location and Medium

4.1.1 ODF/ SDF Transfer Between XSCS and SSC

Details are given in [1].

4.1.2 File Transfer Between SciSIM and SOCSIM

Details are given in [2].

4.2 Hardware Characteristics and Limitations

4.2.1 ODF/ SDF Transfer Between XSCS and SSC

Details are given in [1].

4.2.2 File Transfer Between SciSIM and SOCSIM

Details are given in [2].

4.3 Data Source, Destination and Transfer Mechanism

4.3.1 ODF/ SDF Transfer Between XSCS and SSC

Details are given in [1].

4.3.2 File Transfer Between SciSIM and SOCSIM

Details are given in [2].

4.4 Node and Device Addressing

4.4.1 ODF/ SDF Transfer Between XSCS and SSC

Details are given in [1].

4.4.2 File Transfer Between SciSIM and SOCSIM

Details are given in [2].

4.5 Relationships with other Interfaces

4.5.1 ODF/ SDF Transfer Between XSCS and SSC

Details are given in [1].

4.5.2 File Transfer Between SciSIM and SOCSIM

Details are given in [2].

5 Access

5.1 Interface Utility Software

5.1.1 ODF/ SDF Transfer Between XSCS and SSC

Details are given in [1].

5.1.2 File Transfer Between SciSIM and SOCSIM

Details are given in [2].

5.2 Failure Protection, Detection and Recovery Procedures

5.2.1 ODF/ SDF Transfer Between XSCS and SSC

Details are given in [1].

5.2.2 File Transfer Between SciSIM and SOCSIM

Details are given in [2].

5.3 File Naming Convention

5.3.1 ODF/ SDF

5.3.1.1 ODF/ SDF Component Files

The filenames associated with ODFs and SDFs will comply with ISO 9660 level 2. They are subject to the following additional constraints:

- Filenames will be up to 27 characters, followed by a '.' (dot), followed by 3 characters.
- All filename characters are upper case.
- Where a fixed number of digits are specified, leading zeros will be present if the field would not otherwise be filled.
- only the following characters are allowed: A-Z, 0-9, '_' (underscore) and '.' (dot).

The naming convention adopted for the ODF/ SDF component files is as follows:

RRRR_PPPPPPOOLL_IIUEEECCMMF.ZZZ

where:

- RRRR is the revolution (orbit) number
- PPPPPPOOLL is the unique 10 digit observation identifier assigned by the XSCS. PPPPPP is the identifier of the proposal which contains the observation and OOLL is the identifier of the observation within the proposal. For slews this 10 digit identifier will be a unique identifier with:
  - The first character of the identifier being '9'.
  - The next four characters repeating the revolution number (RRRR).
  - The last five characters being an incremental counter of the slews associated with the revolution. The first slew of a revolution always has the value '00001'.

  This 10 digit identifier is that assigned to the observation/ slew by the mission planning process.
- II is the instrument identifier:
  - OM: optical monitor
  - R1: RGS-1
  - R2: RGS-2
  - M1: EPIC MOS-1
  - M2: EPIC MOS-2
  - PN: EPIC p-n
  - RM: EPIC Radiation Monitor
  - SC: Spacecraft
- U is a flag to indicate whether or not the exposure was scheduled (S = scheduled, U = unscheduled, X = not applicable). See Section 5.3.4 for additional details.
- EEE is the exposure number within the observation. See Section 5.3.4 for details.
- CC is the CCD identifier/ OM Window identifier.
  - EPIC MOS instruments: For the EPIC MOS instruments the first 'C' will be the CCD number (1-7) and the second 'C' will be the CCD read-out node (0,1)
  - EPIC p-n instrument: For the EPIC p-n instrument 'CC' is the CCD number (01-12). The CCD number is calculated using the formula Quad_Id * 3 + (CCD_No + 1).
  - RGS instruments: For the RGS instruments 'CC' is the CCD number (00-15). **Note:** CCD number 0 and 10-15 represent internally generated data. For example, CCD number = 13 is the RFC hardwired test pulse generator CCD [32]. That is, spectroscopy and diagnostic modes provide the possiblity to inject charge with the on-board test generator. This will be identified in the diagnostic mode telemetry as CCD 13 (Section 7.6.5).
  - OM instrument: For the OM instrument 'CC' is the science window identifier. **Note** The science window identifier is available in the Standard Data Set Header [7].
  - For those files which which do not having a corresponding CCD or science window (for example, the spacecraft files) this field will take the value '00'
  - OM Fast mode and image mode data are treated in the same numbering scheme. Fast and Image mode data do not have independant numbering schemes. The cc number follows the sequence of the window list in the DP_WDW dataset

- MM is the data contained within the file
  - EPIC MOS
    - IM: Imaging
    - TI: Timing
    - RI: Reduced Imaging
    - CT: Compressed Timing
    - AU: Auxiliary
    - DI: Diagnostic
    - OV: Offset/ Variance
    - CC: Counting Cycle Report (Auxiliary File)
    - PE: Periodic Housekeeping
    - HC: HBR Configuration Non-periodic Housekeeping
    - HB: HBR Buffer Size Non-periodic Housekeeping
    - HT: HBR Threshold Values Non-periodic Housekeeping
    - EC: Extraheating Configuration Non-periodic Housekeeping
    - TM: Thermal Monitoring Limits Non-periodic Housekeeping
    - PT: Bright Pixel Table Non-periodic Housekeeping
  - EPIC p-n
    - IM: Imaging
    - TI: Timing
    - BU: Burst
    - AU: Auxiliary
    - DI: Diagnostic
    - OD: Offset Data
    - NO: Noise Data
    - DL: Discarded Lines Data
    - CC: Counting Cycle Report (Auxiliary File)
    - PM: Main Periodic Housekeeping
    - PA: Additional Periodic Housekeeping
    - HC: HBR Configuration Non-periodic Housekeeping
    - HB: HBR Buffer Size Non-periodic Housekeeping
    - TM: Thermal Monitoring Limits Non-periodic Housekeeping
  - EPIC Radiation Monitor
    - EC: ERM Count Rate
    - ES: ERM Spectra
  - RGS
    - SP: Spectroscopy
    - HT: High Time Resolution
    - AU: Auxiliary
    - DI: Diagnostic
    - PF: Full Periodic Housekeeping
    - *Item deleted.*
    - PC: CCD Temperature Periodic Housekeeping
    - D1: DPP Non-periodic Housekeeping
    - D2: DPP Non-periodic Housekeeping

- OM
  - IM: Imaging
  - FA: Fast
  - En: Engineering where n=1-7 (see Section 7.8.9)
  - PA: Priority Field Acquisition (Auxiliary File)
  - WD: Priority Window Data (Auxiliary File)
  - PF: Priority Fast (Auxiliary File)
  - TH: Tracking History (Auxiliary File)
  - RF: Reference Frame (Auxiliary File)
  - PE: Periodic Housekeeping
  - NP: Non-periodic Housekeeping
- Spacecraft
  - AT: Attitude
  - RA: Raw Attitude
  - DA: Dummy Attitude
  - PO: Predicted Orbit
  - RO: Reconstructed Orbit
  - TC: Time Correlation
  - P1: Housekeeping 1 Periodic Housekeeping
  - P2: Housekeeping 2 Periodic Housekeeping
  - P3: Attitude 1 Periodic Housekeeping
  - P4: Attitude 2 Periodic Housekeeping
  - P5: SYS_HK_SID0 Periodic Housekeeping
  - P6: SYS_HK_SID1 Periodic Housekeeping
  - P7: SYS_HK_SID4 Periodic Housekeeping
  - P8: SYS_HK_SID5 Periodic Housekeeping
  - P9: SYS_HK_SID6 Periodic Housekeeping
- SU: Summary Information

- F is the file type:
  - E: event list file
  - I: image file
  - X: auxiliary file
  - H: housekeeping
  - S: spacecraft
  - M: summary
- ZZZ is the file format and can be one of:
  - FTZ. A compressed FITS file
  - ASZ. A compressed ASCII file
  - FIT. A FITS file
  - ASC. An ASCII file

All ODF/ SDF component files are either FITS or ASCII files. If these files are transferred to the SSC without first being compressed then the file formats FIT and ASC should be used. If they are compressed then FTZ and ASZ should be used.

5.3.1.2 ODF transfer from SOC to SSC

An ODF/ SDF is stored within the XMM archive as:

1. An ODF/ SDF summary file
2. A spacecraft orbit file
3. A spacecraft attitude file
4. A spacecraft time correlation file
5. A tar file containing all of the other ODF/ SDF component files

The transport of the ODFs and SDFs to the SSC uses the XTFS and must adhere to the XFTS filenaming convention [1]. The naming of the summary file, the spacecraft orbit, attitude and time correlation files will be as described above in Section 5.3.1.1. The naming convention used for the tar file will be:

RRRR_PPPPPPOOLL.TAR

where the meaning of RRRR and PPPPPPOOLL is descibed in Section 5.3.1.1 and TAR identifies the file as being a tar file.

The XFTS tar file [1] containing the 5 files identified above will have the filename:

FFFF_SORDES_TXXXXXXXXXXXXXXX_VVVVV.XMM

where

- FFFF is the file type identifier and always has the value 'ODF_' for ODFs and 'SDF_' for SDFs.
- SOR is the source mnemonic and always has the value 'SOC'.
- DES is the destination mnemonic and always has the value 'SSC'.
- T is the data type identifier and always has the value 'D'
- XXXXXXXXXXXXXXX is the file specific field and has the form PPPPPPOOLL (see Section 5.3.1.1).
- VVVVV is the file version number (00001 - 99999).
- XMM identifies the project as being XMM.

5.3.1.2.1 Transaction File

The transaction file [1] is used by systems which are submitting data to the AMS. Therefore, it is assumed that there is no transaction file associated with the transfer of an ODF or SDF from the AMS to the SSC.

The SSC will use the information contained within the observation summary file (Section 7.12) to determine the contents of an ODF.

5.3.2 SciSIM Output Files

There are no constraints placed upon the names allocated to the SciSIM output files. The naming of the files is at the SciSIM users discretion. Procedures defining the format of the filenames must be established by the various users of the SciSIM output files. The following users are identified:

- SOCSIM (Pre-IC File Conversion Utility). SciSIM output files are converted by this utility into a form suitable for input to SOCSIM. The format of the filenames for these files should be defined in [2].
- Science Analysis Subsystem. SciSIM output files are processed by this subsystem. The format of the filenames for these files should be defined in the relevant documentation.

5.3.3 Radiation Monitor Fixed Configuration Period Files

The naming convention for the EPIC Radiation Monitor FCP files will be:

RRRR_RADMONITOR_IIUEEECCMMF.ZZZ

where the exposure number field (EEE) is an internal counter to distinguish files generated for FCPs with the same revolution number. All other fields (II, U, CC, MM F and ZZZ) are as described in Section 5.3.1.1.

5.3.4 Exposure numbering for the ODF/ SDF component files

There is a 3 character exposure number field associated with every ODF/ SDF component file (Section 5.3.1.1). The values for this field are allocated as follows to the files associated with each observation/ slew:

1. Scheduled exposures.
   Note: A scheduled exposure is denoted by an "S" in the exposure scheduled/ unscheduled field of the filename (Section 5.3.1.1).
   (a) For the science primary exposures (those submitted by the PI) the exposure number is a monotonically increasing sequential counter from 1-399 which is independent of instrument.
   (b) For SOC added exposures the exposure is a monotonically increasing sequential counter from 400-899 which is independent of instrument.
   (c) In the special case of RGS Spectroscopy + Q exposures (Section 7.6.5) the exposure number associated with the diagnostic Q files is a monotonically increasing sequential counter from 900-999 (the generated spectroscopy files use the exposure numbering scheme (a) or (b) above). The first diagnostic Q dump file resulting from an RGS spectroscopy + Q mode exposure will be allocated an exposure number of '900'. The exposure number will be incremented by 1 for each subsequent diagnostic Q-dump file. This exposure number allocation is local to an observation. That is, the first diagnostic Q dump of any observation will begin with '900'. Note: The exposure identifier keyword in the header of the file will be that corresponding to the spectroscopy + Q exposure.

2. Unscheduled exposures.
   Note: An unscheduled exposure is denoted by a "U" in the exposure scheduled/ unscheduled field of the filename (Section 5.3.1.1).

   The exposure number is a monotonically increasing sequential counter from 1-999 which is local to each instrument.

3. Exposure number is not applicable.
   For those files which do not correspond to exposure periods (for example, the spacecraft files) this field will take the value '000'.

4. Schedule flag not applicable.
   For completeness it is also stated that the scheduled/ unscheduled flag will be set to "X" when there is no meaning to the notion of scheduled/ unscheduled. This is the case for:

   (a) All instrument housekeeping files. In these cases the exposure number is '000'.
   (b) All spacecraft files (see Section 7.1.4). In these cases the exposure number is '000'.
   (c) EPIC radiation monitor files. In this case the exposure counter starts from '001' and increases for each radiation monitor fixed configuration period overlapping the observation/ slew.

5.4 Storage and File Detection Requirements

5.4.1 ODF/ SDF Transfer Between XSCS and SSC

Details are given in [1].

5.4.2 File Transfer Between SciSIM and SOCSIM

Details are given in [2].

5.5 Security Requirements

5.5.1 ODF/ SDF Transfer Between XSCS and SSC

Details are given in [1].

5.5.2 File Transfer Between SciSIM and SOCSIM

Details are given in [2].

5.6 Data Integrity Checks

5.6.1 ODF/ SDF Transfer Between XSCS and SSC

Details are given in [1].

5.6.2 File Transfer Between SciSIM and SOCSIM

Details are given in [2].

5.7 Backup Requirements

5.7.1 ODF/ SDF Transfer Between XSCS and SSC

Details are given in [1].

5.7.2 File Transfer Between SciSIM and SOCSIM

Details are given in [2].

5.8 Error Handling

5.8.1 Transport/ Network Layer

5.8.1.1 ODF/ SDF Transfer Between XSCS and SSC

Details are given in [1].

5.8.1.2 File Transfer Between SciSIM and SOCSIM

Details are given in [2].

5.8.2 Application Layer

5.8.2.1 ODF/ SDF Transfer Between XSCS and SSC

Details are given in [1].

5.8.2.2 File Transfer Between SciSIM and SOCSIM

Details are given in [2].

6 Detailed Interface Specifications

6.1 Data Structure

6.1.1 ODF/SDF

The data structures addressed in this document are the component files of ODFs and SDFs. An ODF or SDF consists of all the data files generated for a specific observation or slew [4]. Observations and slews consist of a number of exposures for each active instrument. Each instrument will be in a specific mode of operation for each exposure. The instrument data files which are generated for each instrument mode of operation are described in Section 7. Spacecraft files are also generated for each observation and slew [4]. These files are also described in Section 7.

6.1.2 SciSIM Output

The data structures generated by SciSIM are described in Section 8.

6.2 Generation Method

6.2.1 ODF/SDF

The component files of ODFs and SDFs are generated from the XMM telemetry and associated data files by the XSCS Observation Data Subsystem [4].

6.2.2 SciSIM Output

The output files of SciSIM are generated by first setting the simulator to the required configuration for each instrument that is to be operational during the simulation run. The required names for the SciSIM output files is also specified. Having configured the instruments and specified the filenames the simulation run is started and the output files generated [19].

6.3 Data Passed Across the Interface and Their Direction

6.3.1 ODF/SDF

XFTS wrapped ODFs and SDFs are passed from the SOC to the SSC using the XFTS.

6.3.2 SciSIM Output

Details are given in [2].

6.4 Size and Frequency of Transfers

6.4.1 ODF/SDF

The transfer of XFTS wrapped ODFs and SDFs from the SOC to the SSC is continuous and is estimated at 750 MBytes per day (compressed).

6.4.2 SciSIM Output

Details are given in [2].

6.5 Timing and Synchronisation Requirements

6.5.1 ODF/ SDF Transfer Between XSCS and SSC

Details are given in [1].

6.5.2 File Transfer Between SciSIM and SOCSIM

Details are given in [2].

7 ODF/ SDF Data Definition

7.1 Overview of the ODF/ SDF Component Files

This section details all possible ODF/ SDF component files. There are 5 categories of ODF/ SDF component file:

- Instrument science files
- Instrument housekeeping files
- Radiation monitor science files
- Spacecraft files
- Summary files

All of the ODF/ SDF component files, with the exception of the summary files, are FITS files and conform to the FITS standard [15]. The details of the various categories are presented below:

7.1.0.1 Primary Header Contents

All ODF/ SDF FITS files share a common primary header structure. The primary header unit consists of, in the order given:

1. The mandatory FITS Primary Header Keywords. For more details refer to [15].
   (a) SIMPLE. Value is always 'T' signifying that the file conforms to the FITS standard.
   (b) BITPIX. Value is always 8 and indicates that the data in the primary array (although no actual data is present) consists of 8-bit unsigned integers.
   (c) NAXIS. Value is always 0 indicating that there is no data associated with the current header.
   (d) EXTEND. Value is always 'T' indicating that extensions are present in this file.
2. General file information
   (a) ORIGIN: The processing site
   (b) DATE: The (UTC) file creation date in the form yyyy-mm-ddThh:mm:ss
   (c) FILENAME: The name of the file
   (d) CREATOR: The system generating the code and the applicable version of the ODF ICD. It is a string up to 18 characters that could take the following values depending on whether the FITS files was generated by PMS or ODS:

   ```
   - PMS/ODF Vxxxxxxxxx
   - ODS/ODF Vxxxxxxxxx
   ```

   where `xxxxxxxxx` is a string of at most 9 characters representing the version number of the applicable ODF ICD.
   (e) CATEGORY: This file is part of an ODF or SDF
   (f) ODSVER: the version number of the ODS used to create the ODF or SDF. This version number should change each time any constituent part of the ODS changes

(g) ODSCHAIN: it indicates whether the ODF was processed by the operational or the bulk reprocessing line. Possible values are: "`OPER `" or "`BKRP `" (8 characters)

3. END statement

Note 1: The syntax for the UTC time is yyyy-mm-ddThh:mm:ss and not yyyy-mm-ddThh:mm:ssZ. This is compliant with the latest FITS definition of UTC times. This applies to all UTC time formats used throughout this ICD.

Note 2: Unless otherwise stated the epoch for all UTC time references will be 1958 January 1.

Note 3: All ODF header records will have a relevant comment associated with them.

The following is given as an example of an ODF/ SDF FITS file primary header.

```
SIMPLE  =                    T / Standard FITS format
BITPIX  =                    8 / Character information
NAXIS   =                    0 / No image array data present
EXTEND  =                    T / An extension is present
ORIGIN  = 'XMM-SOC'            / Processing site
DATE    = '1999-09-21T12:12:12'/ File creation date
FILENAME= '    '               / Filename
CREATOR = 'PMS/ODF V2.4'       / FITS generated code
CATEGORY= 'XMMODF'             / The file is part of an XMM ODF
ODSVER  = '10.1'               / The ODS version number
ODSCHAIN= 'OPER    '           / ODS line
END
```

7.1.1 Instrument Science Files

No calibration of the science telemetry is performed before it is stored in the instrument science files. The science parameters are extracted from the telemetry packets and stored in their raw form with, in general, no further processing being performed. Where any additional processing is required in order to generate an instrument science file then it is described in the relevant section for that file.

All instrument science files are FITS files and are of 1 of 2 types; a binary table file or an image file. A binary table file consists of a primary header unit, a primary data unit of zero length and 1 or 2 binary table extension header data units. These binary table files are further classified in this document as being either an event list file or an auxiliary file. An event list file contains the events detected on a specific CCD during an exposure while an auxiliary file contains the frame/ cycle information, plus any other general information, generated for all of the CCDs active during the exposure. An ODF/ SDF image file consists of a primary header unit, a primary data unit of zero length and 1 image extension header data unit.

7.1.1.1 Binary Table Extension Header Contents

Each binary table extension header unit consists of, in the order given:

1. The mandatory FITS Binary Table Extension Header Keywords. For more details refer to [15].

(a) XTENSION. Value is always 'BINTABLE' indicating that the extension is a binary table.

(b) BITPIX. Value is always 8 indicating 8 bit bytes.

(c) NAXIS. Value is always 2 indicating a 2 dimensional binary table.

(d) NAXIS1. The number of bytes in a row of the binary table.

(e) NAXIS2. Number of rows in the binary table and is equal to the number of events detected.

(f) PCOUNT. Value is always 0 indicating that no data values precede the binary table.

(g) GCOUNT. Value is always 1 indicating that only 1 binary table is present

(h) TFIELDS. Number of columns in each row of the binary table.

(i) EXTNAME. The name assigned to this extension. This is a reserved (not mandatory) FITS keyword which is always present in the ODF FITS file binary table extension headers. The convention used for these files is instrument (II) plus datatype (MM) plus filetype (F) plus extension number (1, 2). Refer to Section 5.3.1 for further details.

(j) EXTVER. The version of this extension. The initial value is 1. Any subsequent modification to the extension (change in format, change in keyword names, etc.) will result in the EXTVER value being incremented by 1. This is a reserved (not mandatory) FITS keyword which is always present in the ODF FITS files.

2. Common Instrument Keywords. The science files associated with each instrument have a collection of common keywords. The Common Instrument Keywords for each instrument are described in the relevant sections. If for a given instance of a binary table extension a common instrument keyword is not applicable then it will not appear in that header. Those common keywords which are not applicable are detailed with each file description.

3. TFORM, TTYPE and TUNIT keywords which describe the contents of the binary table. Each binary table is described in terms of a table in which the values to be assigned to TTYPE, TFORM and TUNIT are specified in columns 1 to 3 respectively (see Table 3 for an example). For a description of the format conventions (values for the TFORM keyword) used in this document refer to Section 7.1.6.

4. END statement

Note: All ODF header records will have a relevant comment associated with them.

Taking an EPIC MOS Imaging Mode Event List File as an example the first extension binary table would have the format:

```
XTENSION= 'BINTABLE'           / Binary Table FITS file extension
BITPIX  =                    8 / Binary extension contains 8 bit bytes
NAXIS   =                    2 / Mandatory for binary table extension
NAXIS1  =                   18 / Number of bytes in a row
NAXIS2  =                 9999 / Number of tabulated rows
PCOUNT  =                    0 / No data values precede the binary table
GCOUNT  =                    1 / 1 table
TFIELDS =                    9 / Number of columns in each row
EXTNAME = 'M1IME1  '           / Extension name
EXTVER  =                    1 / Extension version
TELESCOP= 'XMM     '           / XMM mission
INSTRUME= 'EMOS1   '           / EPIC MOS Instrument
DATATYPE= 'IMAGE.EL'           / Type of data
```

```
OBS_ID  = 'XXXXXXXXXX'         / Observation Identifier
EXP_ID  = 'XXXXXXXXXXYYY'      / Exposure Identifer
CCDID   =                    1 / Numerical Identifier of the CCD (1-7)
CCDNODE =                    0 / CCD Node
WINDOWX0=                    0 / X-coordinate of bottom left corner of window
WINDOWY0=                    0 / Y-coordinate of bottom left corner of window
WINDOWDX=                  600 / Size, along x-axis, of window
WINDOWDY=                  600 / Size, along y-axis, of window
EDUID   =                    1 / EDU Identifier
EDUMODE =                    3 / EDU Mode
EDUTHR  =                  200 / EDU Threshold
FRMTIME =                  260 / Frame Time
EMDHLOW =                 1000 / EMDH Lower Threshold
EMDHUPP =                 2000 / EMDH Upper Threshold
DATE-OBS= '1999-09-21T12:12:12'/ Start time of exposure
DATE-END= '1999-09-21T14:14:14'/ End time of exposure
TFORM1  = '1J      '           / Field 1 - 32-bit integer
TTYPE1  = 'FRAME   '           / Frame Number
TUNIT1  = 'COUNTER '           / Counter
TFORM2  = '1I      '           / Field 2 - 16-bit integer
TTYPE2  = 'RAWX    '           / Event X Position
TUNIT2  = 'PIXEL   '           / Pixels
TFORM3  = '1I      '           / Field 3 - 16-bit integer
TTYPE3  = 'RAWY    '           / Event Y Position
TUNIT3  = 'PIXEL   '           / Pixels
TFORM4  = '1I      '           / Field 4 - 16-bit integer
TTYPE4  = 'ENERGYE1'           / Event Energy (E1)
TUNIT4  = 'CHANNEL '           / Channels
TFORM5  = '1I      '           / Field 5 - 16-bit integer
TTYPE5  = 'ENERGYE2'           / Event Energy (E2)
TUNIT5  = 'CHANNEL '           / Channels
TFORM6  = '1I      '           / Field 6 - 16-bit integer
TTYPE6  = 'ENERGYE3'           / Event Energy (E3)
TUNIT6  = 'CHANNEL '           / Channels
TFORM7  = '1I      '           / Field 7 - 16-bit integer
TTYPE7  = 'ENERGYE4'           / Event Energy (E4)
TUNIT7  = 'CHANNEL '           / Channels
TFORM8  = '1B      '           / Field 8 - 8-bit integer
TTYPE8  = 'PATTERN '           / Pattern Number
TUNIT8  = ' '                  / Units are TBD
TFORM9  = '1B      '           / Field 9 - 8-bit integer
TTYPE9  = 'PERIPIX '           / Periph Pix above Threshold Cntr
TUNIT9  = 'PIXELS  '           / Pixels
```

7.1.1.2 Image Extension Header Contents

Each image extension header unit consists of, in the order given:

1. The mandatory FITS image extension header keywords. For more details refer to [15].
   (a) XTENSION. Value is always 'IMAGE ' indicating that the extension is an image.
   (b) BITPIX. Can take of 8, 16 or 32. This describes how the array (image) values are represented.

(c) NAXIS. This is the number of axis in the image (the number of dimensions of the array).

(d) NAXISn, n=1,...,NAXIS. This is the number of elements along axis n of the array.

(e) PCOUNT. Value is always 0 indicating that no data values precede the binary table.

(f) GCOUNT. Value is always 1 indicating that only 1 binary table is present

(g) EXTNAME. The name assigned to this extension. This is a reserved (not mandatory) FITS keyword which is always present in the ODF FITS file binary table extension headers. The convention used for these files is instrument (II) plus datatype (MM) plus filetype (F) plus extension number (1, 2). Refer to Section 5.3.1 for further details.

(h) EXTVER. The version of this extension. The initial value is 1. Any subsequent modification to the extension (change in format, change in keyword names, etc.) will result in the EXTVER value being incremented by 1. This is a reserved (not mandatory) FITS keyword which is always present in the ODF FITS files.

2. Common Instrument Keywords. The science files associated with each instrument have a collection of common keywords. The Common Instrument Keywords for each instrument are described in the relevant sections. If for a given instance of an image extension a common instrument keyword is not applicable then it will not appear in that header. Those common keywords which are not applicable are detailed with each file description.

3. Specific Keywords. Keywords which are specific to that instance of the image file type. For example, the OM science file 'OM Imaging Mode Image File' has the keyword BUNIT following the collection of OM science common keywords.

4. END statement

When describing an ODF/ SDF image file in the subsequent file descriptions the values of BITPIX, NAXIS, NAXISn and the specific keywords are detailed.

Note: All ODF header records will have a relevant comment associated with them.

