

XMM

Interface Control Document for the XMM Current Calibration File

XMM-SOC-ICD-0005-SSD

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Revision history

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2.0	October 13, 1997	G. Vacanti	reduction of file sizes
3.0	April 9, 1998	G. Vacanti	major restructuring, bring in line with PCS/PMS requirements
3.1	April 15, 1998	G. Vacanti	minor changes to make the nomenclature consistent across all of the sections
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3.3	November 24, 1998	G. Vacanti	rephrase section 7.7.01
3.4	December 8, 1999	G. Vacanti	implements: CR214-CCF03 CR215-PMS29 CR216-PMS30 CR61-CCF01

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Part I

General

1 Introduction

1.1 Purpose

This interface control document describes the XMM current calibration file insofar as this is needed by the combined XMM science and mission operations development.

1.1.1 Purpose of the Current Calibration File

The XMM current calibration file is the collection of data sets — here on referred to as *calibration files*, or *constituents* (section 1.3) — necessary to reduce and analyze the data collected with the scientific payload of XMM.

1.2 Scope

Some of the data structures in a number of calibration files are used by the payload monitoring and the payload calibration subsystems. They are described in part II to make them readily identifiable. This document is applicable to all phases of the XMM mission, from the start of the flight-model calibration campaign to the end of the post operational phase.

1.3 Nomenclature

- **calibration data type:** a kind of data related to a particular aspect of the calibration or analysis.
- **calibration file** or **constituent:** one instance of a particular calibration data type.
A calibration file has an issue number and a start-of-validity date, by which it can uniquely be identified (see section 5.4).
Several calibration files can refer to the same calibration data type. They may refer to different instruments (or scope), or to different issues of the same data. Each triplet {scope, calibration data type, issue } is unique.
- **current calibration file:** the collection of all the calibration files that are valid at a particular time.
This is different from the collection of all the calibration files stored in the archive.
The current calibration file does not have a version number, and it should be seen as a view of what calibration files are valid for a time and for a specific observation date. See section 5.4 for more details.

2 Operational Assumptions and Constraints

2.1 Usage Constraints

The following should be borne in mind when applying the contents of this document.

It must be understood that while every effort is being made to predict the number, size and contents of the calibration files, this can only reflect the XMM science operations team's current understanding of the performance of the flight instruments. Changes of varying significance may occur as our understanding of the instruments improves and the flight models are actually built, assembled, tested and delivered.

As with many scientific missions, the type of instrumentation aboard XMM has never been flown on a satellite before, or if it has, never with the same level of complexity and with the same requirements on the accuracy of the calibration.

After the learning experience of the qualification models, the flight models are often the only examples of such instruments ever to be built, tested, measured and flown. This means that while it is approximately known how to analyze the data collected by the scientific payload, the details can only be worked out when the data from the calibrations become available and are fully understood.

This learning process is expected to last at least until launch, and it will, with great probability, extend into the first 12–18 months of operation.

As a consequence, it is very likely that the way some of the calibration data types are rendered into files may substantially change in the years to come.

The impact of these prospective changes on the payload monitoring and calibration subsystems is expected to be minimal given the limited extent of the interface these two subsystems have with the current calibration file.

3 Requirements

Once a new constituent of the current calibration file is submitted to the archive, it becomes available for retrieval by the staff at the science operations and survey science centers, and the scientific community in accordance with the requirements given for the archive management subsystem [1] and the XMM file transfer system [2].

3.1 Functional Requirements

None.

3.2 On-line Data Delivery Requirements

Refer to the file transfer system [2] and the archive management subsystem [1] documents.

3.3 Off-line Data Delivery Requirements

Refer to the file transfer system [2] and the archive management subsystem [1] documents.

4 Interface Characteristics

4.1 Interface Location and Medium

With each observation data file, guest observers receive a corresponding current calibration file. It is foreseen to distribute the data on compact disc. The decision of what calibration files are relevant to a given observation is solely based on the time when the observation was made. Section 5.4 describes in detail how the association between an observation and the current calibration file is done.