Taking an OM imaging mode image file as an example the image extension header would have the format:

```
XTENSION= 'IMAGE   '           / Image FITS file extension
BITPIX  =                   32 / Image elements are 32 bit integers
NAXIS   =                    2 / 2-D image array present
NAXIS1  =                   64 / Size, along the x-axis, of the window
NAXIS2  =                   64 / Size, along the y-axis, of the window
PCOUNT  =                    0 / No data values precede the image
GCOUNT  =                    1 / 1 table
EXTNAME = 'OMIMI1  '           / Extension name
EXTVER  =                    1 / Extension version
TELESCOP= 'XMM     '           / Constant string indicating XMM mission
INSTRUME= 'OM      '           / Instrument to which data applicable
CHAIN   =                    1 / OM detector chain
DATATYPE= 'DD_IMG  '           / Type of data
OBS_ID  = 'XXXXXXXXXX'         / Observation Identifier
EXP_ID  = 'XXXXXXXXXXYYY'      / Exposure Identifer
TMEXPID =                    2 / Exposure Identifer identified in the telemetry
SCIWIN  =                    1 / Science Window Identifier
PARAM   =                    0 / Parameter associated with image mode data
FRMTIME =                   10 / Frame integration time
WINDOWX0=                    0 / X-coordinate of bottom left corner of window
```

```
WINDOWY0=                    0 / Y-coordinate of bottom left corner of window
WINDOWDX=                   64 / Size, along x-axis, of window
WINDOWDY=                   64 / Size, along y-axis, of window
DATE-OBS= '1999-09-21T12:12:12'/ Start time of exposure
DATE-END= '1999-09-21T14:14:14'/ End time of exposure
BUNIT   = 'COUNTS  '           / The units of the image are ounts
END
```

7.1.2 Instrument Housekeeping Files

7.1.2.1 Instrument Periodic Housekeeping Files

Each instrument periodic housekeeping file contains the **calibrated** instrument periodic housekeeping parameters and instrument related derived parameters. The periodic housekeeping parameters are extracted from the telemetry packets and the derived parameters calculated. The parameters are then calibrated using the applicable calibration curve (as defined in the XMM telemetry database) and stored, with the corresponding time key, in the relevant instrument periodic housekeeping file.

Only the generic details of the instrument periodic housekeeping files are presented in this document. The exact specification of the periodic housekeeping parameters, how they are calibrated and how they are stored within the periodic housekeeping files is to be found in the Operational Database definition.

All instrument periodic housekeeping files are FITS files. They consist of a primary header unit, a primary data unit of zero length and a binary table extension header data unit. Each calibrated instrument housekeeping parameter or derived parameter being represented by a column of the binary table.

7.1.2.1.1 Primary Header Contents

All ODF/ SDF FITS files share a common primary header structure. The primary header unit is as described in Section 7.1.0.1.

7.1.2.1.2 Binary Table Extension Header Contents

Each binary table extension header unit consists of, in the order given:

1. The mandatory FITS Binary Table Extension Header Keywords. As described in Section 7.1.1.1.
2. Common Instrument Housekeeping File Keywords. Each instrument housekeeping file has the additional, non-mandatory keywords detailed in Table 1.
3. TFORM, TTYPE and TUNIT keywords which describe the contents of the binary table. The first column of the binary table contains the reception time, in UTC format, of the telemetry packet containing the periodic housekeeping parameters. All subsequent columns contain the calibrated instrument periodic housekeeping parameters. For a description of the format conventions (values for the TFORM keyword) used in this document refer to Section 7.1.6.
4. END statement

Note: All ODF header records will have a relevant comment associated with them.

Table 1: Instrument Housekeeping Files Common Information Keywords

Keyword	Keyword Value	Identifier in Telemetry Definition	Comments
Instrument Housekeeping Files: Common Information Keywords			
TELESCOP	'XMM'	N/A	Note 1
INSTRUME		N/A	Note 2
DATATYPE	'PERHK.EL' 'NPERHK.EL'	N/A	Note 3
OBS_ID		N/A	Note 4
EXP_ID		N/A	Note 5
DATE-OBS			Note 6
DATE-END			Note 7

Notes on Table 1

1. Identifies the observatory as being XMM
2. Identifies the instrument.
   - EMOS1
   - EMOS2
   - EPN
   - ERM
   - RGS1
   - RGS2
   - OM
3. The type of data held in the file.
4. Observation/ Slew Identifier (10 characters) assigned in the XMM archive.
5. Exposure Identifier (13 characters).
6. Start time (UTC) of observation as calculated by XSCS (yyyy-mm-ddThh:mm:ss). Please note that the start time is earlier by a configurable margin (nominally set to 10 minutes) than the actual observation start in order to archive instrument set-up data
7. End time (UTC) of observation as calculated by XSCS . (yyyy-mm-ddThh:mm:ss). Please note that the end time is later than the actual obseration end as it extends until the next slew (or observation) start time.

7.1.2.2 Instrument Non-Periodic Housekeeping Files

All instrument non-periodic housekeeping files are FITS files. They consist of a primary header unit, a primary data unit of zero length and a binary table extension header data unit.

7.1.2.2.1 Primary Header Contents

All ODF/ SDF FITS files share a common primary header structure. The primary header unit is as described in Section 7.1.0.1.

7.1.2.2.2 Binary Table Extension Header Contents

Each binary table extension header unit consists of, in the order given:

1. The mandatory FITS Binary Table Extension Header Keywords. As described in Section 7.1.1.1.
2. Common Instrument Housekeeping File Keywords. Each instrument housekeeping file has the additional, non-mandatory keywords detailed in Table 1.
3. TFORM, TTYPE and TUNIT keywords which describe the contents of the binary table. The first column of the binary table contains the reception time, in UTC format, of the non-periodic housekeeping report. All subsequent columns contain the details of the non-periodic housekeeping report. For a description of the format conventions (values for the TFORM keyword) used in this document refer to Section 7.1.6.
4. END statement

Note: All ODF header records will have a relevant comment associated with them.

7.1.3 EPIC Radiation Monitor Science Files

The ODS creates 2 sets of EPIC radiation monitor science files:

- EPIC radiation monitor fixed configuration period files. These are EPIC radiation monitor science files created for each EPIC radiation monitor fixed configuration period. The EPIC radiation monitor performs independently of the other XMM instruments and has fixed configuration periods which do not correspond to the observation/ slew period concept. These files are a separate data type within the archive and do not constitute part of an ODF/ SDF. Note: These files will be closed at the end of each revolution. That is, the maximum duration covered by an EPIC radiation monitor fixed configuration period file is 1 revolution.
- EPIC radiation monitor observation/ slew period files. These are EPIC radiation monitor science files which correspond to observation and slew periods. The EPIC radiation monitor data is partitioned to correspond to observation and slew periods. These file do form part of an ODF/ SDF and are described in this document. Note: If the EPIC radiation monitor should change configuration during an observation or slew period then the corresponding ODF/ SDF would contain 2 EPIC radiation monitor observation/ slew period files.

All EPIC radiation monitor files are FITS files. They consist of a primary header unit, a primary data unit of zero length and a binary table extension header data unit. The 2 sets of files (EPIC radiation monitor fixed configuration period files and EPIC radiation monitor observation/ slew period files) have the same format and structure. The only difference between the 2 sets of files is the time periods covered.

7.1.3.0.3 Primary Header Contents

All ODF/ SDF FITS files share a common primary header structure. The primary header unit is as described in Section 7.1.0.1.

7.1.3.0.4 Binary Table Extension Header Contents

Each binary table extension header unit consists of, in the order given:

1. The mandatory FITS Binary Table Extension Header Keywords. As described in Section 7.1.1.1.
2. Common EPIC Radiation Monitor File Keywords. Each instrument periodic housekeeping file has the additional, non-mandatory keywords. These are detailed in the relevant section.
3. TFORM, TTYPE and TUNIT keywords which describe the contents of the binary table. For a description of the format conventions (values for the TFORM keyword) used in this document refer to Section 7.1.6.
4. END statement

Note: All ODF header records will have a relevant comment associated with them.

7.1.4 Spacecraft Files

The following spacecraft files are generated such that they contain information relating to an observation or slew period.

- Spacecraft time correlation file
- Spacecraft attitude history file
- Spacecraft raw attitude history file
- Spacecraft dummy attitude file
- Spacecraft predicted orbit file
- Spacecraft reconstructed orbit file
- Spacecraft periodic housekeeping files

The specific details of these files are presented in the relevant sections. The generic details are that all spacecraft files (except the orbit files) are FITS files and they consist of a primary header unit, a primary data unit of zero length and a binary table extension header data unit. Note: the exact specification of the periodic housekeeping parameters, how they are calibrated and how they are stored within the periodic housekeeping files is to be found in the Operational Database definition

7.1.4.1 Primary Header Contents

All ODF/ SDF FITS files share a common primary header structure. The primary header unit is as described in Section 7.1.0.1.

7.1.4.2 Binary Table Extension Header Contents

Each binary table extension header unit consists of, in the order given:

1. The mandatory FITS Binary Table Extension Header Keywords. As described in Section 7.1.1.1.
2. Common Periodic Housekeeping File Keywords. These common keywords are detailed in the relevant section.
3. TFORM, TTYPE and TUNIT keywords which describe the contents of the binary table. The details of the binary table are specific to each spacecraft filetype. For a description of the format conventions (values for the TFORM keyword) used in this document refer to Section 7.1.6.
4. END statement

Note: All ODF header records will have a relevant comment associated with them.

7.1.5 Summary Files

There is a single summary file associated with each ODF and SDF. The summary files are ASCII files containing a summary of the information relating to the observation or slew. This summary information includes:

- Observation/ slew record. This record provides the general details relating to the observation/ slew.
- File details record. Identifies all of the files contained within the ODF/ SDF.
- Instrument details. Records describe the configuration of the instrument for each exposure in terms of its mode and its instrument programmable parameters. The time details of each exposure all also provided.
- A summary of the proposal information. The PGO, PGO address and target details are provided.
- A summary of the data quality during the observation/ slew.

7.1.6 Datatypes in the ODF/ SDF component files

This document identifies the following datatypes (where n is an integer value greater than or equal to 1):

- nB: n unsigned 8 bit integers. Where this is specified for an ODF/ SDF component file the actual implementation will be TFORM = nB.
- nI: n signed 16 bit integers. Where this is specified for an ODF/ SDF component file the actual implementation will be TFORM = nI.
- nU: n unsigned 16 bit integers. Where this is specified for an ODF/ SDF component file the actual implementation will be TFORM = nI, TZERO = 32768 (2^{15}) and TSCAL = 1. The value can then be retrieved using stored_value * TSCAL + TZERO

- nJ: n signed 32 bit integers. Where this is specified for an ODF/ SDF component file the actual implementation will be TFORM = nJ.
- nV: n unsigned 32 bit integers. Where this is specified for an ODF/ SDF component file the actual implementation will be TFORM = nJ, TZERO = 2147483648 (2^{31}) and TSCAL = 1. The value can then be retrieved using stored_value * TSCAL + TZERO
- nE: n 32 bit IEEE floating point numbers. Where this is specified for an ODF/ SDF component file the actual implementation will be TFORM = nE.
- nA: n 8 bit ASCII characters.Where this is specified for an ODF/ SDF component file the actual implementation will be TFORM = nA.

7.2 EPIC MOS Science Files

7.2.1 Overview of EPIC MOS Science Files

The following EPIC MOS science files are defined:

- EPIC MOS Imaging Mode Event List File.
- EPIC MOS Reduced Imaging Mode Event List File
- EPIC MOS Timing Mode Event List File.
- EPIC MOS Compressed Timing Mode Event List File
- EPIC MOS Auxiliary File.
- EPIC MOS Diagnostic Mode Image File
- EPIC MOS Offset/ Variance Mode Event List File
- EPIC MOS Counting Cycle Report Auxiliary File

A brief overview of the EPIC MOS science telemetry is given in Section C.1.

In the tables describing the EPIC MOS Science files in this section all telemetry references are taken from the Science Telemetry Data Formats in applicable document [11].

7.2.1.1 EPIC MOS Science Files Common Instrument Keywords

The common instrument keywords (see Section 7.1.1.1 and 7.1.1.2) associated with EPIC MOS science files are detailed in Table 2 along with their possible values and their location within the EPIC MOS science telemetry definition where applicable. If for a given instance of an EPIC MOS extension a common instrument keyword is not applicable then it will not appear in that header. Those common keywords which are not applicable are detailed with each file description.

Table 2: EPIC MOS Science Files Common Information Keywords

Keyword	Keyword Value	Identifier in EPIC MOS Telemetry Definition [11]	Comments
EPIC MOS Science Files Common Information Keywords			
TELESCOP	'XMM'	N/A	Note 1
INSTRUME	'EMOS1 ' 'EMOS2 '	N/A	Note 2
DATATYPE		N/A	Note 3
OBS_ID		N/A	Note 4
EXP_ID		N/A	Note 5
CCDID	1-7	CCD ID in Header data formats	
CCDNODE	0,1	CCD Node in Header data formats	Note 6
WINDOWX0	0-609	Window X0-Position in Header Data Formats	Note 7
WINDOWY0	0-601	Window Y0-Position in Header Data Formats	Note 7
			continued on next page

continued from previous page			
Keyword	Keyword Value	Identifier in EPIC MOS Telemetry Definition [11]	Comments
WINDOWDX	0-610	Window ΔX in Header Data Formats	
WINDOWDY	0-602	Window ΔY in Header Data Formats	
EDUID	0-7	EDU ID in Trailer data formats	
EDUMODE	0-3	EDU Mode in Header data formats	
EDUTHR	0-4095	EDU THRES. MSBits, EDU Threshold and EDU Threshold LSBits in Header Data Formats	Note 8
FRMTIME	0-1023	INTEGRAT. TIME MSBits and INTEGRAT. LSBits in Header Data Formats	Note 9,10
EMDHLOW	0-32767	Programmed EMDH Lower Threshold in Trailers	
EMDHUPP	0-32767	Programmed EMDH Upper Threshold in Trailers	
DATE-OBS			Note 11
DATE-END			Note 12

Notes on Table 2

1. Identifies the observatory as being XMM
2. Identifies the instrument as being an EPIC MOS instrument
3. The type of data held in the file. The possible values are:
   - 'IMAGE.EL'. An event list containing imaging mode data.
   - 'RIMAGE.EL'. An event list containing reduced imaging mode data.
   - 'TIME.EL'. An event list containing timing mode data.
   - 'CTIME.EL'. An event list containing compressed timing mode data.
   - 'AUX.EL'. An event list containing auxiliary data.
   - 'DIAG.IM'. An image containing diagnostic mode data.
   - 'OFFVAR.EL'. An event list containing offset/ variance mode data.
   - 'COUNT.EL'. An event list containing counting cycle report data.
4. Observation/ Slew Identifier (10 characters) assigned in the XMM archive.
5. Exposure Identifier (13 characters) as assigned in the XMM archive.
6. The keyword 'CCDNODE' can have the values:
   - 0: Nominal
   - 1: Redundant
7. The X, Y coordinates are of the bottom corner of the current selected read-out window close to the selected output node.
8. The EDU Threshold is defined in the science telemetry in 3 components: EDU Threshold MSBits (2 bits), EDU Threshold (5 bits) and EDU Threshold LSBits (5 bits). The ODS must combine these 3 components to produce the final 12 bit EDU Threshold parameter.
9. The Frame Accumulation Time. This is refered to as the integration time in the Imaging/ Timing Mode full format header. It has a resolution of 100 ms [11].

10. The integration time is defined in the science telemetry in 2 components: Integration Time MSBits (5 bits) and Integration Time LSBits (5 bits). The ODS must combine these 2 components to produce the final Integration Time parameter. If the integration time is set to 0, it means the CCD is read out in free running mode (the integration time is EMAE sequence dependent).

11. Start time (UTC) of exposure as calculated by XSCS (yyyy-mm-ddThh:mm:ss). This time will not be the precise exposure start time as the accurate orbit and attitude information is not available to the XSCS when the time is calculated. It will however be calculated using the available time correlation information.

12. End time (UTC) of exposure as calculated by XSCS (yyyy-mm-ddThh:mm:ss).

7.2.1.2 General Comments Relating to the EPIC MOS Science Files

1. Section B.1 defines how the frame counter in the EPIC MOS science files will be calculated.

7.2.2 EPIC MOS Imaging Mode Event List File

- An EPIC MOS imaging mode event list file will be created for each CCD node which is producing imaging mode data
- Each EPIC MOS imaging mode event list file will contain the details of each detected event on the specified CCD node during an exposure.
- Each EPIC MOS imaging mode event list file will consist of a single binary table.
- All EPIC MOS common instrument keywords are applicable (Section 7.2.1.1).
- The binary table will consist of the columns detailed in Table 3

Table 3: EPIC MOS Imaging Mode Event List File: Binary Table Columns

Name	Type	Units	Comment	Location in EPIC MOS Imaging Mode Telemetry [11]
FRAME	1J	COUNTER	Frame Number	Full Format Header (see Section 7.2.1.2)
RAWX	1I	PIXEL	Event X Position	Full Format Event Data
RAWY	1I	PIXEL	Event Y Position	Full Format Event Data
ENERGYE1	1I	CHANNEL	Event Energy (E1)	Full Format Event Data
ENERGYE2	1I	CHANNEL	Event Energy (E2)	Full Format Event Data
ENERGYE3	1I	CHANNEL	Event Energy (E3)	Full Format Event Data
ENERGYE4	1I	CHANNEL	Event Energy (E4)	Full Format Event Data
PATTERN	1B		Pattern Number	Full Format Event Data
PERIPIX	1B		Periph. Pixels above Thresh. Counter	Full Format Event Data

7.2.3 EPIC MOS Reduced Imaging Mode Event List File

- An EPIC MOS reduced imaging mode event list file will be created for each CCD node which is producing reduced imaging mode data
- Each EPIC MOS reduced imaging mode event list file will contain the details of each detected event on the specified CCD node during an exposure.
- Each EPIC MOS reduced imaging mode event list file will consist of a single binary table.
- All EPIC MOS common instrument keywords are applicable (Section 7.2.1.1).
- Each binary table will consist of the columns detailed in Table 4

Table 4: EPIC MOS Reduced Imaging Mode Event List File: Binary Table Columns

Name	Type	Units	Comment	Location in EPIC MOS Imaging Mode Telemetry [11]
FRAME	1J	COUNTER	Frame Identifier	Full Format Header (see Section 7.2.1.2)
RAWX	1I	PIXEL	Event X Position	Reduced Format Event Data
RAWY	1I	PIXEL	Event Y Position	Reduced Format Event Data
ENGYE1E2	1I	CHANNEL	Event Energy (E1+E2)	Reduced Format Event Data
PATTERN	1B		Pattern Number	Reduced Format Event Data
PERIPIX	1B		Periph. Pixels above Thresh. Counter	Reduced Format Event Data

7.2.4 EPIC MOS Timing Mode Event List File

- An EPIC MOS timing mode event list file will be created for each CCD node which is producing timing mode data
- Each EPIC MOS timing mode event list file will contain the details of each detected event on the specified CCD node during
- Each EPIC MOS timing mode event list file will consist of a single binary table.
- All EPIC MOS common instrument keywords are applicable (Section 7.2.1.1).
- Each binary table will consist of the columns detailed in Table 5.

Table 5: EPIC MOS Timing Mode Event List File: Binary Table Columns

Name	Type	Units	Comment	Location in EPIC MOS Timing Mode Telemetry [11]
FRAME	1J	COUNTER	Frame Identifier	Time Info (see Section 7.2.1.2)
RAWX	1I	PIXEL	Event X Position	Full Format Event Data
RAWY	1I	PIXEL	Event Y Position	Full Format Event Data
ENGYE1E2	1I	CHANNEL	Event Energy (E1+E2)	Full Format Event Data
PATTERN	1B		Pattern Number	Full Format Event Data
PERIPIX	1B		Periph. Pixels above Thresh. Counter	Full Format Event Data

7.2.5 EPIC MOS Compressed Timing Mode Event List File

- An EPIC MOS compressed timing mode event list file will be created for each CCD node which is producing compressed timing mode data.
- Each EPIC MOS compressed timing mode event list file will contain the details of each detected event on the specified CCD node during an exposure.
- Each EPIC MOS compressed timing mode event list file will consist of a single binary table.
- All EPIC MOS common instrument keywords are applicable (Section 7.2.1.1).
- Each binary table will consist of the columns detailed in Table 6. Note that the binary table has the same format as the EPIC MOS timing mode event list file.

Table 6: EPIC MOS Compressed Timing Mode Event List File: Binary Table Columns

Name	Type	Units	Comment	Location in EPIC MOS Timing Mode Telemetry [11]
FRAME	1J	COUNTER	Frame Identifier	Time Info (see Section 7.2.1.2)
RAWX	1I	PIXEL	Event X Position	Full Format Event Data Not available in Compressed format Event *Data*[1]
RAWY	1I	PIXEL	Event Y Position ΔY	Full Format Event Data Compressed Format Event *Data*[2]
ENGYE1E2	1I	CHANNEL	Event Energy (E1+E2)	Full Format Event Data Compressed Format Event Data
PATTERN	1B		Pattern Number	Full Format Event *Data*[3]
PERIPIX	1B		Periph. Pixels above Thresh. Counter	Full Format Event *Data*[3]

Notes on Table 6:

1. The Event X Position field is not present in the compressed format event data. The value '-1' is assigned when a compressed event is received.
2. When a compressed event is received the Y coordinate must be reconstructed using the previous Y value: Y= Previous Y + *Delta*Y.
3. The Pattern Number and the Number of Peripheral Pixels above the Threshold Counter are not present in the compressed format event data. The value 255 is assigned when a compressed event is recieved.

7.2.6 EPIC MOS Auxiliary File

- An EPIC MOS auxiliary file will be created for each exposure in which at least one CCD is producing either imaging (full or reduced) mode or timing (full or compressed) mode data.
- Each EPIC MOS auxiliary file will contain the details of each frame/ cycle (for all CCDs) of the exposure.
- There will be a single binary table combining all of the frame/ cycle information.
- The frame identifier in the EPIC MOS auxiliary file is the link with the frame/ cycle information in the imaging (full and reduced) and timing (full or compressed) mode event list files.
- The applicable EPIC MOS common keywords (Section 7.2.1.1) are:
  - TELESCOP
  - INSTRUME
  - DATATYPE
  - OBS_ID
  - EXP_ID
  - DATE-OBS
  - DATE-END
- Each binary table will consist of the columns detailed in Table 7

Table 7: EPIC MOS Auxiliary File: Binary Table Columns

Name	Type	Units	Comment	Location in EPIC MOS Imaging/ Timing Mode Telemetry [11]
FRAME	1J	COUNTER	Frame Identifier	Full Format Header/Time Info[2] (see Section 7.2.1.2)
CCDID	1B		CCD Identifier	Full Format Header
CCDNODE	1B		CCD Node Identifier	Full Format Header
FTCOARSE	1I	SECOND	Coarse Frame Time	Trailer and/ or Time Info[1]
FTFINE	1I		Fine Frame Time	Trailer and/ or Time Info[1]
NPIXEL	1J	PIXEL	Pixel Count	Trailer and/ or Time Info[1]
NVALID	1I	COUNTS	No. of valid events	Trailer and/ or Time Info[1]
NBELOW	1I	COUNTS	No of events rejected by lower thresholding	Trailer and/ or Time Info[1]
NABOVE	1I	COUNTS	No of events rejected by upper thresholding	Trailer and/ or Time Info[1]
GATTIFLG	1B		Gatti Flag	Full Format Header
FIFOOVF	1B		FIFO Overflow Flag	Trailer and/ or Time Info[1]

Notes on Table 7:

1. If the Trailer or Time-info is not available (typically the last frame/ cycle [11]) then these fields will all be set to 0 (zero).
2. For imaging modes the frame number is taken from the header data structure while for timing modes the frame number is taken from the time-info data structure.

7.2.7 EPIC MOS Diagnostic Mode Image File

- An EPIC MOS diagnostic mode image file will be created for each CCD node which is producing diagnostic mode data
- Each EPIC diagnostic mode image file will contain a single image.
- The 2-D image can be reconstructed from the stream of events by using the EOL flag in the Event Data data format [11].
- The following EPIC MOS common keywords are not applicable (Section 7.2.1.1).
  - *Item deleted.*
  - EMDHLOW
  - EMDHUPP
- The specific keywords and the BITPIX and NAXIS values for a diagnostic mode image file extension header are detailed in Table 8. This information is to be used in conjunction with that contained in Section 7.1.1.2.

Table 8: EPIC MOS Diagnotic Mode Image File: Image Extension Keyword Details

Keyword	Keyword Value	Location in EPIC MOS Diagnostic Mode Telemetry [11]	Comments
Mandatory FITS Extension Header Keywords			
BITPIX	16	N/A	Note 1
NAXIS	2	N/A	
NAXIS1		Window-ΔX in Header	Note 2
NAXIS2		Window-ΔY in Header	Note 3
EPIC MOS Diagnostic Mode Specific Keywords			
FRAME		Frame Number in Header and Trailer	
FTCRSE		Coarse Time in Trailer	
FTFINE		Fine Time in Trailer	
NPIXEL		Pixel Count (MSBits+LSBits) in Trailer	
FIFOOVF		FIFO OVF in Trailer	

Notes on Table 8:

1. 16 bit array corresponding to the Pixel Energy in the energy data formats.
2. NAXIS1 will have the value of Window-ΔX in the Header data format.
3. NAXIS2 will have the value of Window-ΔY in the Header data format.

7.2.8 EPIC MOS Offset/ Variance Mode Event List File

- An EPIC MOS offset/ variance mode event list file will be created for each CCD node which is producing offset/ variance mode data
- Each EPIC MOS offset/ variance mode event list file will contain a single offset/ variance frame.
- An EPIC MOS offset/ variance mode event list file consists of a single binary table extension.
- The following EPIC MOS common keywords are not applicable (Section 7.2.1.1).
  - *Item deleted.*
  - EMDHLOW
  - EMDHUPP
- The binary table extension header will contain the additional keywords shown in Table 9.
- The binary table will consist of the columns detailed in Table 10.

Table 9: EPIC MOS Offset/Variance Mode Event List File: Additional Header Keyword Details

Keyword	Keyword Value	Location in EPIC MOS Offset/ Variance Mode Telemetry [11]	Comments
EPIC MOS Offset/ Variance Mode Additional Header Keywords			
FRAME		Frame Number in Header and Trailer	
FTCRSE		Coarse Time in Trailer	
FTFINE		Fine Time in Trailer	
CCDVAR		CCD Variance in Trailer	
NPIXEL		Pixel Count (MSBits+LSBits) in Trailer	
FIFOOVF		FIFO OVF in Trailer	

Table 10: EPIC MOS Offset/ Variance Mode Event List File: First Binary Table Columns

Name	Type	Units	Comment	Location in EPIC MOS Offset/ Variance Mode Telemetry [11]
COLOFFST	610I		Column offset values	Offset Data
ROWOFFST	602I		Row offset values	Offset Data

Notes on Table 10

1. *2 items deleted.*

7.2.9 EPIC MOS Counting Cycle Report Auxiliary File

- An EPIC MOS counting cycle report auxiliary file will be created for each exposure in which at least one imaging or timing counting cycle report is generated.
- An EPIC MOS counting cycle report auxiliary file will contain all counting cycle reports generated during the exposure.
- There will be a single binary table containing all of the report information.
- The applicable EPIC MOS common keywords (Section 7.2.1.1) are:
  - TELESCOP
  - INSTRUME
  - DATATYPE
  - OBS_ID
  - EXP_ID
  - DATE-OBS
  - DATE-END
- Each binary table will consist of the columns detailed in Table 11

Table 11: EPIC MOS Counting Cycle Report Auxiliary File: Binary Table Columns

Name	Type	Units	Comment	Location in EPIC MOS Telemetry [11]
HBRID	1I	COUNTER	HBR Identifier	Counting Cycle Report
STCOARSE	1J	SECOND	Coarse Start Time	Counting Cycle Report
STFINE	1U		Fine Start Time	Counting Cycle Report
ETCOARSE	1J	SECOND	Coarse End Time	Counting Cycle Report
ETFINE	1U		Fine End Time	Counting Cycle Report
VECNTR	1I	COUNTER	Cumulative valid events counter	Counting Cycle Report
VEOVF	1B	FLAG	Cumulative valid events overflow flag	Counting Cycle Report
RELTCNTR	1I	COUNTER	Cumulative rejected events by lower threshold	Counting Cycle Report
RELTOVF	1B	FLAG	Cumulative rejected events by lower threshold overflow flag	Counting Cycle Report
REUTCNTR	1I	COUNTER	Cumulative rejected events by upper threshold	Counting Cycle Report
REUTOVF	1B	FLAG	Cumulative rejected events by upper threshold overflow flag	Counting Cycle Report
FRAMCNTR	1I	COUNTER	Cumulative frame/ cycle counter	Counting Cycle Report
FRAMOVF	1B	FLAG	Cumulative frame/ cycle overflow flag	Counting Cycle Report

7.3 EPIC MOS Housekeeping Files

7.3.1 EPIC MOS Periodic Housekeeping File

- There is only 1 type of EPIC MOS periodic housekeeeping telemetry. It is [11]:
  - H/K Main TM packets (SID=10).
- An EPIC MOS periodic housekeeping file will be created for each EPIC MOS instrument.
- Each EPIC MOS periodic housekeeping file will contain the calibrated periodic housekeeping parameters produced during an observation period.
- Each EPIC MOS periodic housekeeping file will contain the calibrated derived parameters, relevant to the corresponding telemetry packet, produced during an observation period.
- All common instrument housekeeping keywords are applicable (Section 7.1.2).
- Each EPIC MOS periodic housekeeping file will consist of a single binary table.
- The binary table will consist of the columns detailed in Table 12

Table 12: EPIC MOS Periodic Housekeeping File: Binary Table Columns

Name	Type	Units	Comment	Location in EPIC MOS Per. HK Telemetry [11]
TIME	19A	yyyy-mm-ddThh:mm:ss	ERT	Note 1
PARAM1				Note 2,6
...	...	...	...	
PARAMn				Note 6
DERPAR1				Note 3,4,5,6
...	...	...	...	
DERPARm				Note 6

Notes on Table 12:

1. The XSCS calculated UTC Earth Received Time associated with each periodic housekeeping telemetry packet.
2. The description of the raw periodic housekeeping parameters is given in [11] (Annex 4). There will be a binary table column allocated to each identified periodic housekeeping parameter.
3. The derived parameters will be stored after the periodic housekeeping telemetry.
4. The details of the derived parameters are currently unknown and will not be known until they have been defined as part of operational procedures.
5. In all likelihood the derived parameters associated with an instrument will change over the lifetime of XMM. The derived parameters relevant at the time of file generation will be stored.
6. The exact specification of the periodic housekeeping parameters, how they are calibrated and how they are stored within the periodic housekeeping files is to be found in the Operational Database definition. The correspondence between the IPPV definition and the HK parameters is detailed in Appendix A.

7.3.2 EPIC MOS Non-Periodic Housekeeping Files

7.3.2.1 EPIC MOS HBR Configuration Non-Periodic Housekeeping File

- An EPIC MOS HBR configuration non-periodic housekeeping file will be created for each EPIC MOS instrument.
- Each EPIC MOS HBR configuration non-periodic housekeeping file will contain the "HBR configuration" telemetry management data produced during an observation period.
- An EPIC MOS HBR configuration non-periodic housekeeping file will only be created if "HBR configuration" telemetry management data is detected during an observation period.
- Each EPIC MOS HBR configuration non-periodic housekeeping file will consist of a single binary table.
- The applicable EPIC MOS common keywords (Section 7.2.1.1) are:
  - TELESCOP
  - INSTRUME
  - DATATYPE
  - OBS_ID
  - EXP_ID
  - DATE-OBS
  - DATE-END
- The binary table will consist of the columns detailed in Table 13

Table 13: EPIC MOS HBR Configuration Non-Periodic Housekeeping File: Binary Table Columns

Name	Type	Units	Comment	Location in EPIC MOS Non-Per. HK Telemetry [11]
TIME	19A	yyyy-mm-ddThh:mm:ss	ERT[1]	
HBRID	1B		HBR identifier[2]	HBR configuration tm packet
HBRACTIV			HBR Active Ch[3]	HBR configuration tm packet
HBRPROC			HBR Processing[3]	HBR configuration tm packet

Notes on Table 13:

1. The XSCS calculated UTC Earth Received Time associated with each periodic housekeeping telemetry packet.
2. The telemetry packet contains the data for all HBRs. There will be 8 entries resulting from an HBR configuration telemetry packet.
3. The exact specification of each of the non-periodic housekeeping parameters, how they are calibrated and how they are stored within the non-periodic housekeeping files is to be found in the Operational Database definition. The correspondence between the IPPV definition and the HK parameters is detailed in Appendix A.

7.3.2.2 EPIC MOS HBR Buffer Size Non-Periodic Housekeeping File

- An EPIC MOS HBR buffer size non-periodic housekeeping file will be created for each EPIC MOS instrument.
- Each EPIC MOS HBR buffer size non-periodic housekeeping file will contain the "HBR buffer size" telemetry management data produced during an observation period.
- An EPIC MOS HBR buffer size non-periodic housekeeping file will only be created if "HBR buffer size" telemetry management data is detected during an observation period.
- Each EPIC MOS HBR buffer size non-periodic housekeeping file will consist of a single binary table.
- The applicable EPIC MOS common keywords (Section 7.2.1.1) are:
  - TELESCOP
  - INSTRUME
  - DATATYPE
  - OBS_ID
  - EXP_ID
  - DATE-OBS
  - DATE-END
- The binary table will consist of the columns detailed in Table 14

Table 14: EPIC MOS HBR Buffer Size Non-Periodic Housekeeping File: Binary Table Columns

Name	Type	Units	Comment	Location in EPIC MOS Non-Per. HK Telemetry [11]
TIME	19A	yyyy-mm-ddThh:mm:ss	ERT[1]	
HBRID	1B		HBR identifier[2]	HBR buffer size tm packet
STRTADDR			Buffer start address[3]	HBR buffer size tm packet
ENDADDR			Buffer end address[3]	HBR buffer size tm packet

Notes on Table 14:

1. The XSCS calculated UTC Earth Received Time associated with each periodic housekeeping telemetry packet.
2. The telemetry packet contains the data for all HBRs. There will be 8 entries resulting from an HBR buffer size telemetry packet.
3. The exact specification of each of the non-periodic housekeeping parameters, how they are calibrated and how they are stored within the non-periodic housekeeping files is to be found in the Operational Database definition. The correspondence between the IPPV definition and the HK parameters is detailed in Appendix A.

7.3.2.3 EPIC MOS HBR Threshold Values Non-Periodic Housekeeping File

- An EPIC MOS HBR threshold values non-periodic housekeeping file will be created for each EPIC MOS instrument.
- Each EPIC MOS HBR threshold values non-periodic housekeeping file will contain the "HBR threshold values " telemetry management data produced during an observation period.
- An EPIC MOS HBR threshold values non-periodic housekeeping file will only be created if "HBR threshold values" telemetry management data is detected during an observation period.
- Each EPIC MOS HBR threshold values non-periodic housekeeping file will consist of a single binary table.
- The applicable EPIC MOS common keywords (Section 7.2.1.1) are:
  - TELESCOP
  - INSTRUME
  - DATATYPE
  - OBS_ID
  - EXP_ID
  - DATE-OBS
  - DATE-END
- The binary table will consist of the columns detailed in Table 15

Table 15: EPIC MOS HBR Threshold Values Non-Periodic Housekeeping File: Binary Table Columns

Name	Type	Units	Comment	Location in EPIC MOS Non-Per. HK Telemetry [11]
TIME	19A	yyyy-mm-ddThh:mm:ss	ERT[1]	
HBRID	1B		HBR identifier[2]	HBR threshold values tm packet
LTHRESH			Lower Threshold[3]	HBR threshold values tm packet
UTHRESH			Upper threshold [3]	HBR threshold values tm packet
PATTERN			Pattern Identifier[3]	HBR threshold values tm packet

Notes on Table 15:

1. The XSCS calculated UTC Earth Received Time associated with each periodic housekeeping telemetry packet.
2. The telemetry packet contains the data for all HBRs. There will be 8 entries resulting from a HBR configuration telemetry packet.
3. The exact specification of each of the non-periodic housekeeping parameters, how they are calibrated and how they are stored within the non-periodic housekeeping files is to be found in the Operational Database definition. The correspondence between the IPPV definition and the HK parameters is detailed in Appendix A.

7.3.2.4 EPIC MOS Extraheating Configuration Non-Periodic Housekeeping File

- An EPIC MOS extraheating configuration non-periodic housekeeping file will be created for each EPIC MOS instrument.
- Each EPIC MOS extraheating configuration non-periodic housekeeping file will contain the "extraheating configuration" telemetry management data produced during an observation period.
- An EPIC MOS extraheating configuration non-periodic housekeeping file will only be created if "extraheating configuration" telemetry management data is detected during an observation period.
- Each EPIC MOS extraheating configuration non-periodic housekeeping file will consist of a single binary table.
- The applicable EPIC MOS common keywords (Section 7.2.1.1) are:
  - TELESCOP
  - INSTRUME
  - DATATYPE
  - OBS_ID
  - EXP_ID
  - DATE-OBS
  - DATE-END
- The binary table will consist of the columns detailed in Table 16

Table 16: EPIC MOS Extraheating Configuration Non-Periodic Housekeeping File: Binary Table Columns

Name	Type	Units	Comment	Location in EPIC MOS Non-Per. HK Telemetry [11]
TIME	19A	yyyy-mm-ddThh:mm:ss	ERT[1]	
PROCESS	16A		Process identifier[2]	HBR extraheating conf. tm packet
LOWTEMP			Lower temperature[3]	HBR extraheating conf. tm packet
HIGHTEMP			Upper temperature[3]	HBR extraheating conf. tm packet
THERCNTL			Operating thermal control[3]	HBR extraheating conf. tm packet
SHRDHTR			Shroud heater switch[3]	HBR extraheating conf. tm packet
ANNLHTR			Annealing heater switch[3]	HBR extraheating conf. tm packet

Notes on Table 16:

1. The XSCS calculated UTC Earth Received Time associated with each periodic housekeeping telemetry packet.
2. The telemetry packet contains the data for 3 processes/modes (deicing, decontamination and annealing). There will be 3 entries resulting from a extraheating configuration telemetry packet. The PROCESS column will take the value 'DEICING', 'DECONTAMINATION ' and 'ANNEALING' respectively.
3. The exact specification of each of the non-periodic housekeeping parameters, how they are calibrated and how they are stored within the non-periodic housekeeping files is to be found in the Operational Database definition. The correspondence between the IPPV definition and the HK parameters is detailed in Appendix A.

7.3.2.5 EPIC MOS Thermal Monitoring Non-Periodic Housekeeping File

- An EPIC MOS thermal monitoring non-periodic housekeeping file will be created for each EPIC MOS instrument.
- Each EPIC MOS thermal monitoring non-periodic housekeeping file will contain the "thermal monitoring" telemetry management data produced during an observation period.
- An EPIC MOS thermal monitoring non-periodic housekeeping file will only be created if "thermal monitoring" telemetry management data is detected during an observation period.
- Each EPIC MOS thermal monitoring non-periodic housekeeping file will consist of a single binary table.
- The applicable EPIC MOS common keywords (Section 7.2.1.1) are:
  - TELESCOP
  - INSTRUME
  - DATATYPE
  - OBS_ID
  - EXP_ID
  - DATE-OBS
  - DATE-END
- The binary table will consist of the columns detailed in Table 17

Table 17: EPIC MOS Thermal Monitoring Non-Periodic Housekeeping File: Binary Table Columns

Name	Type	Units	Comment	Location in EPIC MOS Non-Per. HK Telemetry [11]
TIME	19A	yyyy-mm-ddThh:mm:ss	ERT[1]	
UPPTEMP			Upper temperature limit[2]	Thermal monitoring tm packet
LOWTEMP			Upper temperature limit[2]	Thermal monitoring tm packet

Notes on Table 17:

1. The XSCS calculated UTC Earth Received Time associated with each periodic housekeeping telemetry packet.
2. The exact specification of each of the non-periodic housekeeping parameters, how they are calibrated and how they are stored within the non-periodic housekeeping files is to be found in the Operational Database definition. The correspondence between the IPPV definition and the HK parameters is detailed in Appendix A.

7.3.2.6 EPIC MOS Bright Pixel Table Non-Periodic Housekeeping File

- An EPIC MOS bright pixel table non-periodic housekeeping file will be created for each EPIC MOS instrument.
- Each EPIC MOS bright pixel table non-periodic housekeeping file will contain the "bright pixel table" telemetry management data produced during an observation period.
- An EPIC MOS bright pixel table non-periodic housekeeping file will only be created if "bright pixel table" telemetry management data is detected during an observation period.
- Each EPIC MOS bright pixel table non-periodic housekeeping file will consist of a single binary table.
- The applicable EPIC MOS common keywords (Section 7.2.1.1) are:
  - TELESCOP
  - INSTRUME
  - DATATYPE
  - OBS_ID
  - EXP_ID
  - DATE-OBS
  - DATE-END
- The binary table will consist of the columns detailed in Table 18

Table 18: EPIC MOS Bright Pixel Table Non-Periodic Housekeeping File: Binary Table Columns

Name	Type	Units	Comment	Location in EPIC MOS Non-Per. HK Telemetry [11]
TIME	19A	yyyy-mm-ddThh:mm:ss	ERT[1]	
HBRID	1B		HBR identifier[2]	HBR n bright pixel table tm packet
BPID	1B		Bright Pixel Identifier[3]	
COLUMN			Column number[4,6]	HBR n bright pixel table tm packet
LINE			Line number[4,6]	HBR n bright pixel table tm packet
PIXELNO			Bright Pixels Number[5,6]	HBR n bright pixel table tm packet

Notes on Table 18:

1. The XSCS calculated UTC Earth Received Time associated with each periodic housekeeping telemetry packet.
2. There is a HBR bright pixel table telemetry packet for each HBR (1 to 8). The FID must be used to determine the HBR to which the packet is relevant.
3. Within each telemetry packet there is column and line information for bright pixels 1 to 50. Therefore BPID can take a value from 1 to 50. BPID is an index introduced by the FITS writing software.
4. Only bright pixel coordinates with a BPID less than or equal to PIXELNO are valid.
5. The number of bright pixels. A constant for each HBR.

6. The exact specification of each of the non-periodic housekeeping parameters, how they are calibrated and how they are stored within the non-periodic housekeeping files is to be found in the Operational Database definition. The correspondence between the IPPV definition and the HK parameters is detailed in Appendix A

7.4 EPIC p-n Science Files

7.4.1 Overview of EPIC p-n Science Files

The following EPIC p-n science files are defined:

- EPIC p-n Imaging Mode Event List File.
- EPIC p-n Timing Mode Event List File
- EPIC p-n Burst Mode Event List File.
- EPIC p-n Auxiliary File.
- EPIC p-n Diagnostic Mode Image File
- EPIC p-n Offset Data Image File
- EPIC p-n Noise Data Image File
- EPIC p-n Discarded Lines Image File
- EPIC p-n Counting Cycle Report Auxiliary File

A brief overview of the EPIC p-n science telemetry is given in Section C.2.

In the tables describing the EPIC p-n Science files in this section all telemetry references are taken from the Science Telemetry Data Formats in applicable document [10].

7.4.1.1 EPIC p-n Science Files Common Instrument Keywords

The common instrument keywords (see Section 7.1.1.1 and 7.1.1.2) associated with EPIC p-n science files are detailed in Table 19 along with their possible values and their location within the EPIC p-n science telemetry definition where applicable. If for a given instance of an EPIC p-n extension a common instrument keyword is not applicable then it will not appear in that header. Those common keywords which are not applicable are detailed with each file description.

Table 19: EPIC p-n Science Files Common Information Keywords

Keyword	Keyword Value	Identifier in EPIC p-n Telemetry Definition [10]	Comments
EPIC p-n Science Files Common Information Keywords			
TELESCOP	'XMM '	N/A	Note 1
INSTRUME	'EPN '	N/A	Note 2
DATATYPE		N/A	Note 3
OBS_ID		N/A	Note 4
EXP_ID		N/A	Note 5
QUADRANT	0-3	QUAD. ID. in ITB-Header and D-Header	
CCDID	0-2	CCD ID in Event Data Format CCD ID in Pixel Data Format CCD ID in T-Header	

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Keyword	Keyword Value	Identifier in EPIC p-n Telemetry Definition [10]	Comments
QUADMODE	0,3	Quadrant Mode in ITB-Header and D-Header	
CCDMODE	0-5	CCD x Mode in ITB-Header and D-Header	
FRMTIME			Note 6
WINDOWX0			Note 7
WINDOWY0			Note 7
WINDOWDX			Note 7
WINDOWDY			Note 7
DATE-OBS			Note 8
DATE-END			Note 9
F1294		Stored in HK TM packet 1010.EP1	Note 10

Notes on Table 19

1. Identifies the observatory as being XMM
2. Identifies the instrument as being the EPIC p-n instrument
3. The type of data held in the file. The possible values are:
   - 'IMAGE.EL'. An event list containing imaging mode data.
   - 'TIME.EL'. An event list containing timing mode data.
   - 'BURST.EL'. An event list containing burst mode data.
   - 'AUX.EL'. An event list containing auxiliary data.
   - 'DIAG.IM'. An image containing diagnostic mode data.
   - 'OFFSET.IM'. An image containing offset data.
   - 'NOISE.IM'. An image containing noise data.
   - 'DISCLIN.IM'. An image containing discarded line data.
   - 'COUNT.EL'. An event list containing counting cycle report data
4. Observation/ Slew Identifier (10 characters) assigned in the XMM archive.
5. Exposure Identifier (13 characters) as assigned in the proposal
6. The frame time is not directly available from the telemetry. It is extracted from the EPIC p-n (epn) TimeCorr CCF component file [34]. For a given mode (where the modes are the SOC defined modes of operation and not the detector modes) the frame time for each quadrant is specified in milliseconds. All CCDs belonging to this quadrant will have the same frame time.
7. The window coordinates are not directly available from the telemetry. These values is will be held internally within the XSCS. The current scenario is that the values will be contained within a simple look-up table.
8. Start time (UTC) of exposure as calculated by XSCS (yyyy-mm-ddThh:mm:ss). This time will not be the precise exposure start time as the accurate orbit and attitude information is not available to the XSCS when the time is calculated. It will however be calculated using the available time correlation information.
9. End time (UTC) of exposure as calculated by XSCS (yyyy-mm-ddThh:mm:ss).
10. Frame Time Description. Only in Image Mode Event List files.

7.4.1.2 General Comments Relating to the EPIC p-n Science Files

1. Section B.2 defines how the frame counter in the EPIC p-n science files will be calculated.

7.4.2 EPIC p-n Imaging Mode Event List File

- An EPIC p-n imaging mode event list file will be created for each CCD which is producing imaging mode data
- Each EPIC p-n imaging mode event list file will contain the details of each detected event on the specified CCD during an exposure.
- Each EPIC MOS imaging mode event list file will consist of a single binary table.
- All EPIC p-n common instrument keywords are applicable (Section 7.4.1.1).
- The binary table will consist of the columns detailed in Table 20

Table 20: EPIC p-n Imaging Mode Event List File: Binary Table Columns

Name	Type	Units	Comment	Location in EPIC p-n Imaging Mode Telemetry [10]
FRAME	1J	COUNTER	Frame Identifier	(see Section 7.4.1.2)
RAWX	1B	PIXEL	Column Identifier	Event Data Format
RAWY	1B	PIXEL	Line Identifier	Event Data Format
ENERGY	1I	CHANNEL	Pixel Energy	Event Data Format

7.4.3 EPIC p-n Timing Mode Event List File

- An EPIC p-n timing mode event list file will be created for each CCD which is producing timing mode data
- Each EPIC p-n timing mode event list file will contain the details of each detected event on the specified CCD during an exposure.
- Each EPIC p-n timing mode event list file will consist of a single binary table.
- All EPIC p-n common instrument keywords are applicable (Section 7.4.1.1).
- The binary table will consist of the columns detailed in Table 21

Table 21: EPIC p-n Timing Mode Event List File: Binary Table Columns

Name	Type	Units	Comment	Location in EPIC p-n Timing Mode Telemetry [10]
FRAME	1J	COUNTER	Frame Identifier	(see Section 7.4.1.2)
RAWX	1B	PIXEL	Column Identifier	Event Data Format
RAWY	1B	PIXEL	Line Identifier	Event Data Format
ENERGY	1I	CHANNEL	Pixel Energy	Event Data Format

7.4.4 EPIC p-n Burst Mode

- An EPIC p-n burst mode event list file will be created for each CCD which is producing burst mode data
- Each EPIC p-n burst mode event list file will contain the details of each detected event on the specified CCD during an exposure.
- Each EPIC p-n timing mode event list file will consist of a single binary table.
- All EPIC p-n common instrument keywords are applicable (Section 7.4.1.1).
- The binary table will have the same structure as the timing mode event list file binary table detailed in Table 21

7.4.5 EPIC p-n Auxiliary File

- An EPIC p-n auxiliary file will be created for each exposure in which at least one CCD is producing either imaging, timing or burst mode data.
- Each EPIC p-n auxiliary file will contain the details of each frame/ cycle (for all CCDs) of the exposure.
- There will be a 2 binary table extensions in the EPIC p-n auxiliary file. The first binary table extension contains the frame information (see Section 7.4.1.2) for all of the active CCDs. The second binary table contains the statistical information which is produced by each quadrant after every n cycles (see Section 7.4.1.2), where n is a programmable parameter.
- The applicable EPIC p-n common keywords (Section 7.4.1.1) are:
  - TELESCOP
  - INSTRUME
  - DATATYPE
  - OBS_ID
  - EXP_ID
  - DATE-OBS
  - DATE-END
- The first binary table will consist of the columns detailed in Table 22
- The second binary table will consist of the columns detailed in Table 23

Table 22: EPIC p-n Auxiliary File: First Binary Table Columns

Name	Type	Units	Comment	Location in EPIC p-n Imaging/ Timing/ Burst Mode Telemetry [10]
FRAME	1J	COUNTER	Frame Identifier	(see Section 7.4.1.2)
CYCLE	1J	COUNTER	Cycle Identifier	(see Section 7.4.1.2)
FTCOARSE	1I	SECOND	Coarse Frame Time	Time Info Data format
FTFINE	1U		Fine Frame Time	Time Info Data format
QUADRANT	1B		Quadrant Identifier	ITB-Header
CCDID	1B		CCD Identifier	ITB-Header

Table 23: EPIC p-n Auxiliary File: Second Binary Table Columns

Name	Type	Units	Comment	Location in EPIC p-n Imaging/ Timing/ Burst Mode Telemetry [10]
CYCLE	1J	COUNTER	Cycle Identifier	(see Section 7.4.1.2)
QUADRANT	1B		Quadrant Identifier	ITB-Header
NABOVE	1U	COUNTS	ATHR Counter	Count Info Data format
NDEFA	1I		DEFA Counter	Count Info Data format
NEPDH	1U		EPDH Counter	Count Info Data format
NDISCLIN	1I		Discarded Line Counter	Count Info Data format
MCOMMODE	1U		Mean Common Mode	Count Info Data format

7.4.6 EPIC p-n Diagnostic Mode Image File

- An EPIC p-n diagnostic mode image file will be created for each CCD which is producing diagnostic data
- *Item deleted.*
- Each EPIC p-n diagnostic image file will contain a single image extension.
- The following EPIC p-n common keywords are not applicable (Section 7.4.1.1).
  - FRMTIME
- The specific keywords and the BITPIX and NAXIS values for a diagnostic mode image file extension header are detailed in Table 24. This information is to be used in conjunction with that contained in Section 7.1.1.2.

Table 24: EPIC p-n Diagnotic Mode Image File: Image Extension Keyword Details

Keyword	Keyword Value	Location in EPIC p-n Diagnostic Mode Telemetry [10]	Comments
Mandatory FITS Extension Header Keywords			
BITPIX	16	N/A	Note 1
NAXIS	3	N/A	Note 2
NAXIS1	64	N/A	
NAXIS2	M	N/A	
NAXIS3	N	N/A	
EPIC p-n Diagnostic Mode Additional Keywords			
FTCOARSE		Seconds in Time Info Data format	
FTFINE		Fraction of seconds in Time Info Data format	
FIRSTLR		First Line Read in the first EPEA Header format	
LASTLR		Last Line Read in the last EPEA Header format	

Notes on Table 24:

1. A 16 bit array is required to contain the Pixel Energies (12 bits) in the Pixel Data Format. also contained in the Pixel Data Format is the Pixel Counter. This is used to detect missing events in the diagnostic mode frames. When an event is detected as missing the value 0 is assigned.
2. A 3-D image is constructed. A 64 by M region of the CCD is read-out N times, where N is the Line Readout Repetition Number in the EPEA Header Format and M is the number of lines read from the CCD.

7.4.7 EPIC p-n Pixel Characteristics Mode: Offset Data Image File

- An EPIC p-n offset data image file will be created for each CCD which is producing offset data
- Each EPIC p-n offset data image file will contain a single image extension.
- The image extension will contain 2 images (stored as a single 3-D array): An Offset Value image and a Pixel Status image.
- The following EPIC p-n common keywords are not applicable (Section 7.4.1.1).
  - FRMTIME
- The specific keywords and the BITPIX and NAXIS values for an offset data image file extension header are detailed in Table 25. This information is to be used in conjunction with that contained in Section 7.1.1.2.

Table 25: EPIC p-n Offset Data Image File: Image Extension Keyword Details

Keyword	Keyword Value	Location in EPIC p-n Offset Data Telemetry [10]	Comments
Mandatory FITS Extension Header Keywords			
BITPIX	16	N/A	Note 1
NAXIS	3	N/A	
NAXIS1	64		Notes 3
NAXIS2	200		
NAXIS3	2		Note 2
EPIC p-n Offset Data Specific Keywords			
FTCOARSE		Seconds in Offset calculation starting time data format	
FTFINE		Fraction of seconds in Offset calculation starting time data format	
TABLEID		Table ID in T-Header	

Notes on Table 25:

1. 16 bit array is required to contain the Offset Values (12 bits) in the Offset Value Data Format
2. There are 2 images. The first is the offset value image and the second is the pixel status image.
3. The total number of offset table blocks is 217. Each offset table block consists of 59 entries except the last which contains 56 [10]. These are reconstructed into 2 (offset value and pixel status) 64 x 200 images of the CCD.

7.4.8 EPIC p-n Pixel Characteristics Mode: Noise Data Image File

- An EPIC p-n noise data image file will be created for each CCD which is producing noise data
- Each EPIC p-n noise data image file will contain a single image extension.
- The image extension will contain a single noise image
- The following EPIC p-n common keywords are not applicable (Section 7.4.1.1).
  - FRMTIME
- The specific keywords and the BITPIX and NAXIS values for an offset data image file extension header are detailed in Table 26. This information is to be used in conjunction with that contained in Section 7.1.1.2.

Table 26: EPIC p-n Noise Data Image File: Image Extension Keyword Details

Keyword	Keyword Value	Location in EPIC p-n Noise Data Telemetry [10]	Comments
Mandatory FITS Extension Header Keywords			
BITPIX	16	N/A	Note 1
NAXIS	2	N/A	
NAXIS1	64	N/A	Note 2
NAXIS2	200	N/A	
BSCALE	1	N/A	
BZERO	32678	N/A	
EPIC p-n Noise Data Specific Keywords			
FTCOARSE		Seconds in Noise calculation starting time data format	
FTFINE		Fraction of seconds in Noise calculation starting time data format	
TABLEID		Table ID in T-Header	

Notes on Table 26:

1. 16 bit array is required to contain the Noise Values (16 bits) in the Noise Value Data Format
2. The total number of offset table blocks is 217. Each noise table block consists of 59 entries except the last which contains 56 [10]. These are reconstructed into a 64 x 200 image of the CCD.

7.4.9 EPIC p-n Pixel Characteristics Mode: Discarded Lines Image File

- An EPIC p-n discarded lines data image file will be created for each CCD which is producing discarded lines data.
- Each EPIC p-n discarded lines data image file will contain a single image extension.
- The image extension will contain a single discarded lines image
- The following EPIC p-n common keywords are not applicable (Section 7.4.1.1).
  - FRMTIME
- The specific keywords and the BITPIX and NAXIS values for an offset data image file extension header are detailed in Table 27. This information is to be used in conjunction with that contained in Section 7.1.1.2.

Table 27: EPIC p-n Discarded Lines Data Image File: Image Extension Keyword Details

Keyword	Keyword Value	Location in EPIC p-n Discarded Lines Data Telemetry [10]	Comments
Mandatory FITS Extension Header Keywords			
BITPIX	16	N/A	Note 1
NAXIS	2	N/A	
NAXIS1	1	N/A	Note 2
NAXIS2	200	N/A	
BSCALE	1	N/A	
BZERO	32678	N/A	
EPIC p-n Noise Data Specific Keywords			
FTCOARSE		Seconds in D.L.A starting time data format	
FTFINE		Fraction of seconds in D.L.A starting time data format	
ETCOARSE		Seconds in D.L.A ending time data format	
ETFINE		Fraction of seconds in D.L.A ending time data format	
TABLEID		Table ID in T-Header	

Notes on Table 27:

1. 16 bit array is required to contain the Discarded Line Counter values (16 bits) in the Discarded Lines Data Format.
2. The total number of discarded line table blocks is 4. Each discarded line table block consists of 59 entries except the last which contains 23. These are reconstructed into a 1 x 200 image with the first block being allocated positions 1 to 59, the second block 60 to 118, the third block 119 to 177 and the fourth block positions 178 to 200.

7.4.10 EPIC p-n Counting Cycle Report Auxiliary File

- An EPIC p-n counting cycle report auxiliary file will be created for each exposure in which at least one counting cycle report is generated.
- An EPIC p-n counting cycle report auxiliary file will contain all counting cycle reports generated during the exposure.
- There will be a single binary table containing all of the report information.
- The applicable EPIC p-n common keywords (Section 7.4.1.1) are:
  - TELESCOP
  - INSTRUME
  - DATATYPE
  - OBS_ID
  - EXP_ID
  - DATE-OBS
  - DATE-END
- Each binary table will consist of the columns detailed in Table 28

Table 28: EPIC p-n Counting Cycle Report Auxiliary File: Binary Table Columns

Name	Type	Units	Comment	Location in EPIC MOS Telemetry [11]
QUADRANT	1I	IDENTIFIER	quadrant Identifier	Counting Cycle Report
STCOARSE	1I	SECOND	Coarse Start Time	Counting Cycle Report
STFINE	1U		Fine Start Time	Counting Cycle Report
ETCOARSE	1I	SECOND	Coarse End Time	Counting Cycle Report
ETFINE	1U		Fine End Time	Counting Cycle Report
CYCLCNTR	1I	COUNTER	Rejected read-out cycles counter	Counting Cycle Report
CYCLOVF	1B	FLAG	Rejected read-out cycles overflow flag	Counting Cycle Report
ATHRCNTR	1J	COUNTER	Cumulative ATHR counter	Counting Cycle Report
ATHROVF	1B	FLAG	Cumulative ATHR overflow flag	Counting Cycle Report
DEFACNTR	1J	COUNTER	Cumulative DEFA counter	Counting Cycle Report
DEFAOVF	1B	FLAG	Cumulative DEFA overflow flag	Counting Cycle Report
EPDHCNTR	1J	COUNTER	Cumulative EPDH counter	Counting Cycle Report
EPDHOVF	1B	FLAG	Cumulative EPDH overflow flag	Counting Cycle Report
DSLNCNTR	1J	COUNTER	Cumulative DSLIN counter	Counting Cycle Report
DSLNOVF	1B	FLAG	Cumulative DSLIN overflow flag	Counting Cycle Report
MCOMMODE	1U		Mean common mode	Counting Cycle Report

7.5 EPIC p-n Housekeeping Files

7.5.1 EPIC p-n Periodic Housekeeping File

- There are 2 types of EPIC p-n periodic housekeeeping telemetry. They are [10]:
  - H/K Main TM packets (SID=2).
  - H/K Additional TM packets (SID=3).

  These 2 types of EPIC p-n periodic housekeeping telemetry will be stored in separate EPIC p-n periodic housekeeping files.
- The EPIC p-n periodic housekeeping files will be created for each EPIC p-n instrument.
- Each EPIC p-n periodic housekeeping file will contain the calibrated periodic housekeeping parameters produced during an observation period.
- Each EPIC p-n periodic housekeeping file will contain the calibrated derived parameters, relevant to the corresponding telemetry packet, produced during an observation period.
- All common instrument housekeeping keywords are applicable (Section 7.1.2).
- Each EPIC p-n periodic housekeeping file will consist of a single binary table.
- The binary table will consist of the columns detailed in Table 29

Table 29: EPIC p-n Periodic Housekeeping File: Binary Table Columns

Name	Type	Units	Comment	Location in EPIC p-n Per. HK Telemetry [10]
TIME	19A	yyyy-mm-ddThh:mm:ss	ERT	Note 1
PARAM1				Note 2,6
...	...	...	...	
PARAMn				Note 6
DERPAR1				Note 3,4,5,6
...	...	...	...	
DERPARm				Note 6

Notes on Table 29:

1. The XSCS calculated UTC Earth Received Time associated with each periodic housekeeping telemetry packet.
2. The description of the raw periodic housekeeping parameters is given in [10] (Annex 4). There will be a binary table column allocated to each identified periodic housekeeping parameter.
3. The derived parameters will be stored after the periodic housekeeping telemetry.
4. The details of the derived parameters are currently unknown and will not be known until they have been defined as part of operational procedures.
5. In all likelihood the derived parameters associated with an instrument will change over the lifetime of XMM. The derived parameters relevant at the time of file generation will be stored.

6. The exact specification of the periodic housekeeping parameters, how they are calibrated and how they are stored within the periodic housekeeping files is to be found in the Operational Database definition. The correspondence between the IPPV definition and the HK parameters is detailed in Appendix A.

7.5.2 EPIC p-n Non-Periodic Housekeeping Files

7.5.2.1 EPIC p-n HBR Configuration Non-Periodic Housekeeping File

- Each EPIC p-n HBR configuration non-periodic housekeeping file will contain the "HBR configuration" telemetry management data produced during an observation period.
- An EPIC p-n HBR configuration non-periodic housekeeping file will only be created if "HBR configuration" telemetry management data is detected during an observation period.
- Each EPIC p-n HBR configuration non-periodic housekeeping file will consist of a single binary table.
- The applicable EPIC p-n common keywords (Section 7.4.1.1) are:
  - TELESCOP
  - INSTRUME
  - DATATYPE
  - OBS_ID
  - EXP_ID
  - DATE-OBS
  - DATE-END
- The binary table will consist of the columns detailed in Table 30

Table 30: EPIC p-n HBR Configuration Non-Periodic Housekeeping File: Binary Table Columns

Name	Type	Units	Comment	Location in EPIC p-n Non-Per. HK Telemetry [10]
TIME	19A	yyyy-mm-ddThh:mm:ss	ERT[1]	
HBRID	1B		HBR identifier[2]	HBR configuration tm packet
HBRACTIV			HBR Active Channel[3]	HBR configuration tm packet
HBRPROC			HBR Processing status[3]	HBR configuration tm packet
CCD0MODE			HBR CCD mode[3]	HBR configuration tm packet
CCD1MODE			HBR CCD mode[3]	HBR configuration tm packet
CCD2MODE			HBR CCD mode[3]	HBR configuration tm packet

Notes on Table 30:

1. The XSCS calculated UTC Earth Received Time associated with each periodic housekeeping telemetry packet.
2. The telemetry packet contains the data for all HBRs. There will be 4 entries resulting from an HBR configuration telemetry packet.
3. The exact specification of each of the non-periodic housekeeping parameters, how they are calibrated and how they are stored within the non-periodic housekeeping files is to be found in the Operational Database definition. The correspondence between the IPPV definition and the HK parameters is detailed in Appendix A

7.5.2.2 EPIC p-n HBR Buffer Size Non-Periodic Housekeeping File

- Each EPIC p-n HBR buffer size non-periodic housekeeping file will contain the "HBR buffer size" telemetry management data produced during an observation period.
- An EPIC p-n HBR buffer size non-periodic housekeeping file will only be created if "HBR buffer size" telemetry management data is detected during an observation period.
- Each EPIC p-n HBR buffer size non-periodic housekeeping file will consist of a single binary table.
- The applicable EPIC p-n common keywords (Section 7.4.1.1) are:
  - TELESCOP
  - INSTRUME
  - DATATYPE
  - OBS_ID
  - EXP_ID
  - DATE-OBS
  - DATE-END
- The binary table will consist of the columns detailed in Table 31

Table 31: EPIC p-n HBR Buffer Size Non-Periodic Housekeeping File: Binary Table Columns

Name	Type	Units	Comment	Location in EPIC p-n Non-Per. HK Telemetry [10]
TIME	19A	yyyy-mm-ddThh:mm:ss	ERT[1]	
HBRID	1B		HBR identifier[2]	HBR buffer size tm packet
STRTADDR			Buffer start address[3]	HBR buffer size tm packet
ENDADDR			Buffer end address[3]	HBR buffer size tm packet

Notes on Table 31:

1. The XSCS calculated UTC Earth Received Time associated with each periodic housekeeping telemetry packet.
2. The telemetry packet contains the data for all HBRs. There will be 4 entries resulting from an HBR buffer size telemetry packet.
3. The exact specification of each of the non-periodic housekeeping parameters, how they are calibrated and how they are stored within the non-periodic housekeeping files is to be found in the Operational Database definition. The correspondence between the IPPV definition and the HK parameters is detailed in Appendix A

7.5.2.3 EPIC p-n Thermal Monitoring Non-Periodic Housekeeping File

- Each EPIC p-n thermal monitoring non-periodic housekeeping file will contain the "thermal monitoring" telemetry management data produced during an observation period.
- An EPIC p-n thermal monitoring non-periodic housekeeping file will only be created if "thermal monitoring" telemetry management data is detected during an observation period.
- Each EPIC p-n thermal monitoring non-periodic housekeeping file will consist of a single binary table.
- The applicable EPIC p-n common keywords (Section 7.4.1.1) are:
  - TELESCOP
  - INSTRUME
  - DATATYPE
  - OBS_ID
  - EXP_ID
  - DATE-OBS
  - DATE-END
- The binary table will consist of the columns detailed in Table 32

Table 32: EPIC p-n Thermal Monitoring Non-Periodic Housekeeping File: Binary Table Columns

Name	Type	Units	Comment	Location in EPIC p-n Non-Per. HK Telemetry [10]
TIME	19A	yyyy-mm-ddThh:mm:ss	ERT[1]	
UPPTEMP			Upper temperature limit[2]	Thermal monitoring tm packet
LOWTEMP			Upper temperature limit[2]	Thermal monitoring tm packet

Notes on Table 32:

1. The XSCS calculated UTC Earth Received Time associated with each periodic housekeeping telemetry packet.
2. The exact specification of each of the non-periodic housekeeping parameters, how they are calibrated and how they are stored within the non-periodic housekeeping files is to be found in the Operational Database definition. The correspondence between the IPPV definition and the HK parameters is detailed in Appendix A.

7.6 RGS Science Files

Sentence deleted.

7.6.1 Overview of RGS Science Files

The following RGS science files are defined:

- RGS Spectroscopy Mode Event List File.
- RGS HTR Mode Event List File
- RGS Auxiliary File.
- RGS Diagnostic Mode Image File

A brief overview of the RGS science telemetry is given in Section C.3.

In the tables describing the RGS Science files in this section all telemetry references are taken from the Science Telemetry description in applicable document [8].

7.6.1.1 RGS Science Files Common Instrument Keywords

The common instrument keywords (see Section 7.1.1.1 and 7.1.1.2) associated with RGS science files are detailed in Table 33 along with their possible values and their location within the RGS science telemetry definition where applicable. If for a given instance of an RGS extension a common instrument keyword is not applicable then it will not appear in that header. Those common keywords which are not applicable are detailed with each file description.

Table 33: RGS Science Files Common Information Keywords

Keyword	Keyword Value	Identifier in RGS Spectroscopy Mode Telemetry Definition [8]	Comments
RGS Science Files Common Information Keywords			
TELESCOP	'XMM'	N/A	Note 1
INSTRUME	'RGS1' 'RGS2'	N/A	Note 2
DATATYPE		N/A	Note 3
OBS_ID		N/A	Note 4
EXP_ID		N/A	Note 5
TMEXP_ID		Exposure ID in Science Exposure Packet and in Diagnostic Exposure Packet	
CCDID	1-9	CCD-N in Frame Packet	
CCDOCB		OCB in Frame Packet, Diagnostic exposure packet and SID of Science Packet	
WINDOWX0		CCD-n X-start in Science Exposure Packet and in Diagnostic Exposure Packet	

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Keyword	Keyword Value	Identifier in RGS Spectroscopy Mode Telemetry Definition [8]	Comments
WINDOWY0		CCD-n Y-start in Science Exposure Packet and in Diagnostic Exposure Packet	
WINDOWDX		CCD-n X-length in Science Exposure Packet and in Diagnostic Exposure Packet	
WINDOWDY		CCD-n X-length in Science Exposure Packet and in Diagnostic Exposure Packet	Note 8
SCITYPE		Science type in Science Exposure Packet	
PSCHEME		Packing scheme in Science Exposure Packet	
DATE-OBS			Note 6
DATE-END			Note 7

1. Identifies the observatory as being XMM
2. Identifies the instrument as being an RGS instrument
3. The type of data held in the file. The possible values are:
   - 'SPECT.EL'. An event list containing spectroscopy mode data.
   - 'HTR.EL'. An event list containing HTR mode data.
   - 'AUX.EL'. An event list containing auxiliary data.
   - 'DIAG.IM'. An image containing diagnostic mode data.
4. Observation/ Slew Identifier (10 characters) assigned in the XMM archive.
5. Exposure Identifier (13 characters) as assigned in the XMM archive.
6. Start time (UTC) of exposure as calculated by XSCS (yyyy-mm-ddThh:mm:ss). This time will not be the precise exposure start time as the accurate orbit and attitude information is not available to the XSCS when the time is calculated. It will however be calculated using the available time correlation information.
7. End time (UTC) of exposure as calculated by XSCS (yyyy-mm-ddThh:mm:ss).
8. For diagnostic mode WINDOWDY must be derived using WINDOWX0, WINDOWY0, WINDOWDX and the number of pixels to be acquired (PIXELNO in Table 38). Note that for 2 node readout WINDOWDX must be multiplied by 2 when calculating WINDOWDY.
9. Note: The frame integration time is not included in the common information keywords. As the calculation of the frame integration time is a non-trivial issue its calculation has been deferred. It is noted however that the frame integration time field still appears in the RGS auxiliary first binary table (as Scisim calculates the value). The value of 0 (zero) is assigned.

7.6.1.2 General Comments Relating to the RGS Science Files

1. Section B.3 defines how the frame counter in the RGS science files will be calculated.
2. *Item deleted.*

7.6.2 RGS Spectroscopy Mode Event List File

- An RGS spectroscopy mode event list file will be created for each CCD which is producing spectroscopy mode data
- Each RGS spectroscopy mode event list file will contain the details of each detected event on the specified CCD during an exposure.
- It is possible to have CCD numbers ranging from 0 to 15. For example, spectroscopy mode provides the possibility to inject charge with an on-board generator. This mimics a 10th CCD. The keyword CCDID in the common instrument keywords can take a value of 13 in this instance.
- Each RGS spectroscopy mode event list file will consist of a single binary table.
- All RGS common instrument keywords are applicable (Section 7.6.1.1).
- The binary table will consist of the columns detailed in Table 34

Table 34: RGS Spectroscopy Mode Event List File: Binary Table Columns

Name	Type	Units	Comment	Location in RGS Spectroscopy Mode Telemetry [8]
FRAME	1J	COUNTER	Frame Identifier	Frame Packet
RAWX	1I	PIXEL	X	Spectroscopy Science Data (*Packed*)[1] Spectroscopy Science Data (Unprocessed)
RAWY	1I	PIXEL	Y	Spectroscopy Science Data (Packed) Spectroscopy Science Data (Unprocessed)
ENERGY	1I	CHANNEL	E	Spectroscopy Science Data (Packed) Spectroscopy Science Data (Unprocessed)
CCDNODE	1B		X^2	Spectroscopy Science Data (Packed) Spectroscopy Science Data (Unprocessed)
SER	1B		Y^3	Spectroscopy Science Data (Packed) Spectroscopy Science Data (Unprocessed)

Notes on Table 34:

1. The spectroscopy science data can be either packed or unprocessed. For further details refer to [8].
2. The node is identified in the MSBit of the X-coordinate. For further details refer to [8].
3. The details of the Split Event Reconstruction are contained the 3 MSBits of the Y coordinate. For further details refer to [8].

7.6.3 RGS HTR Mode Event List File

- An RGS HTR mode event list file will be created for each CCD which is producing HTR mode data
- Each RGS HTR mode event list file will contain the details of each detected event on the specified CCD during an exposure.
- Each RGS HTR mode event list file will consist of a single binary table.
- All RGS common instrument keywords are applicable (Section 7.6.1.1).
- Each binary table will consist of the columns detailed in Table 35.

Table 35: RGS HTR Mode Event List File: First Binary Table Columns

Name	Type	Units	Comment	Location in RGS HTR Mode Telemetry [8]
FRAME	1J	COUNTER	Frame Identifier	HTR Science Data
RAWX	1I	PIXEL	X	HTR Science Data
ENERGY	1I	CHANNEL	E	HTR Science Data
CCDNODE	1B		*X*[1]	HTR Science Data

Notes on Table 35:

1. The node is identified in the MSBit of the X-coordinate. For further details refer to [8].

7.6.4 RGS Auxiliary File

- An RGS auxiliary file will be created for each exposure in which at least one CCD is producing either spectroscopy or HTR mode data.
- Each RGS auxiliary file will contain the details of each frame/ cycle (for all CCDs) of the exposure.
- There will be a 2 binary table extensions in the RGS auxiliary file. The first binary table extension contains the frame/ cycle details and statistics for all of the active CCDs. The second binary table contains the CCD read-out sequence description.
- The applicable RGS common keywords (Section 7.6.1.1) are:
  - TELESCOP
  - INSTRUME
  - DATATYPE
  - OBS_ID
  - EXP_ID
  - DATE-OBS
  - DATE-END
- The first binary table will consist of the columns detailed in Table 36. The following keywords are contained in the header of the AUX file (first extension after the primary, *i.e.* the FITS table corresponding to Tab. 36): EOSCOARS, EOSFINE, and will be filled with the RBI end of the read-out time, that is provided by the telemetry in the last packet of the HTR mode. EOSCOARS has units of seconds, EOSFINE is in $1/2^{16}th$ of a second.
- The second binary table will consist of the columns detailed in Table 37

Table 36: RGS Auxiliary Event List File: First Binary Table Columns.

Name	Type	Units	Comment	Location in RGS Science Telemetry [8]
FRAME	1J	COUNTER	Frame Identifier[4]	Frame Packet
CCDID	1B		CCD Identifier	Frame Packet/ HTR science packet
NLOSTEVT	1I	COUNTS	Lost event counter	Last spectroscopy science packet
			LEF in HTR marker	HTR science packet
ABORTFLG	1I		Abort flag	Last spectroscopy science packet HTR science packet
DELTA_T	1I	$1/2^{16}th$ seconds	Time resolution	

Table 37: RGS Auxiliary Event List File: Second Binary Table Columns

Name	Type	Units	Comment	Location in RGS Science Telemetry [8]
SEQINDEX	1I	COUNTER	Sequence *Index*[1,2]	
CCDID	1B		CCD Identifier	Science exposure packet

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Name	Type	Units	Comment	Location in RGS Science Mode Telemetry [8]
CCDNODES	1B		CCD Read-out nodes(s)	Science exposure packet
CCDOCB	1B		CCD OCB	Science exposure packet
CCDCSG	1B		CCD CSG ID	Science exposure packet
RTHRESHC	1I		CCD rejection threshold (side C)	Science exposure packet
ATHRESHC	1I		CCD acceptance threshold (side C)	Science exposure packet
UTHRESHC	1I		CCD upper threshold (side C)	Science exposure packet
RTHRESHD	1I		CCD rejection threshold (side D)	Science exposure packet
ATHRESHD	1I		CCD acceptance threshold (side D)	Science exposure packet
UTHRESHD	1I		CCD upper threshold (side D)	Science exposure packet
WINDOWX0	1I	PIXEL	CCD X-start	Science exposure packet
WINDOWY0	1I	PIXEL	CCD Y-start	Science exposure packet
WINDOWDX	1I	PIXEL	CCD X-length	Science exposure packet
WINDOWDY	1I	PIXEL	CCD Y-length	Science exposure packet

Notes on Table 37:

1. This table is simply the information contained in the science exposure packet and describes the details of the CCD read-out sequence.
2. The sequence index is a counter from 1 to 12. The 12 records in this table describe the read-out sequence to be used for the exposure. For further details refer to [8].

7.6.5 RGS Diagnostic Mode Image File

- An RGS diagnostic mode image file will be created for each CCD which is producing diagnostic mode data
- An RGS diagnostic mode image file consists of a single image table extension.
- The image extension will contain a single diagnostic image.
- The following RGS common keywords are not applicable (Section 7.6.1.1).
  - SCITYPE
  - PSCHEME
- Note: RGS Q dump data is identical to diagnostic mode. The only distinction is in the filenaming convention (Section 5.3.1.1). As it is possible to have several Q dump files associated with a spectroscopy + Q exposure separate, distinct exposure numbers are allocated to these files. The exposure identifier (EXP_ID) in the header of the file will however be that associated with the spectroscopy + Q exposure.
- Diagnostic mode also provides the possibility to inject charge with an on-board generator. This mimics a 10th CCD. The keyword CCDID in the common instrument keywords can take a value of 13 in this instance.
- The additional keywords and the NAXIS values for a diagnostic mode image file extension are detailed in Table 38. This information is to be used in conjunction with that contained in Section 7.1.1.2.

Table 38: RGS Diagnostic Mode Image File: Image Extension Keyword Details

Keyword	Keyword Value	Location in RGS Diagnostic Mode Telemetry [8]	Comments
Mandatory FITS Extension Header Keywords			
BITPIX	16	N/A	Note 1
NAXIS	2	N/A	
NAXIS1		N/A	Note 2
NAXIS2		N/A	Note 3
RGS Diagnostic Mode Additional Keywords			
FTCOARSE		Exposure packet - coarse time field	Note 5
FTFINE		Exposure packet - fine time field	Note 5
BLOCKNO	0-6, X	Block number in Diagnostic Exposure Packet	Note 4
PIXELNO		No. of pixels to be acquired in Diagnostic Exposure Packet	
CSGID		CSG-ID in Diagnostic Exposure Packet	
CCDFLUSH		No. of CCD flushes in Diagnostic Exposure Packet	
CCDNODE		Read-out nodes in Diagnostic Exposure Packet	
BLANK	6666	"Blank" value	

Notes on Table 38:

1. 16 bits corresponding to the value of E in the diagnostic queue packets
2. NAXIS1 will have the value of X-length in the diagnostic exposure packet for single node readout. For 2 node readout NAXIS1 = 2 * X-length.

3. NAXIS2 will be calculated, using the total number of pixels and X-length contained in the exposure telemetry packet, according to the following formulas for single and 2 node readout:
   - For single node readout: NAXIS2 = Y-length = (Number of pixels + 1) / X-length
   - For 2 node readout: NAXIS2 = Y-length = (Number of pixels + 1) / 2 / X-length
4. Block number can take the value 0 to 6 for OCB=1 and don't care (X) for OCB=3 (full CCD-N acquisition) [8].
5. The diagnostic exposure packet time stamp is tied down to a frame time-stamp (read-out time), when spectroscopy and diagnostic are interleaved. In both diagnostic mode and interleaved diagnostic, the exposure packet time stamp reflects the diagnostic acquisition time.

7.7 RGS Housekeeping Files

7.7.1 RGS Periodic Housekeeping File

- There are 2 types of RGS periodic housekeeeping telemetry. They are [9]:
  - Full H/K TM packets (SID=10).
  - *Item deleted.*
  - 12 CCD PN diode temperature reading sensors.

  These 3 types of RGS periodic housekeeping telemetry will be stored in separate RGS periodic housekeeping files.
- RGS periodic housekeeping file will be created for each RGS instrument.
- Each RGS periodic housekeeping file will contain the calibrated periodic housekeeping parameters produced for that instrument during an observation period.
- Each RGS periodic housekeeping file will contain the calibrated derived parameters, relevant to the corresponding telemetry packet , produced during an observation period.
- All common instrument housekeeping keywords are applicable (Section 7.1.2).
- Each RGS periodic housekeeping file will consist of a single binary table.
- The binary table will consist of the columns detailed in Table 39

Table 39: RGS Periodic Housekeeping File: Binary Table Columns

Name	Type	Units	Comment	Location in RGS Per. HK Telemetry [9]
TIME	19A	yyyy-mm-ddThh:mm:ss	ERT	Note 1
PARAM1				Note 2,6
...	...	...	...	
PARAMn				Note 6
DERPAR1				Note 3,4,5,6
...	...	...	...	
DERPARm				Note 6

Notes on Table 39:

1. The XSCS calculated UTC Earth Received Time associated with each periodic housekeeping telemetry packet.
2. The description of the raw periodic housekeeping parameters is given in [9]. There will be a binary table column allocated to each identified periodic housekeeping parameter.
3. The derived parameters will be stored after the periodic housekeeping telemetry.
4. The details of the derived parameters are currently unknown and will not be known until they have been defined as part of operational procedures.
5. In all likelihood the derived parameters associated with an instrument will change over the lifetime of XMM. The derived parameters relevant at the time of file generation will be stored.

6. The exact specification of the periodic housekeeping parameters, how they are calibrated and how they are stored within the periodic housekeeping files is to be found in the Operational Database definition. The correspondence between the IPPV definition and the HK parameters is detailed in Appendix A.

7.7.2 RGS Non-Periodic Housekeeping Files

7.7.2.1 RGS DPP Non-Periodic Housekeeping File

- Two RGS DPP non-periodic housekeeping files will be created for each RGS instrument.
- Each RGS DPP non-periodic housekeeping file will contain the "Report DPP task functional parameters" telemetry data produced during an observation period.
- An RGS DPP non-periodic housekeeping file will only be created if "Report DPP task functional parameters" telemetry data is detected during an observation period.
- Each RGS DPP non-periodic housekeeping file will consist of a single binary table.
- The applicable RGS common keywords (Section 7.6.1.1) are:
  - TELESCOP
  - INSTRUME
  - DATATYPE
  - OBS_ID
  - EXP_ID
  - DATE-OBS
  - DATE-END
- The binary table will consist of the columns detailed in Table 40 and 41

Table 40: RGS DPP Non-Periodic Housekeeping File 1: Binary Table Columns

Name	Type	Units	Comment	Location in RGS Non-Per. HK Telemetry [8]
TIME	19A	yyyy-mm-ddThh:mm:ss	ERT[1]	
CCDID	1B		CCD identifier[2]	DPP task management report
WINDOWX0	1U		X-start[3]	DPP task management report
WINDOWY0	1U		Y-start[3]	DPP task management report
WINDOWDX	1U		X-length[3]	DPP task management report
WINDOWDY	1U		Y-length[3]	DPP task management report
SCITYPE	1B		Science type[3]	DPP task management report
CCDNODES	1B		Read-out node[3]	DPP task management report
HOTSTUFF	1B		Hot stuff rejection status[3]	DPP task management report
ATHRESHC	1U		Acceptance threshold (side C)[3]	DPP task management report
ATHRESHD	1U		Acceptance threshold (side D)[3]	DPP task management report
UTHRESHC	1U		Upper threshold (side C)[3]	DPP task management report
UTHRESHD	1U		Upper threshold (side D)[3]	DPP task management report
REALX0	1U		Real X-start[3]	DPP task management report
REALXE	1U		Real X-end[3]	DPP task management report
HOTCOL	1U		Hot column shift size[3]	DPP task management report
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Name	Type	Units	Comment	Location in RGS Non-Per. HK Telemetry [8]

Notes on Table 40:

1. The XSCS calculated UTC Earth Received Time associated with each periodic housekeeping telemetry packet.
2. The DPP task functional parameters, in two packets (FID=40 and FID=41), contain data for CCDs 1-9.
3. The exact specification of each of the non-periodic housekeeping parameters, how they are calibrated and how they are stored within the non-periodic housekeeping files is to be found in the Operational Database definition. The correspondence between the IPPV definition and the HK parameters is detailed in Appendix A.

Table 41: RGS DPP Non-Periodic Housekeeping File 2: Binary Table Columns

Name	Type	Units	Comment	Location in RGS Non-Per. HK Telemetry [8]
TIME	19A	yyyy-mm-ddThh:mm:ss	ERT[1]	
RDOUTSEQ	1B		CCD readout sequence[2]	DPP task management report
CCDSNUM	1U		Number of CCDs[2]	DPP task management report
OCBMODE	1B		OCB mode[2]	DPP task management report
READOUT	1B		Readout nodes	DPP task management report
REJTHRC	1U		Rejection threshold (side C)[2]	DPP task management report
REJTHRD	1U		Rejection threshold (side D)[2]	DPP task management report
CGSPATT	1B		CSG pattern[2]	DPP task management report

Notes on Table 41:

1. The XSCS calculated UTC Earth Received Time associated with each periodic housekeeping telemetry packet.
2. The exact specification of each of the non-periodic housekeeping parameters, how they are calibrated and how they are stored within the non-periodic housekeeping files is to be found in the Operational Database definition. The correspondence between the IPPV definition and the HK parameters is detailed in Appendix A.

7.8 OM Science Files

7.8.1 Overview of the OM Science Files

The following OM science files are defined:

- OM Imaging Mode Data Image File
- OM Fast Mode Event List File
- OM Priority Field Acquisition Auxiliary File
- OM Priority Window Data Auxiliary File
- OM Priority Fast Auxiliary File
- OM Tracking History Data Auxiliary File
- OM Reference Frame Data Auxiliary File
- OM Engineering Mode Image File

A brief overview of the OM science telemetry is given in Section C.4.

In the following tables all telemetry references are taken from the applicable documents [7] and [6].

7.8.1.1 OM Science Files Common Instrument Keywords

The common instrument keywords (see Section 7.1.1.1 and 7.1.1.2) associated with OM science files are detailed in Table 42 along with their possible values and their location within the OM science telemetry definition where applicable. If for a given instance of an OM extension a common instrument keyword is not applicable then it will not appear in that header. Those common keywords which are not applicable are detailed with each file description.

Table 42: OM Science Files Common Information Keywords

Keyword	Keyword Value	Location in OM Field Acquisition Data Telemetry [6, 7]	Comments
OM Science Files Common Information Keywords			
TELESCOP	'XMM'	N/A	Note 1
INSTRUME	'OM'	N/A	Note 2
CHAIN	1/2	N/A	Note 3
DATATYPE		N/A	Note 4
OBS_ID		N/A	Note 5
EXP_ID		N/A	Note 6
TMEXP_ID		DPUINT exposure; in Standard Data Set Header	Note 7,8
SCIWIN		data_set_id in Standard Data Set Header	Note 8,9
PARAM		data_set_param in DPU	Note 8,10

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Keyword	Keyword Value	Location in OM Field Acquisition Data Telemetry [6, 7]	Comments
		Standard Data Set Header	
FRMTIME			Note 11
WINDOWX0			Note 12
WINDOWY0			Note 12
WINDOWDX			Note 12
WINDOWDY			Note 12
DATE-OBS			Note 13
DATE-END			Note 14

1. Identifies the observatory as being XMM
2. Identifies the instrument as being the OM instrument
3. Identifies the OM detector chain in use. If `CHAIN=1` the *redundant* chain is in use. If `CHAIN=2` the *prime* chain is in use. Note: There is no TM indicating the OM chain. The value must be obtained from the SOC database.
4. The type of data held in the file. The possible values are:
   - 'FAQ.EL'. An event list containing priority field acquisition (DP_FAQ) data.
   - 'WDW.EL'. An event list containing priority window (DP_WDW) data.
   - 'BFAST.EL'. An event list containing priority fast (DP_BFAST) data.
   - 'TRH.EL'. An event list containing tracking history (DD_TRH) data.
   - 'REF.EL'. An event list containing reference frame (DD_REF) data.
   - 'IMG.IM'. An image containing image mode (DD_IMG) data.
   - 'FST.EL'. An event list containing fast mode (DD_FST) data.
   - 'ENG.IM'. An image containing engineering (DD_ENG) data.
5. Observation/ Slew Identifier (10 characters) assigned in the XMM archive.
6. Exposure Identifier (13 characters) as assigned in the XMM archive.
7. Exposure Identifer as identified in the telemetry.
8. The DPU Standard Data Set Header is defined in [7].
9. The data_set_id is the data set identifier, that is, the science window identifer.
10. The data_set_param contains additional information relating to the data type.
11. The frame time is explicitly tranmitted through the DA_BEGOF_EXP and DA_ENDOF_EXP non-periodic housekeeping alerts and can be obtained from there.
12. All window details are contained in the OM priority window data auxiliary file. These can be used where required (in the imaging, fast and engineering files).
13. Start time (UTC) of exposure as calculated by XSCS (yyyy-mm-ddThh:mm:ss). The time will be the start time of the exposure indicated by the housekeeping telemetry and not the time of the first science telemetry. This time will not be the precise exposure start time as the accurate orbit and attitude information is not available to the XSCS when the time is calculated. It will however be calculated using the available time correlation information.
14. End time (UTC) of exposure as calculated by XSCS (yyyy-mm-ddThh:mm:ss). The time will be the end time of the exposure indicated by the housekeeping telemetry and not the start time of the first science telemetry.

7.8.1.2 General Comments Relating to the OM Science Files

1. In the subsequent file definitions the term guide star refers to those stars chosen on-board for frame by frame tracking while reference stars (or absolute guide stars) are those stars whose locations, as defined in the guide star catalogue, have been uplinked to the OM instrument.

7.8.2 OM Imaging Mode Image File

- There will be an OM imaging mode image file for each imaging mode science window.
- Each OM imaging mode image file will consist of a single image extension.
- The image extension will contain a single image.
- All OM common instrument keywords are applicable (Section 7.8.1.1).
- The additional keywords and the NAXIS values for an imaging mode image file extension are detailed in Table 43. This information is to be used in conjunction with that contained in Section 7.1.1.2.

Table 43: OM Image Mode Image File: Image Extension Keyword Details

Keyword	Keyword Value	Location in OM DD_IMG Telemetry [6, 7]	Comments
Mandatory FITS Extension Header Keywords			
BITPIX	32	N/A	
NAXIS	2	N/A	
NAXIS1		DPUINT xsize; in DP_WDW	Note 1
NAXIS2		DPUINT ysize; in DP_WDW	Note 1
OM Imaging Mode Image File Additional Keywords			
BUNIT	COUNTS		
BLANK			Note 2
BINAX1			Note 3
BINAX2			Note 3
BINPE	T/F		Note 4
FILTER			
EXPOSURE	SECONDS		Note 5

Note on Table 43:

1. All window details are contained in the DP_WDW data (stored in the OM priority window data auxiliary file).
2. The BLANK keyword is used to indicate the value assigned to missing pixels.
3. Pixel binning factors in x and y, as stored in the OM priority window data auxiliary file (DP_WDW p1 and p2, respectively).
4. T/F = Low/High resolution
5. The exposure duration in seconds. It is calculated from the a513 and a514 alerts in the non periodic housekeeping

7.8.3 OM Fast Mode Event List File

- There will be an OM fast mode event list file for each fast mode science window.
- Each OM fast mode event list file will contain data from 1 exposure only.
- Each OM fast mode event list file will consist of a single binary table extension.
- All OM common instrument keywords are applicable (Section 7.8.1.1).
- The binary table will consist of the columns detailed in Table 44.

Table 44: OM Fast Mode Event List File: Binary Table Columns

Name	Type	Units	Comment	Location in OM DD_FST Telemetry [6, 7]
FRAME	1J	COUNTER	Frame Identifier	Note 1, 2
FTCOARSE	1J	SECOND	Coarse Frame Time	Note 3
FTFINE	1I		Fine Frame Time	Note 3
RAWX	1I	PIXEL	X coordinate of event	
RAWY	1I	PIXEL	Y coordinate of event	

Notes on Table 44:

1. All event values have to be derived from the DD_FST data as well as the information contained in the DP_WDW and DP_BFAST data. The details of the processing required to generate these parameters are to be found in [22]. It is noted that as a consequence of this algorithm when n photons are detected at pixel position x, y within an OM timing mode time slice there will be n events registered in the OM fast mode event list file.
2. The frame identifier indicates the time slice in which the event was detected.
3. The coarse and fine frame times are the coarse and fine time slice start times. These are calculated from the a513 using the 24 bit TIMESTAMP field

- The additional keywords for Fast Mode Event List files are detailed in Table 45

Table 45: OM Fast Mode Event List File: Binary Table Columns: Additional Keywords

Keyword	Keyword value	Comment
SAMPTIME		Note 1
BFASTID		Note 2
BINPE	T/F	Note 3
FILTER		
EXPOSURE		Note 4

Notes on Table 45:

1. time slice duration in units of DPU cycles as strored in the DP_WDW as p1 values
2. bfast area, *i.e.* the processor of the fast mode window with a value 1 or 2 (p2 in DP_WDW)
3. T/F = Low/High resolution
4. The exposure duration in seconds. It is calculated from the a513 and a514 alerts in the non periodic housekeeping

7.8.4 OM Priority Field Acquisition Auxiliary File

- An OM priority field acquisition auxiliary file will be created for each occurrence of DP_FAQ data
- Each OM priority field acquisition auxiliary file will consist of a single binary table.
- The following OM common instrument keywords are not applicable (Section 7.8.1.1).
  - FRMTIME
  - WINDOWX0
  - WINDOWY0
  - WINDOWDX
  - WINDOWDY
- The binary table will consist of the columns detailed in Table 46

Table 46: OM Priority Field Acquisition Auxiliary File: Binary Table Columns

Name	Type	Units	Comment	Location in OM DP_FAQ Telemetry [6, 7]
ITERATN	1J	COUNTER	No of iterations to solution	DPUINT iterations;
XCOMMAND	1J	PIXEL	Commanded x coordinate	DPUINT xcommand;[1]
YCOMMAND	1J	PIXEL	Commanded y coordinate	DPUINT ycommand;[1]
DX	1J	PIXEL	Calculated pointing error in x	DPUINT dx;[2]
DY	1J	PIXEL	Calculated pointing error in y	DPUINT dy;[2]
SINTHETA	1J		Sin of calculated absolute roll error	DPUINT sintheta;[3]
NGSUP	1J	COUNTER	Number of uplinked guide stars	DPUINT ngsup;
NGSFOUND	1J		No of guide stars found	DPUINT nsgfound;
GSX	16J	PIXEL	X coordinates of the guide stars	POS gs[16]; x;
GSY	16J	PIXEL	Y coordinates of the guide stars	POS gs[16]; y;
RSX	16J	PIXEL	X coordinate of the reference stars	POS ref_stars[16]; x;
RSY	16J	PIXEL	Y coordinate of the reference stars	POS ref_stars[16]; y;

Notes on Table 46:

1. The commanded x and y coordinate in centroided pixels.
2. The calculated pointing error in x and y (1/1000 centroided pixel).
3. The sin of the calculated absolute roll error (1/1000).

7.8.5 OM Priority Window Data Auxiliary File

- An OM priority window data auxiliary file will be created for each occurrence of DP_WDW data
- Each OM priority window data auxiliary file will consist of a single binary table.
- The following OM common instrument keywords are not applicable (Section 7.8.1.1).
  - *Item deleted.*
  - WINDOWX0
  - WINDOWY0
  - WINDOWDX
  - WINDOWDY
- The binary table will consist of the columns detailed in Table 47.

Table 47: OM Priority Window Data Auxiliary File: Binary Table Columns

Name	Type	Units	Comment	Location in OM DP_WDW Telemetry [6, 7]
DETWIND	1J		No of detector windows	DPUINT ndet;
SCIWIND	1J		No of science windows	DPUINT nsci;
MEMWIND	1J		No of memory windows	DPUINT x0;
DWX0	16J	PIXEL	Bottom left x-coord of detector window	DET_WIND det[16]; x0;
DWY0	16J	PIXEL	Bottom left y-coord of detector window	DET_WIND det[16]; y0;
DWXSIZE	16J	PIXEL	X dimension of detector window	DET_WIND det[16]; xsize;
DWYSIZE	16J	PIXEL	Y dimension of detector window	DET_WIND det[16]; ysize;
DWMMWID	16J		Id of corresponding memory window	DET_WIND det[16]; mmwid;
DWKOMPX	16J		MIC data decoding parameter	DET_WIND det[16]; kompx;
DWBB	16J		MIC data decoding parameter	DET_WIND det[16]; bb;
DWAA	16J		MIC data decoding parameter	DET_WIND det[16]; aa;
DWKOMPY	16J		MIC data decoding parameter	DET_WIND det[16]; kompy;
SWX0	16J	PIXEL	Bottom left x-coord of science window	SCI_WIND sci[16]; x0;
SWY0	16J	PIXEL	Bottom left y-coord of science window	SCI_WIND sci[16]; y0;
SWXSIZE	16J	PIXEL	X dimension of science window	SCI_WIND sci[16]; xsize;
SWYSIZE	16J	PIXEL	Y dimension of science window	SCI_WIND sci[16]; ysize;

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Name	Type	Units	Comment	Location in OM DP_WDW Telemetry [6, 7]
SWMODE	16J		Science window operating mode	SCI_WIND sci[16]; mode;
SWP1	16J		Science window mode dependent parameter	SCI_WIND sci[16]; p1;
SWP2	16J		Science window mode dependent parameter	SCI_WIND sci[16]; p2;
SWP3	16J		Science window mode dependent parameter	SCI_WIND sci[16]; p3;
SWP4	16J		Science window mode dependent parameter	SCI_WIND sci[16]; p4;
SWBASE	16J		Science window data storage address	SCI_WIND sci[16]; base;
SWMMWID	16J		Science window id of corresponding mem wind	SCI_WIND sci[16]; mmwid;
MWX0	16J	PIXEL	Bottom left x-coord of memory window	MEM_WIND sci[16]; x0;
MWY0	16J	PIXEL	Bottom left y-coord of memory window	MEM_WIND sci[16]; y0;
MWXSIZE	16J	PIXEL	X dimension of memory window	MEM_WIND sci[16]; xsize;
MWYSIZE	16J	PIXEL	Y dimension of memory window	MEM_WIND sci[16]; ysize;
MWBASE	16J		Memory window retrieval address	MEM_WIND sci[16]; base;

7.8.6 OM Priority Fast Auxiliary File

- An OM priority fast auxiliary file will contain the DP_BFAST produced for an exposure.
- There will be a single OM Priority Fast Auxiliary File for each exposure of an observation (excluding the Field Acquistion exposure) if there are fast windows configured. That is, if there are no fast windows active during the exposure then this file will not be present in the ODF.
- Each OM priority fast auxiliary file will consist of a single binary table.
- It is assumed that a DP_BFAST packet can be produced for each blue dsp. Therefore the binary table will consist of 1 or 2 rows.
- The following OM common instrument keywords are not applicable (Section 7.8.1.1).
  - *Item deleted.*
  - WINDOWX0
  - WINDOWY0
  - WINDOWDX
  - WINDOWDY
- The binary table will consist of the columns detailed in Table 47.

Table 48: OM Priority Fast Auxiliary File: Binary Table Columns

Name	Type	Units	Comment	Location in OM DP_BFAST Telemetry [6, 7]
BFASTID	1J		Blue dsp 1 or 2	DPUINT bfast_id;
SAMPTIME	1J		Sample Time	DPUINT sample_time;
NFASTPIX	1J		No of pixels per fast time slice	DPUINT n_fast_pixels;
FASTDEST	1J		Memory address of fast mode data stream	DPUINT fast_destination;
FASTEND	1J		Termination address of fast mode data	DPUINT fast_end;
NFASTEVT	1J		Total no of events in mode data	DPUINT n_fast_events;
FASTADDR	503J		Fast addresses	DPUINT fast_address;

7.8.7 OM Tracking History Data Auxiliary File

- There will be a single OM tracking history auxiliary file for each exposure of an observation (excluding the Field Acquistion exposure).
- An OM tracking history auxiliary file will be created for each occurrence of DD_WDW data
- Each OM tracking history auxiliary file will consist of a single binary table.
- Each row of the event list represents a frame of the exposure.
- The following OM common instrument keywords are not applicable (Section 7.8.1.1).
  - *Item deleted.*
  - WINDOWX0
  - WINDOWY0
  - WINDOWDX
  - WINDOWDY
- The binary table will consist of the columns detailed in Table 49.

In the following tables all telemetry references are taken from the applicable documents [7] and [6].

Table 49: OM Tracking History Auxiliary File: Binary Table Columns

Name	Type	Units	Comment	Location in OM DD_TRH Telemetry [6, 7]
FRAME	1J	COUNTER	Frame Identifier	
NGGS	1J	COUNTS	No of good guide stars found	DPUINT nggs[i];[1]
DX	1J		Calculated drift in x	DPUINT dx[i];
DY	1J		Calculated drift in y	DPUINT dy[i];
ROLL	1J		Calculated roll drift	DPUINT roll[i];
QUALITY	1J		Quadratic sum of the x and y residuals	DPUINT quality [i];
GSX	10J	PIXEL	Guide star x coordinate	POS x[i];
GSY	10J	PIXEL	Guide star y coordinate	POS y[i];
GSCTS	10J	COUNTS	Guide star counts integrated over psf	STAR cts[i];

Notes on Table 49:

1. The maximum number of guide stars is 16. The actual number of guide stars in the DD_TRH file is defined by the number of guide star found in the reference frame, i.e. by the GOODSTAR counter in the refrence frame auxiliary file (= nggs in DD_REF).

7.8.8 OM Reference Frame Auxiliary File

- There will be a single OM reference frame auxiliary file for each exposure of an observation (excluding the Field Acquistion exposure).
- An OM reference frame auxiliary file will contain the DD_REF data produced for an exposure.
- Each OM reference frame auxiliary file will consist of a single binary table.
- The following OM common instrument keywords are not applicable (Section 7.8.1.1).
  - FRMTIME
  - WINDOWX0
  - WINDOWY0
  - WINDOWDX
  - WINDOWDY
- The binary table will consist of the columns detailed in Table 50.

Table 50: OM Reference Frame Auxiliary File: Binary Table Columns

Name	Type	Units	Comment	Location in OM DD_REF Telemetry [6, 7]
XROLL	1J	PIXEL	Roll centre x coordinate	DPUINT roll_ctr_x;
YROLL	1J	PIXEL	Roll centre y coordinate	DPUINT roll_ctr_y;
GOODSTAR	1J	COUNTER	No of good guide stars	DPUINT stars_found;
BADSTAR	1J	COUNTER	No of bad guide stars	DPUINT stars_rejected;
GGSX	16J	PIXEL	Good guide star x coordinate	STARS_DATA *ggs*[*nggs*][1];
GGSY	16J	PIXEL	Good guide star y coordinate	STARS_DATA ggs[nggs];
GGSCNTS	16J	COUNTS	Good guide star counts	STARS_DATA ggs[nggs];
GGSPKCO	16J	PIXEL	Good guide star peak coords	STARS_DATA ggs[nggs];
GGSPKCNT	16J	COUNTS	Good guide star peak counts	STARS_DATA ggs[nggs];
GGSQUAL	16J		Good guide star star quality	STARS_DATA ggs[nggs];
GGSXMIN	16J	PIXEL	Good guide star box xmin	STARS_DATA ggs[nggs];
GGSXMAX	16J	PIXEL	Good guide star box xmax	STARS_DATA ggs[nggs];
GGSYMIN	16J	PIXEL	Good guide star box ymin	STARS_DATA ggs[nggs];
GGSYMAX	16J	PIXEL	Good guide star box ymax	STARS_DATA ggs[nggs];
GGSX2MNT	16J	PIXEL	Good guide star moment x2mnt	STARS_DATA ggs[nggs];
GGSY2MNT	16J	PIXEL	Good guide star moment y2mnt	STARS_DATA ggs[nggs];
GGSXYMNT	16J	PIXEL	Good guide star moment xymnt	STARS_DATA ggs[nggs];
BGSX	16J	PIXEL	Bad guide star x coordinate	STARS_DATA *bgs*[*nbgs*][2];
BGSY	16J	PIXEL	Bad guide star y coordinate	STARS_DATA bgs[nbgs];
BGSCNTS	16J	COUNTS	Bad guide star counts	STARS_DATA bgs[nbgs];
BGSPKCO	16J	PIXEL	Bad guide star peak coords	STARS_DATA bgs[nbgs];
BGSPKCNT	16J	COUNTS	Bad guide star peak counts	STARS_DATA bgs[nbgs];
BGSQUAL	16J		Bad guide star- star quality	STARS_DATA bgs[nbgs];
BGSXMIN	16J	PIXEL	Bad guide star box xmin	STARS_DATA bgs[nbgs];
BGSXMAX	16J	PIXEL	Bad guide star box xmax	STARS_DATA bgs[nbgs];
BGSYMIN	16J	PIXEL	Bad guide star box ymin	STARS_DATA bgs[nbgs];

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Name	Type	Units	Comment	Location in OM DD_REF Telemetry [6, 7]
BGSYMAX	16J	PIXEL	Bad guide star box ymax	STARS_DATA bgs[nbgs];
BGSX2MNT	16J	PIXEL	Bad guide star moment x2mnt	STARS_DATA bgs[nbgs];
BGSY2MNT	16J	PIXEL	Bad guide star moment y2mnt	STARS_DATA bgs[nbgs];
BGSXYMNT	16J	PIXEL	Bad guide star moment xymnt	STARS_DATA bgs[nbgs];

Notes on Table 50:

1. The maximum number of guide stars used is 16. Therefore the maximum value for nggs is 16.
2. The maximum number of guide stars used is 16. Therefore the maximum value for nbgs is 16.

7.8.9 OM Engineering Mode Image File

- There will be OM engineering mode image files for each engineering mode exposure. Note that it is possible for 2 engineering mode image files (corresponding to PARAM = 3 and PARAM = 7 below) to be created in the same engineering mode exposure.
- Each OM engineering mode image file will consist of a single image extension.
- The image extension will contain a single image.
- All OM common instrument keywords are applicable (Section 7.8.1.1).
- The filename associated with the OM engineering mode image file will indicate the subtype (PARAM keyword in OM common instrument keywords) of the data (Section 5.3.1).
- The additional keywords and the NAXIS values for a diagnostic mode image file extension are detailed in Table 51. This information is to be used in conjunction with that contained in Section 7.1.1.2.
- If window information (DP_WDW) does not arrive before the engineering data, the values of the WINDOWX0, WINDOWY0, WINDOWDX, WINDOWDY keywords are set to the value -1. For Engineering-4 Mode files, these quantities will assume the following fixed values: WINDOWX0=0, WINDOWY0=0, WINDOWDX=2048, WINDOWDY=2048.

Table 51: OM Engineering Mode Image File: Primary Header Keywords

Keyword	Keyword Value	Location in OM DD_ENG Telemetry [6, 7]	Comments
Mandatory FITS Extension Header Keywords			
BITPIX	32	N/A	
NAXIS	3	N/A	
NAXIS1			Note 1
NAXIS2			Note 1
NAXIS3			Note 1
OM Engineering Mode Additional Keywords			
BLANK			Note 2
OM Engineering-4 Mode Additional Keywords			
BUNIT	'COUNT'		
BINAX1			Note 3
BINAX2			Note 4
BINPE	0		Note 5
EXPOSURE			
FILTER			
NAXIS3			Note 6

Note on Table 51:

1. The dimensions of the array depend upon the value of the PARAM keyword (subtype) in the OM common information
   - PARAM = 0 (Raw data with both blue dsps): 1 million raw events for each blue dsp. Therefore dimensions are 2 x 1000000 x 1.
   - PARAM = 1 (Raw data with only blue dsp 1): 1 million raw events for blue dsp 1. Therefore dimensions are 1 x 1000000 x 1.

- PARAM = 2 (Raw data with only blue dsp 2): 1 million raw events for blue dsp 2. Therefore dimensions are 1 x 1000000 x 1.
- PARAM = 3 (Channel boundary data): 2 arrays of 9 elements each. Therefore dimensions are 2 x 9 x 1.
- PARAM = 4 (Full frame, high resolution): An array of 2048 by 2048. Therefore dimensions are 2048 x 2048 x 1.
- PARAM = 5 (Centroiding confirmation data): 64 arrays of 8 by 8. Therefore dimensions are 8 x 8 x 64. This is derived as follows: The 2048 by 2048 detector is divided into 64 regions of 256 by 256. Each of these 256 by 256 regions are modulo 8 binned to give 64 regions of 8 by 8.
- PARAM = 6 (Intensifier characteristics): Therefore dimensions are 1 x 256 x 1.
- PARAM = 7 (M,N images): 2 arrays of 256 by 256 each. Therefore dimensions are 256 x 256 x 2.

2. The BLANK keyword is used to indicate the value assigned to missing pixels.
3. CCD X-axis binning $Y = 2^{P1}$
4. CCD Y-axis binning $Y = 2^{P1}$
5. Value fixed (means FALSE or not-binned)
6. Third dimension in image

7.9 OM Housekeeping Files

7.9.1 OM Periodic Housekeeping File

- There are 2 type of OM periodic housekeeeping telemetry. It is [6]:
  - standard periodic housekeeping telemetry packets (SID=00).
  - diagnostic periodic engineering housekeeping packets (SID=01). The format of this data is identical to that of the periodic housekeeping data. The only difference is that this data is sent every 1 second instead of the usual 10 seconds. This diagnostic housekeeping data will be stored in the OM periodic housekeeping file (alongside periodic housekeeping if necessary). The time key incrementing by 1 second will indicate that the data is diagnostic periodic engineering data.

    Note: standard periodic housekeeping telemetry packets will be disabled when this packet type is enabled.
- Each OM periodic housekeeping file will contain the calibrated periodic housekeeping parameters produced during an observation period.
- Each OM periodic housekeeping file will contain the calibrated derived parameters, relevant to the corresponding telemetry packet, produced during an observation period.
- All common instrument housekeeping keywords are applicable (Section 7.1.2).
- Each OM periodic housekeeping file will consist of a single binary table.
- The binary table will consist of the columns detailed in Table 52

Table 52: OM Periodic Housekeeping File: Binary Table Columns

Name	Type	Units	Comment	Location in OM Per. HK Telemetry [6]
TIME	19A	yyyy-mm-ddThh:mm:ss	ERT	Note 1
PARAM1				Note 2,6
...	...	...	...	
PARAMn				Note 6
DERPAR1				Note 3,4,5
...	...	...	...	
DERPARm				Note 6

Notes on Table 52:

1. The XSCS calculated UTC Earth Received Time associated with each periodic housekeeping telemetry packet.
2. The description of the raw periodic housekeeping parameters is given in [6]. There will be a binary table column allocated to each identified periodic housekeeping parameter.
3. The derived parameters will be stored after the periodic housekeeping telemetry.
4. The details of the derived parameters are currently unknown and will not be known until they have been defined as part of operational procedures.
5. In all likelihood the derived parameters associated with an instrument will change over the lifetime of XMM. The derived parameters relevant at the time of file generation will be stored.

6. The exact specification of the periodic housekeeping parameters, how they are calibrated and how they are stored within the periodic housekeeping files is to be found in the Operational Database definition. The correspondence between the IPPV definition and the HK parameters is detailed in Appendix A.

7.9.2 OM Non-Periodic Housekeeping File

- An OM non-periodic housekeeping file will be created for the OM instrument.
- Each OM non-periodic housekeeping file will contain the non-periodic housekeeping data produced during an observation period.
- An OM non-periodic housekeeping file will only be created if non-periodic housekeeping data is detected during an observation period.
- The details of the following OM non-periodic reports will be stored:
  - Non-DPU event reports
  - DPU event reports
  - Non-DPU exception reports
  - DPU exception reports
  - Major anomaly reports
  - *Item deleted.*
- Each OM non-periodic housekeeping file will consist of a single binary table.
- The binary table will consist of the columns detailed in Table 53

Table 53: OM Non-Periodic Housekeeping File: Binary Table Columns

Name	Type	Units	Comment	Location in OM Non-Per. HK Telemetry [6]
TIME	19A	yyyy-mm-ddT hh:mm:ss	ERT	Note 1
FTCOARSE	1J	SECOND	Telemetry packet header coarse time	
FTFINE	1U		Telemetry packet header fine time	
SID	1I		Structure Identifier	Note 2
TYPE	1J		Report Identifier	Note 3
PAR1	1J		Parameter 1	Note 4
PAR2	1J		Parameter 2	Note 4
PAR3	1J		Parameter 3	Note 4
PAR4	1J		Parameter 4	Note 4
PAR5	1J		Parameter 5	Note 4

Notes on Table 53:

1. The XSCS calculated UTC associated with each non-periodic housekeeping telemetry packet.
2. The SID associated with each non-periodic housekeeping packet.
3. The type of the report:
   - This is referred to as the Event Code of a Non-DPU Event Report [6]. In some cases, no Event Code is present in the telemetry and TYPE is set to -1.
   - This is referred to as the Alert Code of a DPU Event Report [6].

- This is referred to as the Exception Code of a Non-DPU Exception Report [6]. In some cases, no Exception Code is present in the telemetry and TYPE is set to -1.
- This is referred to as the DPU Exception Alert Code of a DPU Exception Report [6].
- The field is not applicable for a Major Anomaly report. The SID is sufficient [6]. Set to -1
- *Item deleted.*

4. The meaning of parameters PAR1 - PAR5 depend on the report type:

   - Non-DPU event reports. PAR1 to PAR5 will contain the values of the parameters associated with these reports or set to -1 if not required. In case of more than 5 parameters, the non-periodic housekeeping record will be repeated with PAR1 to PAR5 being used for the remaining parameter values or set to -1 if not required.
   - DPU event reports
     - PAR1: Exposure number [7] (set it to -1 if not applicable)
     - PAR2: Timestamp (set it to -1 if not applicable)
     - PAR3 to PAR5: Parameters associated with DPU event report.

     Note: A minority of DPU event reports have more than 3 parameters. In these instances the non-periodic housekeeping record will be repeated with PAR1 to PAR5 being used for the remaining parameter values or set to -1 if not required.
   - Non-DPU exception reports. PAR1 to PAR5 will contain the values of the parameters associated with these reports or set to -1 if not required. In case of more than 5 parameters, the non-periodic housekeeping record will be repeated with PAR1 to PAR5 being used for the remaining parameter values or set to -1 if not required.
   - DPU exception reports.
     - PAR1: Exposure number [7] (set it to -1 if not applicable)
     - PAR2: Timestamp (set it to -1 if not applicable)
     - PAR3 to PAR5: Parameters associated with DPU exception report.

     Note: A minority of DPU exception reports have more than 3 parameters. In these instances the non-periodic housekeeping record will be repeated with PAR1 to PAR5 being used for the remaining parameter values or set to -1 if not required.
   - Major anomaly reports. There is a single parameter associated with these reports. PAR1 will be set to this value. The others will be set to -1.
   - *Item deleted.*

5. The correspondence between the IPPV definition and the HK parameters is detailed in Appendix A.

7.10 EPIC Radiation Monitor Science Files

7.10.1 Overview of EPIC Radiation Monitor Files

The ODS creates 2 sets of EPIC radiation monitor science files: EPIC radiation monitor fixed configuration period files and EPIC radiation monitor observation/ slew period files (Section 7.1.3). It is the EPIC radiation monitor observation/ slew period files that are described here. Note however that the 2 sets of files have the same format and structure. The only difference between the 2 sets of files being the time periods covered.

The EPIC Radiation Monitor has 2 modes of operation: fast and slow mode. The data produced by these 2 modes of operation is identical. The difference being that in fast mode the telemetry packet contains the complete spectra while in slow mode only part of the data are contained in each packet and the whole data must be reconstructed on ground.

The following EPIC radiation monitor files are generated from data in the EPIC radiation monitor telemetry packets:

- EPIC radiation monitor count rate file
- EPIC radiation monitor spectra file

7.10.1.1 EPIC Radiation Monitor Science Files Common Instrument Keywords

The common instrument keywords (see Section 7.1.1.1) associated with the EPIC radiation monitor science files are detailed in Table 54 along with their possible values and their location within the spacecraft telemetry definition where applicable.

Table 54: EPIC Radiation Monitor Files: Common Information Keywords

Keyword	Keyword Value	Identifier in EPIC RM Telemetry Definition [12]	Comments
EPIC Radiation Monitor Science Files Common Information Keywords			
TELESCOP	'XMM'	N/A	Note 1
INSTRUME	'ERM'	N/A	Note 2
DATATYPE	' '	N/A	Note 3
OBS_ID		N/A	Note 4
ERMS_ID		APID in Packet Header Data Field	Note 5
TMMODE	0-3	TM Spectra Mode in Header (status word) of Slow and Fast mode telemetry packets	
WKMODE	0-3	Working Mode in Header of Slow and Fast mode telemetry packets	
ITGSTAT	0,1	Test Generator in Header (status word) of Slow and Fast mode telemetry packets	
DATE-OBS			Note 6
DATE-END			Note 7

Notes on Table 54

1. Identifies the observatory as being XMM

2. Identifies the instrument as being the EPIC Radiation Monitor.
3. The type of data held in the file. The possible values are:
   - 'COUNTS.EL'. An event list containing counts data.
   - 'SPECTRA.EL'. An event list containing spectra data.
4. Observation/ Slew Identifier (10 characters) assigned in the XMM archive.
5. The EPIC radiation monitor identifier (nominal or redundant).
6. Start time (UTC) of observation as calculated by XSCS (yyyy-mm-ddThh:mm:ss). Please note that the start time is earlier by a configurable margin (nominally set to 10 minutes) than the actual observation start in order to archive instrument set-up
7. End time (UTC) of observation as calculated by XSCS (yyyy-mm-ddThh:mm:ss). Please note that the end time is later than the actual observation end as it extends until the next slew (or observation) start time

7.10.1.2 General Comments Relating to the EPIC Radiation Monitor Science Files

1. The Frame Identifier is an incremental counter which uniquely identifies the frames of data. When incrementing the Frame Identifier it should be incremented to reflect any frames which were detected as missing.

7.10.2 EPIC Radiation Monitor Count Rate File

- This file contains the counting information contained in the EPIC radiation monitor telemetry packets.
- EPIC radiation monitor count rate files will be generated to cover every observation and slew period.
- Each EPIC radiation monitor count rate file will contain the counting details contained in the EPIC radiation monitor telemetry.
- Each EPIC radiation monitor count rate file will consist of a single binary table.
- The count rate file has an entry (frame) corresponding to each telemetry packet.
- All EPIC radiation monitor science files common instrument keywords are applicable (Section 7.10.1.1).
- The binary table will consist of the columns detailed in Table 55

Table 55: EPIC Radiation Monitor Count Rate File: Binary Table Columns

Name	Type	Units	Comment	Location in ERME Telemetry [12]
FTCOARSE	1J	SECOND	Coarse Frame Time	Coarse Time in Packet Header Data Field of Slow and Fast Mode Telemetry
FTFINE	1U		Fine Frame Time	Fine Time in Packet Header Data Field of Slow and Fast Mode Telemetry
FRAME	1J	COUNTER	Frame Identifier	
NLE0	1U		Counting LE0	Slow and Fast Mode Telemetry
NLE1	1U		Counting LE1	Slow and Fast Mode Telemetry
NLE2	1U		Counting LE2	Slow and Fast Mode Telemetry
NHE0	1U		Counting HE0	Slow and Fast Mode Telemetry
NHE1	1U		Counting HE1	Slow and Fast Mode Telemetry
NHE2	1U		Counting HE2	Slow and Fast Mode Telemetry
NHEC	1U		Counting HEC	Slow and Fast Mode Telemetry
WFSTAT	1I		Warning Flag Status	Header of Slow and Fast Mode Telemetry
EVALCADD	1I		EVALCOMP Address	EvalComp TM, word 1 in Slow and Fast Mode Telemetry
EVALCNO	1I		EVALCOMP Number	EvalComp TM, word 2 in Slow and Fast Mode Telemetry

Notes on Table 55:

1. The counts in columns NLE0, NLE1, NLE2, NHE0, NHE1, NHE2 and NHEC are compressed values. A pseudo log compression is used ([35]).

7.10.3 EPIC Radiation Monitor Spectra File

- This file contains the spectra contained in the EPIC radiation monitor telemetry packets.
- EPIC radiation monitor spectra files will be generated to cover every observation and slew period.
- Each EPIC radiation monitor spectra file will contain the spectra contained in the EPIC radiation monitor telemetry.
- Each EPIC radiation monitor spectra file will consist of a single binary table.
- The spectra file has an entry (frame) corresponding to complete spectra. In fast mode the spectra are downlinked in 2 telemetry packets. In slow mode the spectra are downlinked in 128 telemetry packets.
- All EPIC radiation monitor science files common instrument keywords are applicable (Section 7.10.1.1).
- The binary table will consist of the columns detailed in Table 56

Table 56: EPIC Radiation Monitor Spectra File: Binary Table Columns

Name	Type	Units	Comment	Location in ERME Telemetry [12]
FTCOARSE	1J	SECOND	Coarse Frame *Time*[1]	Coarse Time in Packet Header Data Field of Slow and Fast Mode Telemetry
FTFINE	1U		Fine Frame *Time*[1]	Fine Time in Packet Header Data Field of Slow and Fast Mode Telemetry
FRAME	1J	COUNTER	Frame Identifier	
SPLE	256U	COUNTS	SP_LE Accumulated Spectrum	Slow and Fast Mode Telemetry
SPHES	256U	COUNTS	SP_HES Accumulated Spectrum	Slow and Fast Mode Telemetry
SPHEC	256U	COUNTS	SP_HEC Accumulated Spectrum	Slow and Fast Mode Telemetry

Notes on Table 56

1. The coarse and fine frame time are taken from the packet header of the first telemetry packet.

7.11 Spacecraft Files

7.11.1 Overview of Spacecraft Files

The following spacecraft files are defined:

- Spacecraft time correlation file
- Spacecraft attitude history file
- Spacecraft raw attitude history file
- Spacecraft dummy attitude file
- Spacecraft predicted orbit file
- Spacecraft reconstructed orbit file
- Spacecraft periodic housekeeping files

Both the spacecraft dummy attitude file and the spacecraft predicted orbit file are intermediate files which are replaced by the spacecraft attitude history file and the spacecraft reconstructed orbit file when they become available. The SSC should only receive ODFs which contain the spacecraft attitude history file and the spacecraft reconstructed orbit file.

7.11.1.1 Spacecraft Files Common Instrument Keywords

The common instrument keywords (see Section 7.1.1.1 and 7.1.1.2) associated with science files are detailed in Table 57 along with their possible values and their location within the spacecraft telemetry definition where applicable. If for a given instance of a spacecraft file extension a common instrument keyword is not applicable then it will not appear in that header. Those common keywords which are not applicable are detailed with each file description.

Table 57: Spacecraft Files Common Information Keywords

Keyword	Keyword Value	Identifier in Spacecraft Telemetry Definition	Comments
Spacecraft Files Common Information Keywords			
TELESCOP	'XMM'	N/A	Note 1
INSTRUME	'SC'	N/A	Note 2
DATATYPE		N/A	Note 3
OBS_ID		N/A	Note 4
DATE-OBS			Note 5
DATE-END			Note 6

Notes on Table 57

1. Identifies the observatory as being XMM
2. Identifies the instrument as being the spacecraft

3. The type of data held in the file. The possible values are:
    - 'TIMCOR.EL'. An event list containing spacecraft time correlation data.
    - 'ATTHIS.EL'. An event list containing the spacecraft attitude history data.
    - 'DUMATT.EL'. An event list containing the spacecraft dummy attitude data.
    - 'PREORB.EL'. An event list containing the spacecraft predicted orbit data.
    - 'RECORB.EL'. An event list containing the spacecraft reconstructed orbit data.
    - 'PERHK1.EL'. An event list containing the spacecraft periodic housekeeping 1 data.
    - 'PERHK2.EL'. An event list containing the spacecraft periodic housekeeping 2 data.
    - 'PERAT1.EL'. An event list containing the spacecraft periodic attitude 1 data.
    - 'PERAT2.EL'. An event list containing the spacecraft periodic attitude 2 data.
    - 'PERHK5.EL'. An event list containing the spacecraft periodic housekeeping SYS_HK_SID0 data.
    - 'PERHK6.EL'. An event list containing the spacecraft periodic housekeeping SYS_HK_SID1 data.
    - 'PERHK7.EL'. An event list containing the spacecraft periodic housekeeping SYS_HK_SID4 data.
    - 'PERHK8.EL'. An event list containing the spacecraft periodic housekeeping SYS_HK_SID5 data.
    - 'PERHK9.EL'. An event list containing the spacecraft periodic housekeeping SYS_HK_SID6 data.
4. Observation/ Slew Identifier (10 characters) assigned in the XMM archive.
5. Start time (UTC) of observation as calculated by XSCS (yyyy-mm-ddThh:mm:ss). This time will not be the precise observation start time as the accurate orbit and attitude information is not available to the XSCS when the time is calculated. It will however be calculated using the available time correlation information.
6. End time (UTC) of observation as calculated by XSCS (yyyy-mm-ddThh:mm:ss).

7.11.1.2 General Comments Relating to the Spacecraft Files

None.

7.11.2 Spacecraft Time Correlation File

- This file contains the OBDH time and the corresponding UTC as extracted from the MOC generated time correlation telemetry packets.
- A spacecraft time correlation file will be created for each observation period.
- A spacecraft time correlation file will be created for each slew period.
- Each spacecraft time correlation file will contain the details of each XMCS generated time packet received during the observation/ slew period.
- Each spacecraft time correlation file will consist of a single binary table.
- All spacecraft common instrument keywords are applicable (Section 7.11.1.1).
- All telemetry references are taken from document [29].
- The binary table will consist of the columns detailed in Table 58

Table 58: Spacecraft Time Correlation File: Binary Table Columns

Name	Type	Units	Comment	Location in XMCS Time Packet Telemetry [29]
FRAME	1J	COUNTER		
OBTCOARS	1J	SECOND	Coarse COBT	Coarse $COBT^1$
OBTFINE	1U		Fine COBT	Fine$COBT^1$
UTCDAY	1I		UTC (day) corresponding to COBT	UTC $(day)^2$
UTCMILLI	1J		UTC (ms of day) corresponding to COBT	UTC $(ms\ of\ day)^2$
UTCMICRO	1I		UTC (μs of day) corresponding to COBT	UTC $(\mu s\ of\ ms)^2$
CORRPARA	A39		Slope of least squares fit	Slope of ls fit^5
CORRPARB	A39		Abscissa of least squares fit	Abscissa of ls fit^5
UTCFLAG	1I		UTC quality flag	UTC quality $flag^6$
ERTIME	27A		Corrected Earth received time	Note 3
GSID	5A		Ground station identifier	
ERTIMRAW	27A		Raw (uncorrected) Earth received time	

Notes on Table 58:

1. The spacecraft elapsed time (central onboard time) extracted from the standard time source packet [5].
2. This is the correlated UTC corresponding to the central onboard time. This UTC time reference is in the CCSDS day segmented time code format [30]. The epoch for this time is 1958 January 1.
3. It is the corrected time of reception at the ground station of the leading edge of the first bit of the telemetry transfer frame synchronization marker for virtual channel "0" with a virtual channel frame count which is an integer multiple of 16. This time is corrected to take into account propagation delays from the spacecraft and processing time in the ground station equipment. The format is yyyy-mm-ddThh:mm:ss.ddddddd. The fields has to be left blank if the information is not available.

4. *Item deleted.*

5. These parameters represent the coefficient of the least square regression line that was calculated at the MOC using nominally the last 20 good-time packets. Please note that the number of points on which the regression line is calculated may change for operational reasons. The UTC is calculated as follows:

$$\mathrm{UTC}(\ ) = \mathrm{CORRPARA} \times \mathrm{OBT} + \mathrm{CORRPARB}$$

   where:

   - OBT is the on-board time form the table above to be treated as a 6 byte unsigned integer with the low order two bytes corresponding to OBTFINE
   - CORRPARA, CORRPARB are the the coefficients of the least square regression line to be treated as decimal numbers after conversion from ascii.
   - UTC( ) is the correlated universal time coordinated time expressed in the number of 100 nanoseconds from the Epoch 1858-11-17T00:00:00.000.This number is converted to the CCSDS day segmented time code format to obtain the three values UTCDAY, UTCMILLI and UTCMICRO described in the table above.

6. 0=valid; 1=invalid; 2=in progress

7. This is the actual time of reception at the ground station of the leading edge of the first bit of the telemetry transfer frame synchronization marker for virtual channel "0" with a virtual channel frame count which is an integer multiple of 16. The format is yyyy-mm-ddThh:mm:ss.ddddddd. The field has to be left blank if the information is not available.

7.11.3 Spacecraft Attitude History File

- A single spacecraft attitude history file will be created for each observation period, if available.
- A single spacecraft attitude history file will be created for each slew period, if available.
- Each spacecraft attitude history file will contain the attitude details extracted from the Flight Dynamics supplied attitude history file for the whole revolution, when the observation/slew period occurred.
- Each spacecraft attitude history file will consist of a single binary table.
- All spacecraft common instrument keywords are applicable (Section 7.11.1.1). Additionally, the following keyword specifies the AHF version employded to generate the ATS file:
  `AHF_VERS = 'vvvv' / AHF version used to generate this ATS`
  where 'vvvv'='0001', '0002' etc.
- All attitude information is expressed with respect to the mean geocentric equatorial reference system of Equinox J2000.0 [13].
- In the following table all telemetry references are taken from [13].
- The binary table will consist of the columns detailed in Table 59

Table 59: Spacecraft Attitude History File: Binary Table Columns

Name	Type	Units	Comment	Identifier in Attitude History File Definition [13]
VALTIME	19A	yyyy-mm-ddT hh:mm:ss	Time from which data in this record are valid	Time from which data this record are valid
VALDUR	1E	SECOND	Duration for which data in this record are valid	Duration for which data in this record are valid
OTFTHRES	1E	ARCSEC	On target flag threshold	On target flag threshold
VIEWRA	11A	HH:MM:SS.SS	R.A of viewing direction	R.A of viewing direction
VIEWDECL	11A	±DD:MM:SS.S	Declination of viewing direction	Decl. of viewing direction
ASTPOS	1E	DEGREE	Astronomical position angle	Astronomical position angle in degrees
ROLLANG	1E	DEGREE	Roll angle	Roll angle in degrees
GSREFNO	12A		Guide star reference number in catalogue	Guide star reference number in catalogue
GSRA	11A	HH:MM:SS.SS	Guide star right ascension	Guide star right ascension
GSDEC	11A	±DD:MM:SS.S	Guide star declination	Guide star declination
ASPANGLE	1E	DEGREE	Solar aspect angle	Solar aspect angle
ACFLAG	1B		Attitude contingency flag	Att. contingengy flag
APDAMP	5A	ARCSEC	Observable APD amplitude	Observable APD amplitude in arc-seconds
DIFFVRA	11A	DEGREE	Diff between reconstructed and commanded viewing direction right ascension	Diff between reconstructed and commanded viewing direction right ascension
DIFFVDEC	11A	DEGREE	Diff between reconstructed and commanded viewing direction declination	Diff between reconstructed and commanded viewing direction declination
DIFFPOS	11A	DEGREE	Diff between reconstructed and commanded position angle	Diff between reconstructed and commanded position angle in degrees
PREQID	14A		Pointing request identifier	Pointing request id.
TYPEID	1A		Type identifier	Type identifier
SOURCEID	1A		Source identifier	Source identifier for the data in this record
ATTSEQNO	3A		Attitude sequence number	Attitude sequence number for the data in this record
SLEWTIME	19A	yyyy-mm-ddT hh:mm:ss	Start time of slew to the pointing request	Start time of slew to the pointing request
PTTIME	19A	yyyy-mm-ddT hh:mm:ss	Start time of stable pointing period	Start time of stable pointing period

7.11.4 Spacecraft Raw Attitude History File

- A single spacecraft raw attitude history file will be created, if available, for each observation, corresponding to the entire revolution period when the observation was executed
- A single spacecraft raw attitude history file will be created, if available, for each slew period, corresponding to the entire revolution period when the slew was executed
- Each spacecraft attitude history file will contain the 3-axis attitude of the spacecraft as a function of time at the maximum possible rate (0.5 or 1 s)
- Each spacecraft attitude history file will consist of a single ASCII table, with one header record. The header structure is described in Tab. 60
- All attitude information is expressed with respect to the mean geocentric equatorial reference system of Equinox J2000.0 [36].
- In the following table all telemetry references are taken from [37].
- The ASCII table will consist of the columns detailed in Table 61

Table 60: Spacecraft Raw Attitude History File Header Record Structure

Type	Description	Note
A20, 1X	Start time of interval covered by this file	1
A20, 1X	End time of interval covered by this file	1
A20, 1X	File time generation	
I4, 1X	Revolution number	
I6, 1X	Number of record in the file (header included)	
I4, 1X	RAF version number	
A5, 1X	RAF s/w version number	
A25	Comments	

Notes to Tab. 60

1. start and end time of the PSF for the relevent revolution

Table 61: Spacecraft Raw Attitude History File Columns

Name	Type	Units	Comment	Note
VALTIME	23A	yyyy-mm-ddT hh:mm:ss.msec	Validity time for the data in this record	
REQUESTID	10A		Pointing request identifier	
VIEWRA	11A	HH:MM:SS.SS	R.A of viewing direction	
VIEWDECL	11A	HH:MM:SS.SS	D eclination of viewing direction	
ASTPOS	1E	DEGREE	Position angle of viewing direction	
ASPANGLE	1E	DEGREE	Solar aspect angle	
ROLLANG	1E	DEGREE	Roll angle	
SUSEFLAG	1A		Sun sensor usage flag (T/F)	1
POINTYPE	1A		Pointing type identifier	2
ATRETYPE	2A		Attitude reconstruction method	3

Notes on Tab. 61

1. "T" ("F") indicated that the FSS status has been (has not been) used for attitude determination
2. Type of event associated with a given raw attitude history file record, "O" = open-loop slew; "C" = closed-loop slew; "S" = settling-period attitude; "P" = stable pointing attitude
3. "MO" for attitude determination based on a map; "G*n*" for attutude determination based on *n* tracked stars

7.11.5 Spacecraft Dummy Attitude File

Note: This file is not a component of the ODF delivered to the SSC. The SSC will receive ODFs which contain the spacecraft attitude history file.

- A single spacecraft dummy attitude file will be created for each observation period.
- A single spacecraft dummy attitude file will be created for each slew period.
- Each spacecraft dummy attitude file will contain default/ nominal values for the attitude.
- A spacecraft dummy attitude history file has the same structure as the spacecraft attitude history data file.
- All spacecraft common instrument keywords are applicable (Section 7.11.1.1).
- The binary table will consist of the columns detailed in Table 59. The following values will be assigned to the fields:
  - VALTIME field: start time of the observation
  - VALDUR field: difference between end time and start time of the observation.
  - VIEWRA field: boresight right ascension from the proposal database.
  - VIEWDECL field: boresight declination from the proposal database

  All other fields are assigned default values.

7.11.6 Spacecraft Reconstructed Orbit File

- There will be a single spacecraft reconstructed orbit file for each observation period.
- There will be a single spacecraft reconstructed orbit file for each slew period.
- The spacecraft reconstructed orbit file will be the Flight Dynamics supplied orbit file which contains the reconstructed orbit for the whole revolution in which the observation/slew occurred.
- The details of the Flight Dynamics supplied orbit file are defined in [18].

7.11.7 Spacecraft Predicted Orbit File

Note: This file is not a component of the ODF delivered to the SSC. The SSC will receive ODFs which contain the spacecraft reconstructed orbit file.

- There will be a single spacecraft predicted orbit file for each observation period.
- There will be a single spacecraft predicted orbit file for each slew period.
- The spacecraft predicted orbit file will be the Flight Dynamics supplied orbit file which contains the predicted orbit for the orbit in which the observation/ slew occurred.
- The details of the Flight Dynamics supplied orbit file are defined in [18].

7.11.8 Spacecraft Periodic Housekeeping Files

7.11.8.1 Overview of Spacecraft Periodic Housekeeping Files

Table 62 shows the periodic spacecraft housekeeping telemetry packets generated by the XMM spacecraft and indicates which of these are stored in an ODF/ SDF. Packets are not stored simply because they contain no information of value in the analysis of the instrument generated science data.

The following are the applicable documents used: [14] [16] [17]

Table 62: Spacecraft Periodic Housekeeping Files in the ODF

APID Type Subtype SID	TM Packet Name	ODF File	Reason for storing
129——-1——-1——-24	SASW_HK_SID24	No	
129——-1——-1——-0	SYS_HK_SID0	Yes	Experiment Hk info
129——-1——-1——-1	SYS_HK_SID1	Yes	OM, ERM Hk info
129——-1——-1——-2	SYS_HK_SID2	No	
129——-1——-1——-3	SYS_HK_SID3	No	
129——-1——-1——-4	SYS_HK_SID4	Yes	Spacecraft temperature info.
129——-1——-1——-5	SYS_HK_SID5	Yes	Spacecraft temperature info.
129——-1——-1——-6	SYS_HK_SID6	Yes	Spacecraft temperature info.
129——-1——-1——-15	ACC_RBI_HK	No	
129——-1——-1——-16	OM_RBI_HK	No	
129——-1——-1——-17	RGS1_RBI_HK	No	
129——-1——-1——-18	RGS2_RBI_HK	No	
129——-1——-1——-19	EPICM1_RBI_HK	No	
129——-1——-1——-20	EPICM2_HK	No	
129——-1——-1——-21	EPIC_PN_HK	No	
130——-1——-1——-0	MSSW_HK	No	
640——-1——-1——-1	Hk 1 TM Packet	Yes	Attitude Info
640——-1——-1——-2	Hk 2 TM Packet	Yes	Attitude Info
640——-1——-1——-3	Att 1 TM Packet	Yes	Attitude Info
640——-1——-1——-4	Att 2 TM Packet	Yes	Attitude Info
640——-1——-1——-5	Control States Packet	No	
640——-1——-1——-6	Memory Download Packet	No	

Each spacecraft periodic housekeeping file contains the **calibrated** spacecraft periodic housekeeping parameters and related derived parameters. The periodic housekeeping parameters are extracted from the telemetry packets and the derived parameters calculated. The parameters are then calibrated using the applicable calibration curve (as defined in the XMM telemetry database) and stored, with the corresponding time key, in the relevant spacecraft periodic housekeeping file.

All spacecraft periodic housekeeping files are FITS files. They consist of a primary header unit, a primary data unit of zero length and a binary table extension header data unit. Each calibrated spacecraft housekeeping parameter or derived parameter being represented by a column of the binary table. The exact specification of the periodic housekeeping parameters, how they are calibrated and how they are stored within the periodic housekeeping files is to be found in the Operational Database definition.

7.11.8.2 Details of the Spacecraft Periodic Housekeeping Files

- One spacecraft periodic housekeeping file will be created for each type in each observation or slew period.
- Each spacecraft periodic housekeeping file will contain the calibrated periodic housekeeping parameters contained in the associated telemetry packet for the observation or slew period.
- Each spacecraft periodic housekeeping file will contain the calibrated derived parameters, relevant to the corresponding telemetry packet, produced during an observation/ slew period.
- All spacecraft common instrument keywords are applicable (Section 7.11.1.1).
- Each spacecraft periodic housekeeping file will consist of a single binary table
- The binary table will consist of the columns detailed in Table 63

Table 63: Spacecraft Periodic Housekeeping 1 File: Binary Table Columns

Name	Type	Units	Comment	Location in Spacecraft Per. HK Telemetry [14][16] [17]
TIME	19A	yyyy-mm-ddThh:mm:ss	ERT	Note 1
PARAM1				Note 2,6
...	...	...	...	
PARAMn				Note 6
DERPAR1				Note 3,4,5,6
...	...	...	...	
DERPARm				Note 6

Notes on Table 63:

1. The XSCS calculated UTC Earth Received Time associated with each periodic housekeeping 1 telemetry packet.
2. The description of the raw periodic housekeeping parameters is given in [14][16] [17]. There will be a binary table column allocated to each identified periodic housekeeping parameter.
3. The derived parameters will be stored after the periodic housekeeping telemetry.
4. The details of the derived parameters are currently unknown and will not be known until they have been defined as part of operational procedures.
5. In all likelihood the derived parameters associated with the spacecraft periodic housekeeping 1 data will change over the lifetime of XMM. The derived parameters relevant at the time of file generation will be stored.
6. The exact specification of the periodic housekeeping parameters, how they are calibrated and how they are stored within the periodic housekeeping files is to be found in the Operational Database definition. The correspondence between the IPPV definition and the HK parameters is detailed in Appendix A.

7.12 Observation/ Slew Summary File

7.12.1 File characteristics

Each ODF will contain an observation summary file and each SDF will contain a slew summary file. An observation/ slew summary file is an ASCII file which consists of a number of records. The following record types are present:

- Observation/ Slew Record
- File Details Record
- Configuration details record
- Proposal Summary Record
- Data Quality Record

All records will consist of an integer multiple of 80 character lines and are terminated with an additional linefeed (ASCII 0A hex) character. All lines will be space (ASCII 32) filled. In all of the subsequent tables 'An' specifies n characters and 'nX' specifies n spaces.

7.12.1.1 Observation/ Slew Record

The observation/ slew record is the first record of the file and it will have the following structure.

Table 64: Observation Summary File: Observation Record

Line No.	Offset	Type	Description	Note
1	0	A11, 69X	'OBSERVATION' 'SLEW '	Note 1
2	0	A10, 1X	Observation Id.	Note 2
2	11	A69	Comment	Note 3
3	0	A4, 1X	Orbit/ Revolution No.	Note 4
3	5	A75	Comment	Note 3
4	0	A20,1X	Scheduled Start Time	Note 5
4	21	A59	Comment	Note 3
5	0	A20,1X	Scheduled End Time	Note 5
5	21	A59	Comment	Note 3

1. Identifies the record as an Observation or a Slew Record
2. The syntax is ppppppooll (Section 5.3.1) for an observation and TBD for a slew.
3. All comments will have the syntax ' / text'
4. The syntax is rrrr (Section 5.3.1)
5. yyyy-mm-ddThh:mm:ss

7.12.1.2 File Details Record

The file details record is the second record of the file and it will have the following structure.

Table 65: File Details Record

Line No.	Offset	Type	Description	Note
1	0	A5, 75X	'FILES'	Note 1
2	0	I3, 1X	Number of files	Note 2
2	4	A76	Comment	Note 3
3	0	A31, 1X	File name	Note 4
3	28	A48	Comment	Note 3
...	...	...	...	...
nnn+2	0	A31, 1X	File name	Note 4
nnn+2	28	A48	Comment	Note 3

1. Identifies the record as a File Details Record
2. The syntax is nnn. Identifies the number of files associated with the observation including the summary file.
3. All comments will have the syntax ' / text'
4. The syntax is RRRR_PPPPPPOOLL_IIUEEECCMMF.ZZZ (Section 5.3.1)

7.12.1.3 Configuration record

The configuration record is the third recod of the file, and will have the following structure:

Table 66: File Details Record

Line No.	Offset	Type	Description	Note
1	0	A13, 67X	'CONFIGURATION'	Note 1
2	0	I2, 78X	Number of coming keys	Note 2
3	0	A17, 63X	ODF version	Note 3
4	0	A16, 64X	Prime instrument	Note 4

1. Identifies the record as a Configuration details record
2. *E.g.*: "2" for the time being
3. Format: `ODF_VERSION = YYY`, where `YYY` is in the range 001-999
4. Format: `PRIME_INSTR = ZZ`, where `ZZ` can be either of the following values: "E1", "E2", "E3", "R1", "R2", "O1"

7.12.1.4 Proposal Summary Record

The proposal summary record follows the very last configuration record and contains a summary of the proposal information asssociated with the observation. This is the information contained within the proposal database regarding the proposal submitter and the general observation details.

Only the first line of the proposal summary record will be present in the slew summary file.

Table 67: Proposal Summary Record

Line No.	Offset	Type	Description	Note
1	0	A8, 72X	'PROPOSAL'	Note 1
2	0	A5, 1X	Title	Note 2
2	6	A20, 1X	First name	Note 2
2	26	A20, 33X	Surname	Note 2
3	0	A30, 50X	Institute	Note 3
4	0	A30, 50X	Mailing address Line 1	Note 3
5	0	A30, 50X	Mailing address Line 2	Note 3
6	0	A20, 60X	Mailing address town/ city	Note 3
7	0	A10, 70X	Mailing address state	Note 3
8	0	A20, 60X	Mailing address country	Note 3
9	0	A10, 70X	Mailing address zip/post code	Note 3
10	0	A80	E-mail address	Note 4
11	0	A2, 1X	Announcement of Opportunity	Note 5
11	3	A77	Comment	Note 6
12	0	A2, 1X	Science Type	Note 7
12	3	A77	Comment	Note 6
13	0	A20, 1X	Target name	Note 8
13	21	A59	Comment	Note 6
14	0	F10.7, 1X	Target right ascension	Note 9
14	11	A69	Comment	Note 6
15	0	F11.7, 1X	Target declination	Note 9
15	12	A68	Comment	Note 6
16	0	A6, 1X	Observation Duration	Note 10
16	7	A73	Comment	Note 6
17	0	A80	Alternative names	Note 11
18	0	F10.7, 1X	Boresight RA	Note 13
18	11	A69	Comment	Note 6
19	0	F11.7, 1X	Boresight declination	Note 13
19	12	A68	Comment	Note 6
20	0	A3, 1X	Position angle constraint (lower)	Note 14
20	4	A76	Comment	Note 6
21	0	A3, 1X	Position angle constraint (upper)	Note 14
21	4	A76	Comment	Note 6
22	0	A1, 1X	Position angle origin reference	Note 14
22	2	A78	Comment	Note 6
23	0	A1, 1X	EPIC MOS 1 priority	Note 15
23	2	A78	Comment	Note 6
				continued on next page

continued from previous page

Line No.	Offset	Type	Description	Note
24	0	A1, 1X	EPIC MOS 2 priority	Note 15
24	2	A78	Comment	Note 6
25	0	A1, 1X	EPIC p-n priority	Note 15
25	2	A78	Comment	Note 6
26	0	A1, 1X	RGS-1 priority	Note 15
26	2	A78	Comment	Note 6
27	0	A1, 1X	RGS-2 priority	Note 15
27	2	A78	Comment	Note 6
28	0	A1, 1X	OM priority	Note 15
28	2	A78	Comment	Note 6

1. Identifies the record as a Proposal Summary Record.
2. Name of the PGO.
3. Postal address of the PGO
4. E-mail address of the PGO
5. AO for which the observation was submitted
6. All comments will have the syntax ' / text'.
7. GO identified science type of the observation
8. Name of the observed target
9. Right ascension (hours) and declination (degrees) of the target
10. Estimated duration of the observation in seconds
11. Alternative names for the target.
12. *Item Deleted.*
13. Spacecraft boresight right ascension (hours) and declination (degrees)
14. spacecraft position angle details.
15. Instrument Priority [1-6, 0 if inactive and a blank (“”) if not specified in the AMS].

7.12.1.5 Data Quality Record

Finally there will be a data quality record for each instrument exposure and one for the spacecraft data. The following data quality information will be stored stored in the summary file:

- Number of packets that failed reception
- Number of event report
- Number of errors not resulting from user input
- Number of telemetry drops
- Total duration of these telemetry drops

- Number of OOLs

These items will be stored on a per exposure basis for each instrument and on a per observation basis for the spacecraft telemetry.

Table 68: Data Quality Record

Line No.	Offset	Type	Description	Note
1	0	A12, 58X	'DATA QUALITY'	Note 1
2	0	A2, 1X	Instrument Id.	Note 2
2	3	A77	Comment	Note 3
3	0	A15, 1X	Exposure Id	Note 4
3	5	A66	Comment	Note 3
4	0	A4,1X	Number of packets failing reception	Note 5
4	5	A75	Comment	Note 3
5	0	A4,1X	Number of event reports	Note 6
5	5	A75	Comment	Note 3
6	0	A4,1X	Number PMS errors	Note 7
6	5	A75	Comment	Note 3
7	0	A4,1X	Number of telemetry drops	Note 8
7	5	A75	Comment	Note 3
8	0	A4,1X	Total duration of telemetry drops	Note 9
8	5	A75	Comment	Note 3
9	0	A4,1X	Number of out of limits	Note 10
9	5	A75	Comment	Note 3
10	0	A1,1X	Unscheduled/ scheduled/ not applicable flag	Note 11
10	3	A78	Comment	Note 3

1. Identifies the record as a Data Quality Record.
2. The syntax is ii (Section 5.3.1).
3. All comments will have the syntax ' / text'.
4. The syntax is ppppppoolliieee (Section 5.3.1).
5. Number of telemetry packets associated with the instrument/ spacecraft that failed reception during the period.
6. Number of event reports produced by the instrument/ spacecraft during the period.
7. Number of errors detected by the automatic telemetry processor for the instrument/ spacecraft during the period.
8. Number of drops in the instrument/ spacecraft telemetry during the period.
9. Total duration of the telemetry drops in the instrument/ spacecraft telemetry during the period.
10. Number of out of limits detected in the instrument/ spacecraft telemetry during the period.
11. Flag (S, U or X) indicating whether the exposure was scheduled (S) or unscheduled (U) and set to 'X' when it is not applicable (for the spacecraft data quality records).

8 SciSIM Output Data Definition

8.1 Overview of SciSIM Output Files

This section describes the files that can be generated by SciSIM in terms of their differences from the corresponding ODF component files.

8.1.1 Primary Headers of the SciSIM Output Files

The primary headers of all SciSIM output files are identical to that of the ODF component files (Section 7.1.0.1). Within the primary header the keyword CREATOR will indicate 'SCISIM nn.nn' as the creator of the file (where nn.nn is the version of SciSIM that created the file) and the keyword CATEGORY will state 'SCISIMODF'.

8.1.2 File Naming Convention

The file naming convention used for the SciSIM output files is at the discretion of the SciSIM user (see Section 5.3.2).

8.2 EPIC MOS SciSIM Files

SciSIM can generate the following EPIC MOS ODF component files.

- EPIC MOS imaging mode event list file
- EPIC MOS timing mode event list file
- EPIC MOS auxiliary file

SciSIM can simulate the imaging and timing mode of operation of the EPIC MOS instrument.

When operating in EPIC MOS imaging mode SciSIM will create EPIC MOS imaging mode event list files and an auxiliary file. Each created EPIC MOS imaging mode event list file will contain the events detected across an active node of an active CCD (one event list file per active read-out node). The EPIC MOS auxiliary file will contain the frame information associated with these events.

When operating in EPIC MOS timing mode SciSIM will create EPIC MOS timing mode event list files and an auxiliary file. Each created EPIC MOS timing mode event list file will contain the events detected across an active node of an active CCD (one event list file per active read-out node). The EPIC MOS auxiliary file will contain the frame information associated with these events.

It is possible to configure the EPIC MOS instrument such that it is operating in both imaging and timing mode. That is, some CCDs are in imaging mode and others are in timing mode. In these circumstances an EPIC MOS imaging mode event list file is created for each active node of each active CCD in imaging mode and an EPIC MOS timing mode event list file is created for each active node of each active CCD in timing mode. Again, a single EPIC MOS auxiliary file is created to contain the frame information.

8.2.1 EPIC MOS Imaging Mode Event List File

8.2.1.1 Format

The SciSIM generated EPIC MOS imaging mode event list files are identical to the ODF/ SDF component file defined in Section 7.2.2.

8.2.1.2 Content

The contents of the SciSIM generated EPIC MOS imaging mode event list file are as defined for the ODF/ SDF component file with the following exceptions.

8.2.1.2.1 Binary Table Extension Header Contents

The following keywords are **NOT** defined in the extension header of the SciSIM generated EPIC MOS imaging mode event list file and are set to dummy values:

- EDUID
- EDUTHR
- EMDHUPP
- DATE-OBS
- DATE-END

Sentence deleted.

8.2.1.2.2 Binary Table Contents

All columns of the binary table are assigned valid values by SciSIM. Note however that the frame counter is the value generated by SciSIM and is not calculated according to the rules defined in Section 7.2.1.2.

8.2.2 EPIC MOS Timing Mode Event List File

8.2.2.1 Format

The SciSIM generated EPIC MOS timing mode event list files are identical to the ODF/ SDF component file defined in Section 7.2.4.

8.2.2.2 Content

The contents of the SciSIM generated EPIC MOS timing mode event list file are as defined for the ODF/ SDF component file with the following exceptions.

8.2.2.2.1 Binary Table Extension Header Contents

The following keywords are **NOT** defined in the extension header of the SciSIM generated EPIC MOS timing mode event list file and are set to dummy values:

- EDUID
- EDUTHR
- EMDHUPP
- DATE-OBS
- DATE-END

Sentence deleted.

8.2.2.2.2 Binary Table Contents

All columns of the binary table are assigned valid values by SciSIM. Note however that the frame counter is the value generated by SciSIM and is not calculated according to the rules defined in Section 7.2.1.2.

8.2.3 EPIC MOS Auxiliary File

8.2.3.1 Format

The SciSIM generated EPIC MOS auxiliary files are identical to the ODF/ SDF component file defined in Section 7.2.6.

8.2.3.2 Content

The contents of the SciSIM generated EPIC MOS auxiliary file are as those for the ODF/ SDF component file with the following exceptions.

8.2.3.2.1 Binary Table Extension Header Contents

The following keywords are **NOT** defined in the extension header of the SciSIM generated EPIC MOS auxiliary file and are set to dummy values:

- DATE-OBS
- DATE-END

Sentence deleted.

8.2.3.2.2 Binary Table Contents

The following data fields (see Table 7) are not defined in the binary table of the SciSIM generated EPIC MOS Auxiliary Event List File and are set to dummy values:

- NABOVE
- FIFOOVF
- GATTIFLG

Note also that the frame counter is the value generated by SciSIM and is not calculated according to the rules defined in Section 7.2.1.2.

8.2.4 Timing Information

The frame read-out time of each CCD, or CCD node (see Section 7.2.1.1), is stored in the EPIC MOS auxiliary file as:

- FTCOARSE: Frame read-out time in seconds
- FTFINE: Frame read-out time in milliseconds

In each EPIC MOS imaging and timing mode event list file the frame integration time is specified in the extension header. This gives the time (in milliseconds) between subsequent read-outs of the CCD (or CCD node).

Note: In the EPIC MOS telemetry the coarse frame time only has a resolution of 15 bits whereas the spacecraft coarse time has a resolution of 32 bits. The correspondence between these times is explained in [29].

8.3 EPIC p-n SciSIM Files

SciSIM can generate the following EPIC MOS ODF component files.

- EPIC p-n imaging mode event list file
- EPIC p-n timing mode event list file
- EPIC p-n auxiliary file

SciSIM can simulate the imaging (full frame, large window, small window) and timing modes of operation of the EPIC p-n instrument.

When operating in EPIC p-n imaging mode SciSIM will create EPIC p-n imaging mode event list files and an auxiliary file. Each created EPIC p-n imaging mode event list file will contain the events detected on an active CCD (one event list file per active CCD). The EPIC p-n auxiliary file will contain the frame information associated with these events.

When operating in EPIC p-n timing mode SciSIM will create EPIC p-n timing mode event list files and an auxiliary file. Each created EPIC p-n timing mode event list file will contain the events detected on an active CCD (one event list file per active CCD). The EPIC p-n auxiliary file will contain the frame information associated with these events.

8.3.1 EPIC p-n Imaging Mode Event List File

8.3.1.1 Format

The SciSIM generated EPIC p-n imaging mode event list files are identical to the ODF/ SDF component file defined in Section 7.4.2.

8.3.1.2 Content

The contents of the SciSIM generated EPIC p-n imaging mode event list file are as those defined for the ODF/ SDF component file with the following exceptions.

8.3.1.2.1 Binary Table Extension Header Contents

The following keywords are **NOT** defined in the extension header of the SciSIM generated EPIC p-n imaging mode event list file and are set to dummy values:

- DATE-OBS
- DATE-END

8.3.1.2.2 Binary Table Contents

All columns of the binary table are assigned valid values by SciSIM. Note however that the frame counter is the value generated by SciSIM and is not calculated according to the rules defined in Section 7.4.1.2.

8.3.2 EPIC p-n Timing Mode Event List File

8.3.2.1 Format

The SciSIM generated EPIC p-n timing mode event list files are identical to the ODF/ SDF component file defined in Section 7.4.3.

8.3.2.2 Content

The contents of the SciSIM generated EPIC p-n timing mode event list file are as those defined for the ODF/ SDF component file with the following exceptions.

8.3.2.2.1 Binary Table Extension Header Contents

The following keywords are **NOT** defined in the extension header of the SciSIM generated EPIC MOS timing mode event list file and are set to dummy values:

- DATE-OBS
- DATE-END

8.3.2.2.2 Binary Table Contents

All columns of the binary table are assigned valid values by SciSIM. Note however that the frame counter is the value generated by SciSIM and is not calculated according to the rules defined in Section 7.4.1.2.

8.3.3 EPIC p-n Auxiliary File

8.3.3.1 Format

The SciSIM generated EPIC p-n auxiliary files are identical to the ODF/ SDF component file defined in Section 7.4.5.

8.3.3.2 Content

The contents of the SciSIM generated EPIC p-n auxiliary file are as those defined for the ODF/ SDF component file with the following exceptions.

8.3.3.2.1 Binary Table Extension Header Contents

The following keywords are **NOT** defined in both extension headers of the SciSIM generated EPIC p-n auxiliary file and are set to dummy values:

- DATE-OBS
- DATE-END

8.3.3.2.2 First Binary Table Contents

All columns of the binary table are assigned valid values by SciSIM. Note however that the frame and cycle counters are the value generated by SciSIM and are not calculated according to the rules defined in Section 7.4.1.2.

8.3.3.2.3 Second Binary Table Contents

SciSIM does not generate the summary information associated with the second extension of the EPIC p-n auxiliary file. This binary table therefore consists of a single row will all columns of this single row being set to dummy values.

8.3.4 Timing Information

The frame read-out time of each CCD is stored in the EPIC MOS auxiliary file as:

- FTCOARSE: Frame read-out time in seconds
- FTFINE: Frame read-out time in milliseconds

In each EPIC p-n imaging and timing mode event list file the frame integration time is specified in the extension header. This gives the time (in milliseconds) between subsequent read-outs of the CCD.

8.4 RGS SciSIM Files

SciSIM can generate the following RGS ODF component files.

- RGS spectroscopy mode event list file
- RGS auxiliary file

SciSIM can simulate the spectroscopy mode of operation of the RGS instruments.

When operating in RGS spectroscopy mode SciSIM will create RGS spectroscopy mode event list files and an auxiliary file. Each created RGS spectroscopy mode event list file will contain the events detected on an active CCD (one event list file per active CCD). The RGS auxiliary file will contain the frame information associated with these events.

8.4.1 RGS Spectroscopy Mode Event List File

8.4.1.1 Format

The SciSIM generated RGS spectroscopy mode event list files are identical to the ODF/ SDF component file defined in Section 7.6.2.

8.4.1.2 Content

The contents of the SciSIM generated RGS spectroscopy mode event list file are as those defined for the ODF/ SDF component file with the following exceptions.

8.4.1.2.1 Binary Table Extension Header Contents

The following keywords are **NOT** defined in the extension header of the SciSIM generated RGS spectroscopy mode event list file and are set to dummy values:

- TMEXP_ID
- DATE-OBS
- DATE-END

Sentence deleted.

8.4.1.2.2 Binary Table Contents

All columns of the binary table are assigned valid values by SciSIM. Note however that the frame counter is the value generated by SciSIM and is not calculated according to the rules defined in Section 7.6.1.2.

8.4.2 RGS Auxiliary File

8.4.2.1 Format

The SciSIM generated RGS auxiliary files are identical to the ODF/ SDF component file defined in Section 7.6.4. However it is not possible to calculate reliably the CCD read-out sequence of the simulated RGS instrument. For this reason information relating to the read-out sequence is missing.

8.4.2.2 Content

The contents of the SciSIM generated RGS auxiliary file are as those defined for the ODF/ SDF component file with the following exceptions.

8.4.2.2.1 Binary Table Extension Header Contents

The following keywords are **NOT** defined in both extension headers of the SciSIM generated RGS auxiliary file and are set to dummy values:

- DATE-OBS
- DATE-END

8.4.2.2.2 First Binary Table Contents

The following data fields (see Table 36) are not defined in the SciSIM generated RGS Auxiliary Event List File and are set to dummy values:

- SEQINDEX
- NACCEPTC
- NUPPERC
- NACCEPTD
- NUPPERD
- NLOSTEVT
- ABORTFLG

Note also that the frame counter is the value generated by SciSIM and is not calculated according to the rules defined in Section 7.6.1.2.

8.4.2.2.3 Second Binary Table Contents

SciSIM does not generate the CCD read-out sequence information. This binary table therefore consists of 12 rows with each row of the SEQINDEX column incrementing from 1 to 12. All other columns are set to dummy values.

8.4.3 Timing Information

The frame read-out time of each CCD is stored in the RGS auxiliary file first extension as:

- FTCOARSE: Frame read-out time in seconds
- FTFINE: Frame read-out time in milliseconds

The frame integration time (in milliseconds) is also specified for each frame in the RGS auxiliary file first extension.

8.5 OM SciSIM Files

SciSIM can generate the following OM ODF component files.

- OM imaging mode image file

Section C.4 details a nominal OM observation and describes the telemetry data that will be produced as a result of the observation. SciSIM can simulate OM imaging mode but the result of this simulation is a single image of the whole detector. This image is stored in an OM imaging mode image file.

8.5.1 OM Imaging Mode Image File

8.5.1.1 Format

The SciSIM generated OM imaging mode image files are identical in format to the ODF/ SDF component file defined in Section 7.8.2. However, SciSIM does not produce an image for each specified image window on the detector but a single image of the whole detector.

8.5.1.2 Content

The contents of the SciSIM generated OM imaging mode image file are as those defined for the ODF/ SDF component file with the following exceptions.

8.5.1.2.1 Image Extension Header Contents

The following keywords are **NOT** defined in the extension header of the SciSIM generated OM image mode image file and are set to dummy values:

- TMEXP_ID
- DATE-OBS
- DATE-END

8.5.1.2.2 Image Contents

A single image of the whole detector is held in the image extension.

8.5.2 Timing Information

None.

A Correspondence between IPPV and housekeeping (H/K) parameters

A.1 MOS

MOS IPPV definition	H/K corresponding parameter
Filter wheel	E/K1257[1,3] or E/K1317[1,4]
HBR n Activation Status	E/K1489 to 1496[5]
HBR n Processing Mode	E/K1497 to 1504mapped into E/KU497 to U504[6]
HBR n Low Threshold	E/K1522, 1524, 1526, 1528, 1530, 1532, 1534, 1536[2,7]
HBR n High Threshold	E/K1523, 1525, 1527, 1529, 1531, 1533, 1535, 1537[2,7]
HBR Pattern Reference	E/K1538[8]
EDU n Low Threshold 1	E/K1398, 1400, 1402, 1404, 1406, 1408, 1410, 1412[1,9]
EDU n Low Threshold 2	E/K1399, 1401, 1403, 1405, 1407, 1409, 1411, 1413[1,9]

[1]in periodic H/K
[2]in non-periodic H/K
[3]Values: 0 = OPEN, 1 = FILTER D, 2 = FILTER C, 3 = FILTER B, 4 = FILTER A, 5 = CLOSED; 6= ILLEGALVALUE, 7= NOT VALID CS
[4]Values: for MOS1: 0 = Closed, 1334 = Open, 267 = Thin 1, 534 = Thin 2, 801 = Medium, 1067 = Thick, 1580 = CalClosed, 1314 = CalOpen, 247 = CalThin 1, 514 = CalThin 2, 781 = CalMedium, 1047 = CalThick; for MOS2: 0 = Closed, 1332 = Open, 266 = Thin 1, 533 = Thin 2, 799 = Medium, 1066 = Thick, 1580 = CalClosed, 1312 = CalOpen, 246 = CalThin1, 513 = CalThin2, 779 = CalMedium, 1046 = CalThick
[5]0 = NOT ACTIVE, 1 = ACTIVE
[6]0 = DISABLED, 1 = IMAG.PROC., 2 = IMAG.N.PROC, 3 = IMAG.R.PROC, 4 = IMAG.R.N.PR., 5 = EDU THRESH., 6 = TIM.PROCES., 7 = TIM.N.PROCE. 8 = TIM.C.PROCE. 9 = TIM.C.N.PRO. 10 = TRANSPARENT (these values are alias only for U parameters)
[7]Values:0–32767
[8]Values:0–3
[9]Values:0–4095

Table 69: Correspondence between MOS IPPV definition and H/K parameters

A.2 p-n

p-n IPPV definition	H/K corresponding parameter
Filter wheel	F1118[1,2]
Frame Time Parameter	F1294[1,3]
Lower threshold	F1515 to 1517[4,5,9], F1615 to 1617[4,6,9], F1715 to 1717[4,7,9], F1815 to 1817[4,8,9]
HBR n Activation Status	F2038 to 2041[10,11]
Quadrant undersampling	F1534, 1634, 1734, 1834 (for Q0, Q1, Q2 and Q3, respectively)[4,12]

[1] In periodic H/K
[2] Values: 0 = OPEN, 1 = FILTRD-THICK, 2 = FILTC-MEDIUM, 3 = FILTRB-THIN, 4 = FILTRA-THIN, 5 = CLOSE, 7 = NO STOP POS
[3] Values: 0–15
[4] In Additional Periodic H/K
[5] QO CCD 1 to 3
[6] Q1 CCD 1 to 3
[7] Q2 CCD 1 to 3
[8] Q3 CCD 1 to 3
[9] Values:0–4095
[10] In non-periodic H/K
[11] Values 0 = NOT ACTIVE, 1 = ACTIVE
[12] Vlues: 0–31

Table 70: Correspondence between p-n IPPV definition and H/K parameters

A.3 RGS

RGS IPPV definition	H/K corresponding parameter
Packing scheme	G/L7303[1,2]
CCD Readout sequence	G/L7510, 7520, 7530, 7540, 7550, 7560, 7570, 7580, 7590, 7600, 7610, 7620[3,4]
Number of CCDs	G/L7503[3,5]
OCB_c (c = CCD1 to 9)	G/L7512, 7522, 7532 7542, 7552, 7562, 7572, 7582, 7592, 7602, 7612, 7622[3,6]
Readout nodes_c (c = CCD1 to 9)	G/L7513, 7523, 7533, 7543, 7553, 7563, 7573, 7583, 7593, 7603, 7613, 7623[3,7]
Rejection Threshold Side C_c (c = CCD1 to 9)	G/L7514, 7524, 7534, 7544, 7554, 7564, 7574, 7584, 7594, 7604, 7614, 7624[3,8]
Rejection Threshold Side D_c (c = CCD1 to 9)	G/L7515, 7525, 7535, 7545, 7555, 7565, 7575, 7585, 7595, 7605, 7615, 7625[3,8]
Acceptance Threshold Side C_c (c = CCD1 to 9)	G/L6186, 6286, 6386, 6486, 6586, 6686, 6786, 6886, 6986[3,8]
Acceptance Threshold Side D_c (c = CCD1 to 9)	G/L6187, 6287, 6387, 6487, 6587, 6687, 6787, 6887, 6987[3,8]
CSG Pattern_c (c = CCD1 to 9)	G/L7511, 7521, 7531, 7541, 7551, 7561, 7571, 7581, 7591, 7601, 7611, 7621[3,9]

[1]In periodic H/K
[2]Values: 0 = UNKNOWN, 1 = UNPROCESSED, 2 = PACKED, 3 = REDUCED
[3]In non-periodic H/K
[4]Values: 0 = INP = 14.7K, 1 = CCD-1, 2 = CCD-2, 3 = CCD-3, 4 = CCD-4, 5 = CCD-5, 6 = CCD-6, 7 = CCD-7, 8 = CCD-8, 9 = CCD-9, 10 = INP TO GND, 11 = INP TO GND, 12 = TESTGEN 1, 13 = TESTGEN 2
[5]Values: 1–12
[6]Values: 1 = 1×1, 2 = 2×2, 3 = 3×3, 4 = 4×4, 5 = 5×5
[7]Values: 1 = C NODE ONLY, 2 = D NODE ONLY, 3 = BOTH NODES
[8]Values: 0–4095
[9]Values: 0–255

Table 71: Correspondence between RGS IPPV definition and H/K parameters

A.4 OM

OM IPPV definition	H/K corresponding parameter
Frametime (tracking)	H7640[1,2]
Exposure duration (Frames)	H7645[1,3] ot H5440[4,3]
Filter	H5265[4,5]
Number of science windows	SCIWIND[6,7]
Window Mode n	SWMODE[6,8]
X Science Low n	SWX0[6,9]
Y Science Low n	SWY0[6,9]
Centre Science Window RA-n	Not in telemetry
Centre Science Window Dec-n	Not in telemetry
X Science Size n	SWXSIZE[6,9]
Y Science Size n	SWYSIZE[6,9]
Number of Memory Windows	MEMWIND[6,7]
Centre Memory Window RA-n	Not in telemetry
Centre Memory Window Dec-n	Not in telemetry
X Memory Low n	MWX0[6,9]
Y Memory Low n	MWY0[6,9]
DX Memory Size n	MWXSIZE[6,9]
DY Memory Size n	MWYSIZE[6,9]
DPU Binning Factor X n	SWP1[6,10]
DPU Binning Factor Y n	SWP2[6,10]
Time Slice Duration n	Not in telemetry
Sampling Time n	SWP1[6,11]
Fast Memory Area n	SWP2[6,11]

[1]In non-periodic H/K
[2]Values: frame time in 1/1024 seconds (DPU cycle)
[3]Number of tracking frames in the exposure
[4]In periodic H/K
[5]Values: 1200 = Blocked, 1400 = V, 1600 = Magnifier, 1800 = U, 2000 = B, 0 = White, 200 = Grism 2 (visible), 400 = UVW1, 600 = UVM2, 800 = UVW2, 1000 = Grism 1 (UV), 2100 = Bar, 2200 = position lost
[6]In OM Priority Window Data Auxiliary File
[7]Values: 1–5
[8]Values: 0 = Image mode, 1 = Fast mode, 15 = Tracking window
[9]Values: 0–2047
[10]Values: 0–2
[11]Values: 0 = allocation not possible,, otherwise DPU time
[12]Values: 1–2

Table 72: Correspondence between OM IPPV definition and H/K parameters

B Calculation of Frame and Cycle Identifiers

B.1 EPIC MOS

The frame identifiers (counters) calculated below are local to each CCD node.

The frame number identified in the binary tables of the EPIC MOS science files is derived using the 4 bit frame number available in the telemetry.

newframe (i+1) = newframe(i) + 1 + (frame(i+1)-frame(i)-1)MOD 16

where:

newframe is the frame identifier calculated by the XSCS and frame is the frame number available in the telemetry header records (for imaging modes) and trailer/ time info records (for timing modes).

B.2 EPIC p-n

For Epic p-n imaging, timing and burst modes, the Frame Counter is simply a sequential counter that increments monotonically in steps of 1 for the full detector each time a Time Information is encountered in the telemetry (i.e. there is a single Frame Counter for all quadrants with no duplicated Frame Counter across quadrants). The Cycle is always identical to the Frame Counter.

To summarise the contents of the EPIC p-n event list files (1 for each CCD) and the associated EPIC p-n auxiliary file: each event in the EPIC p-n imaging mode event list files has the frame in which it occurred identified (Table 20). The first table of the EPIC p-n auxiliary file (Table 22) has at most 3 records for every frame identified: one for each CCD on the relevant quadrant. Each record identifies the time information (from the Time Info data format) and the cycle number (identical to the frame number) associated with that frame. A Frame Counter never refers to events on more than one of the four quadrants.

The second extension of the auxiliary file (Table 23) holds information from the Count Info data format. This is produced separately for each quadrant every N quadrant read-out cycles. N is a configurable number that is set by telecommand. These records are indexed by the Cycle number. They can be indexed via Table 22 to a corresponding Time Info. This is the Time Info immediately preceding the Count Info in the telemetry.

B.3 RGS

The frame number identified in the binary tables of the RGS science files is derived using the 16 bit frame counter. The ODS when calculating the counter identifier should, when the telemetry counter wraps around, simply ensure that the counter continues to increment and does not wrap around.

C Instrument Telemetry

C.1 EPIC MOS Science Telemetry

Each science telemetry report packet shall contain data relevant to 1 HBR channel only [27].

C.1.1 EPIC MOS Imaging Mode Telemetry

The source data of imaging reports may contain data related to one or more read-out frames [27].

Event, header or trailer data belonging to the same frame can be split into different packets, if necessary [27].

Data words belonging to the same event, header or trailer cannot be split into 2 different packets [27].

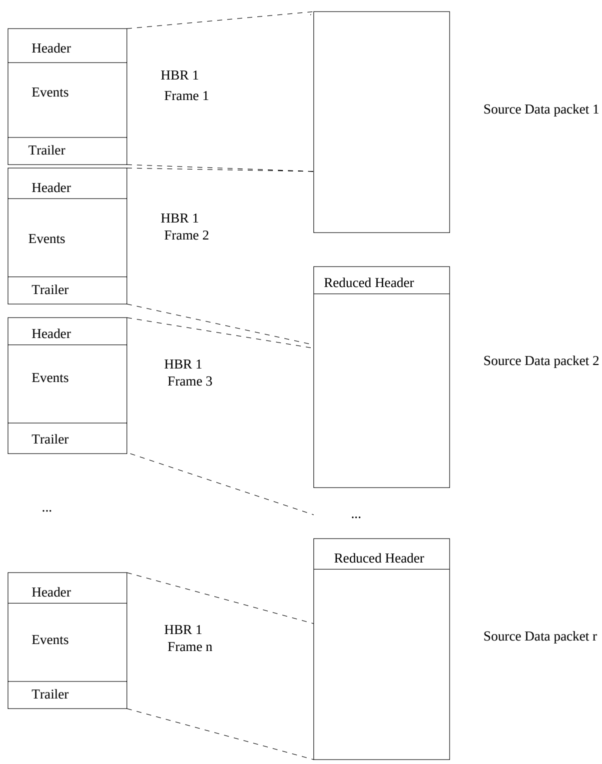

Figure 1: EPIC MOS Imaging Mode Data

The generated data (Header, Events, Trailers) for each frame of the CCD is placed into the telemetry packets. Where the frame data spans more than one telemetry packet then a Reduced Header appears at the start of the source data packet identifying the CCD and the Frame.

C.1.2 EPIC MOS Reduced Imaging Mode

The EPDH shall be capable of performing data reduction on data received from an HBR in imaging channel mode [27].

For data coming from an HBR in imaging channel mode mode (I-EVENTS) the EPDH suppress E3 and E4 energy and replaces E1 and E2 energy data with their sum [27].

When the data reduction is active, all the event data is in reduced format [27].

The flow of telemetry in reduced imaging mode is the same as that for imaging mode. The only difference is that the Event Data are replaced by Reduced format Event Data.

C.1.3 EPIC MOS Timing Mode Telemetry

The source data of timing reports may contain data related to one or more read-out cycles [27].

Event, header or trailer data belonging to the same cycle can be split into different packets, if necessary [27].

Data words belonging to the same event, header or trailer cannot be split into 2 different packets [27].

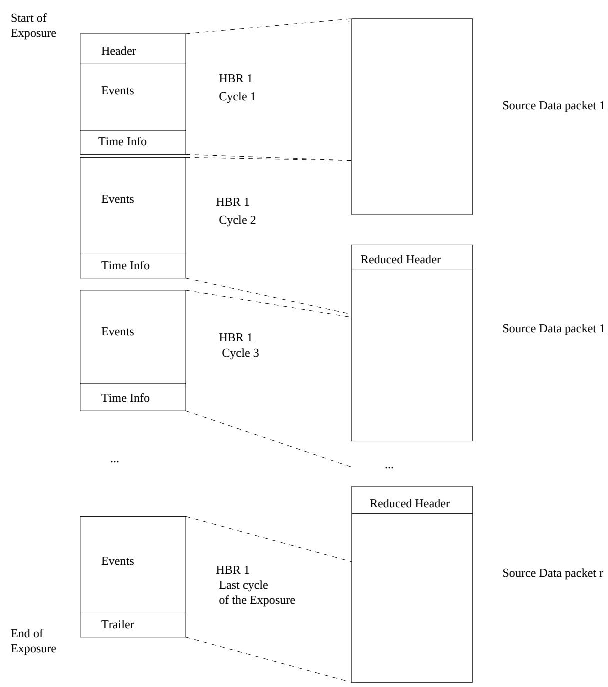

Figure 2: EPIC MOS Timing Mode Data

At the start of the exposure a header is generated. At the end of each cycle a time info appears except the last where a trailer appears. The generated data (Events, Time Infos) for each cycle of the CCD is placed into the telemetry packets. Where the cycle data spans more than one telemetry packet then a Reduced Header appears at the start of the source data packet identifying the CCD and the Cycle. This Reduced Header is derived from the Full Header which appears at the start of the exposure.

C.1.4 EPIC MOS Compressed Timing Mode

The EPDH is capable of performing a non-destructive data compression on data received from an HBR in timing channel mode [27].

For data coming from an HBR in timing channel mode mode (T-EVENTS) the EMDH will suppress all data and will put in the output event the sum of E1 and E2, together with the difference between the Y of the event under process and the Y of the previous event [27].

When the non-destructive data compression is active is active, the event data may be in compressed or uncompressed format according to the following algorithm [27]:

1. If the event is the first event after a T-Header or after a T-Time Info then do not compress the event.
2. If the difference between the Y values of the current event and the Y value of the previous event is greater than 7 then do not compress the event.
3. Compress all other events.

The flow of telemetry in reduced imaging mode is the same as that for imaging mode. The only difference is that the Event Data is replaced by both Event Data and compressed format Event Data according to the rules given above.

C.1.5 EPIC MOS Diagnostic Mode Telemetry

The source data of diagnostic reports will contain data related to one frame of one HBR in Transparent mode only [27].

Event, header or trailer data belonging to the frame can be split into different packets, if necessary [27].

Data words belonging to the same event, header or trailer cannot be split into 2 different packets [27].

At the start of the frame a header is generated. Then N events and finally a trailer. The number of events in a frame is fixed depending on the window selected (360000 in the case where full frame mode is selected). There is a Reduced header at the start of each new telemetry source data packet. This Reduced Header is derived from the Full Header which appears at the start of the exposure.

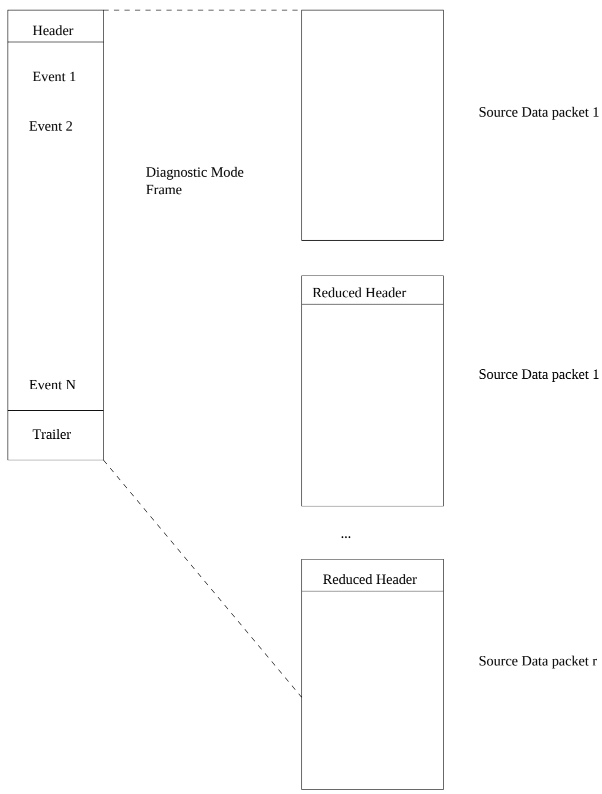

Figure 3: EPIC MOS Diagnostic Mode Data

C.2 EPIC p-n Science Telemetry

Each science telemetry report packet will contain data relevant to 1 HBR channel (1 quadrant) only [26].

C.2.1 EPIC p-n Full Frame Imaging Mode Telemetry

The source data of imaging reports may contain data related to one or more read-out cycles [26].

A read-out cycle is defined as the read-out of all the active CCDs in a quadrant. A frame is the read-out of a single CCD.

Event Data, Time Info and Count Info belonging to the same read-out cycle can be split into different packets, if necessary [26].

Data words belonging to the same Event, Time Info or Count Info cannot be split into 2 different packets [26].

The stream of data for a quadrant in full frame imaging mode would look as shown in Figure 4 (assuming quadrant 1 is being processed).

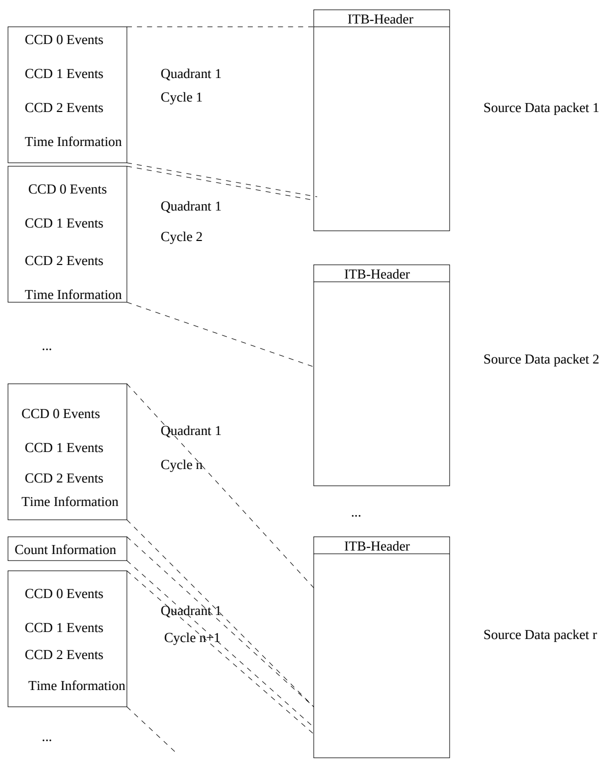

Figure 4: EPIC p-n Full Frame Imaging Mode Data

In Figure 4 CCD 0 Events (and 1 and 2) consist of a number of Event Data formats, 1 for each event detected. The Event Data Formats as well as the ITB-Header, Time Information and Count Information are defined in [10]. Note that the Count Information appears only after every n cycles where n is a programmable parameter.

C.2.2 EPIC p-n Large Window Imaging Mode Telemetry

The data flow is exactly the same as that for EPIC p-n Full Frame Imaging Mode.

C.2.3 EPIC p-n Small Window Imaging Mode Telemetry

In EPIC p-n Small Window Imaging Mode only a single CCD (CCD 0) is active, otherwise the data flow is the same as that shown for EPIC p-n Full Frame Imaging Mode.

C.2.4 EPIC p-n Timing Mode

The source data of timing reports may contain data related to one or more read-out cycles [26].

Event Data, Time Info and Count Info belonging to the same read-out cycle can be split into different packets, if necessary [26].

Data words belonging to the same Event, Time Info or Count Info cannot be split into 2 different packets [26].

The stream of data for a quadrant in timing mode would look as shown in Figure 5 (assuming quadrant 1 is being processed).

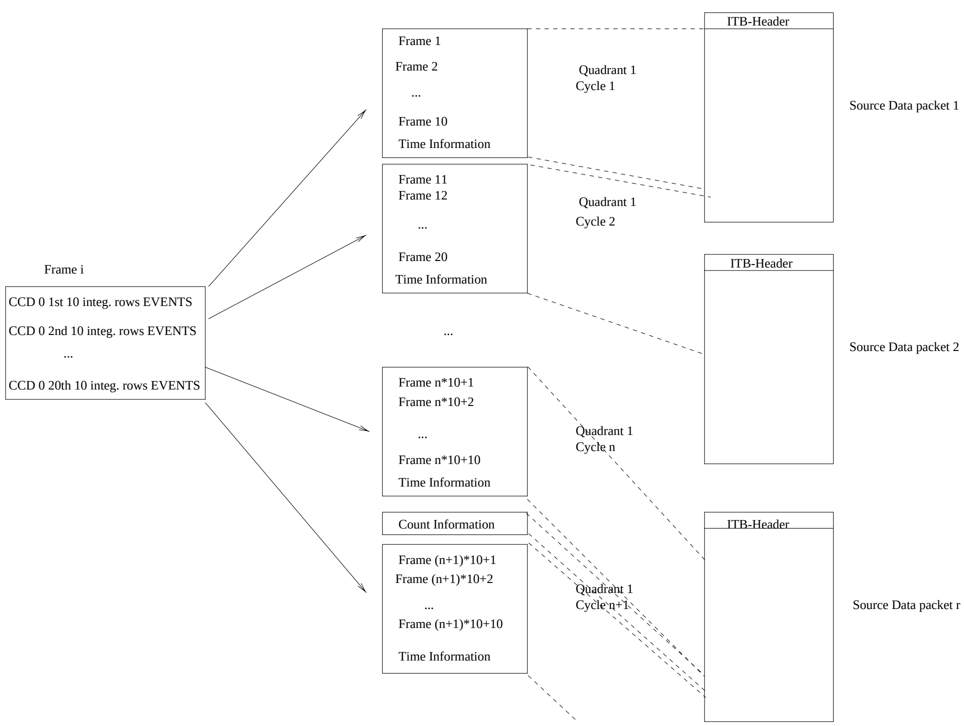

Figure 5: EPIC p-n Timing Mode Data

Only 1 CCD (CCD 0) in a quadrant can be in Timing mode. The other CCDs are not active. The CCD is read-out 10-integrated rows at a time. That is 10 rows are binned into 1 of the read-out nodes. This binned 'super-row' is then read-out normally. A read-out cycle is defined in [10] as the read-out of 20 strips of these ten binned rows. This equates to a complete read-out of the CCD. In this document the term frame is used to denote this read-out of 20 strips of these ten binned rows (Section B.2).

Every 10 frames a Time Info is produced. This is referred to as a macro-frame in [10]. In this document the term cycle is used to denote this read-out of 10 frames (Section B.2). Every n cycles a count information is produced.

In Figure 5 CCD 0 Events consist of a number of Event Data formats (EVENTS), 1 for each event detected. The Event Data Formats as well as the ITB-Header, Time Information and Count Information are defined in [10]. Note that the Count Information appears only after every n cycles where n is a programmable parameter.

C.3 RGS Science Telemetry

C.3.1 RGS Spectroscopy Mode

The start of the data associated with an RGS spectroscopy fixed configuration period is denoted by a science exposure telemetry packet. A science frame packet then signals the start of the data for a specified CCD in the cycle. This frame packet is then followed by science packets which contain the science data for that CCD. The last science packet also contains the CCD read-out statistical information. The start of the data for the next CCD in the sequence is indicated by the next frame packet and so on. **Note:** There is not a new exposure packet at the end of each cycle. The cycle repeats continuously until the end of the exposure.

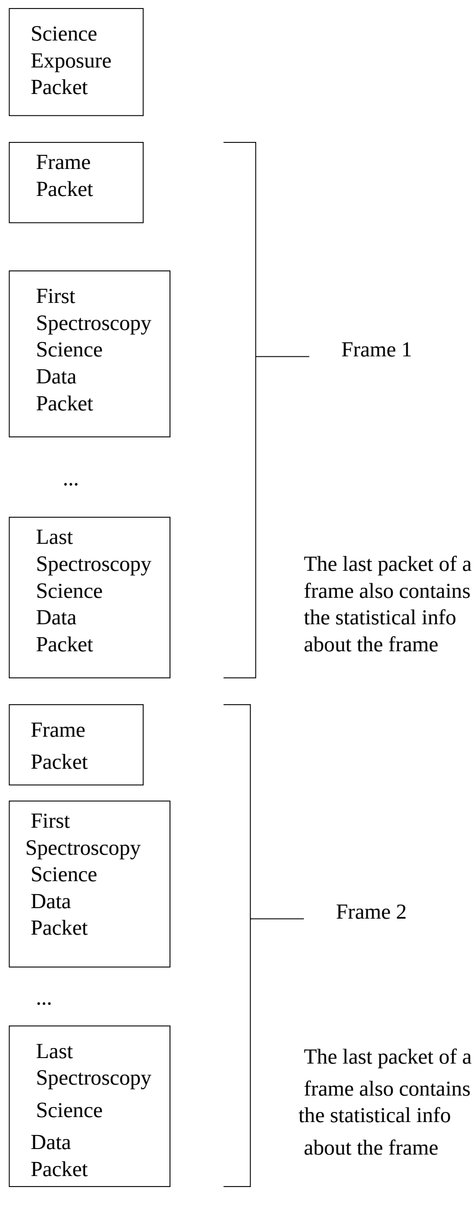

Figure 6: RGS Spectroscopy Mode Data

C.3.2 RGS HTR Mode

The start of the data associated with an RGS HTR fixed configuration period is denoted by a science exposure telemetry packet. A stream of HTR science data packets then follow. These contain the marker and Delta-T frame words and the X position and Energy of the detected events as a bit stream partitioned to fit efficiently into the HTR science data packets. The last HTR packet of the exposure contains, after the X position and Energy of the last event of the last read CCD, the RBI end of read-out time (32 bits in seconds and 16 bits in sub-seconds) [8]

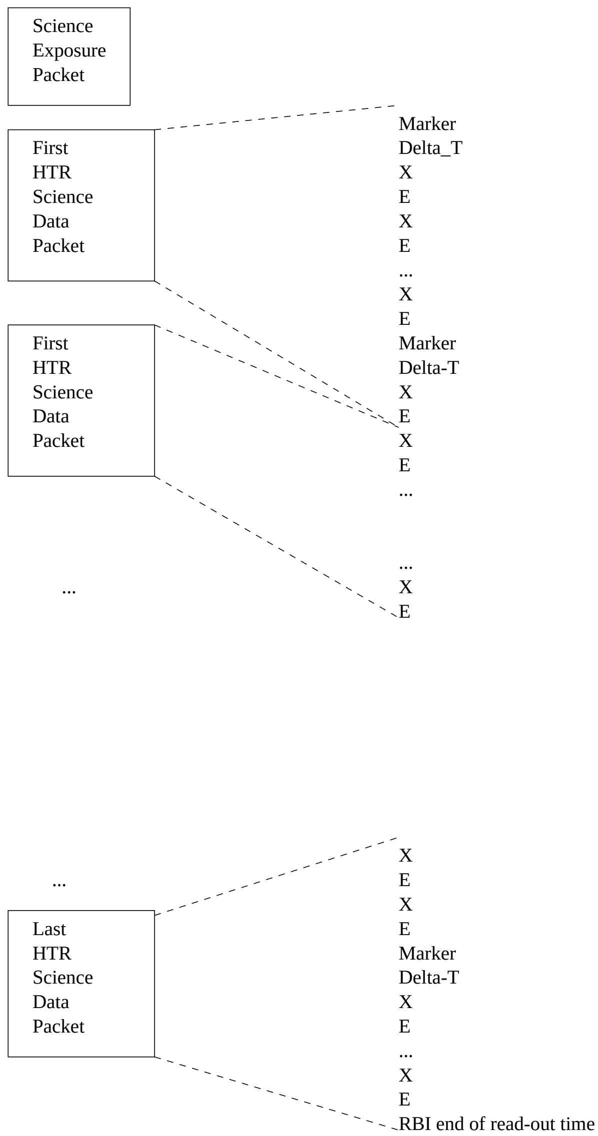

Figure 7: RGS HTR Mode Data

C.3.3 RGS Diagnostic Mode

A Diagnostic Exposure telemetry packet denotes the beginning of the diagnostic mode data for a CCD. This is then followed by n diagnostic queue telemetry packets containing the unprocessed CCD data.

C.4 OM Science Telemetry

A nominal OM observation consists of an acquisition phase followed by n exposures. Each of these exposures consists of a choose guide star phase followed by an accumulation and tracking phase. The following data is generated by the OM instrument during a nominal OM observation:

- Field Acquisition Data (DP_FAQ). This data contains information about the acquisition phase. The data is sent out as soon as it is available.
- Associated with the Field Acqusion Data is the Alert DA_EOT_ACQ_FLD. This alert informs of the end of the acquisition processing.
- Window Data (DP_WDW). At the start of each exposure is the choose guide stars phase. The Window Data contains the details of the windows selected for the exposure during this phase. This data is sent out as soon as it is available.
- Associated with the Window Data is the Alert DA_EOT_CHOOSE_GS. This alert informs of the end of the choose guide star processing.
- Blue Fast Mode Area Information (DP_BFAST). If fast mode science windows are used during the exposure then details of the blue fast mode area are sent down.

  At the end of each exposure the following data is/ can be sent out:
- Tracking History Data (DD_TRH). This provides for each frame of the exposure:
  - The number of good guide stars found
  - caculation of the drift and roll
  - quality information
  - Identifier of the guide stars found (TBC)
- Reference Frame Data (DD_REF). This data contains details of the reference frame taken at the beginning of the exposure. This frame is used as the star zero-drift position reference for tracking purposes.
- Image Mode Data (DD_IMG). The image accumulated over the exposure for each imaging mode science window is sent down.
- Fast Mode Data (DD_FST). The fast mode data accumulated over the exposure for each fast mode window is dispatched.
- Engineering Data. If an engineering exposure is being performed then the engineering data is dispatched.