Within the XMM ground segment, access to the constituents is gained through the XMM archive. The XMM archive is the only storage place for, and source of distribution of, calibration files. Updates of the calibration files are obtained from the XMM archive.

4.2 Hardware Characteristics and Limitations

Refer to the file transfer system [2] and the archive management subsystem [1] documents.

4.3 Data Source, Destination and Transfer Mechanism

The constituents of the current calibration file are generated by personnel at the science operations center. Once the constituents are scientifically validated, they are transferred to the XMM archive for permanent storage. At that moment they become available to the survey science center and the scientific community in accordance with the prescriptions given in the archive management subsystem document [1].

4.4 Node and Device Addressing

Constituents of the current calibration file will be transferred between the following file transfer system nodes:

- the XMM science analysis system (node name: SAS);
- the XMM science control system (node name: XSC);
- the XMM survey science center (node name: SSC).

4.5 Relationships with Other Interfaces

The following systems and subsystems are expected to be able to deal with current calibration file constituents:

- the science analysis system;
- the payload monitoring subsystem;
- the payload calibration subsystem;
- the archive management subsystem;
- the XMM file transfer system.

5 Access

5.1 Interface Utility Software

Refer to the file transfer system [2] and the archive management subsystem [1] documents.

5.2 File Naming Convention

The constituents of the current calibration file are named as follows:

scope_calname_issue.ccf

where:

scope indicates the scope of the calibration file (at most 5 characters long). The list of scope identifiers is given in table 1.

calname is the calibration data type identifier (at most 17 characters long). The list of data type identifiers is given in table 2.

issue is the file issue number (integer ≥ 0 and ≤ 9999 , zero padded).

File names are not case sensitive. In this document they are type set with upper and lower case letters for readability.

xmm	general files or files shared by more than one instrument
om	Optical Monitor files
xrt1, xrt2, xrt3	X-ray Telescope files
emos1, emos2	European Photon Imaging Camera MOS files
epn	European Photon Imaging Camera PN files
rgs1, rgs2	Reflection Grating Spectrometer files
erm	EPIC Radiation Monitor files

Table 1: Allowed scope identifiers

5.3 Data Integrity Checks

Upon submission to the archive, the constituents will be validated according to the requirements in [3].

5.4 Membership of the Current Calibration File

Here we address the issue of how to determine what calibration files make up the current calibration file for a given observation time.

Each calibration file has a validity start date. This is indicated by the FITS key word VALDATE.

Given the naming convention above, a calibration file can be labeled with a triplet of the form $\{Fname, Issue, T_{start}\}$, where $Fname \equiv \text{scope_calname}$.

New issues of a calibration file can enter the archive with any T_{start} and increasing issue numbers.

In the simplest case, a new version of the calibration file — call it $\{Fname, Issue', T'_{start}\}$, will have $T_{start} < T'_{start}$ and $Issue < Issue'$ (figure 1).

A more complex situation is illustrated in figure 2. Here new versions are introduced to improve on past calibrations.

Within this scheme, at any time T the applicable issue of the calibration file $Fname$ is obtained by selecting among all files $\{Fname, Issue, T_{start} \leq T\}$ the one with the higher issue number.

Should it become necessary, a new $Fname$ can be introduced in the archive, as illustrated in figure 3.

With this scheme the number of constituents in the current calibration file is not fixed, and can be determined only when the time T is specified.

	xmm	xrt	om	emos	epn	rgs	erm
AbsCoefs	+						
ADUConv				+	+	+	
AstroMet			+				
Background				+	+	+	
BadPix			+	+	+	+	
BoreSight	+						
CCDrmf						+	
CTI				+	+	+	
CalIndex	+						
CalSourceData				+	+	+	+
ClockPatterns						+	
ColorTrans			+				
Contam				+	+	+	
CrossPSF						+	
DarkCurrent				+	+	+	
DarkFrame			+	+	+	+	
DiffuseGala			+				
Efficiency				+	+		
EventSizeDist				+	+	+	
EXAFS				+	+	+	
FilterTransV				+	+	+	
FilterTransX				+	+		
HKParmInt	+		+	+	+	+	+
LightLeak			+				
LinCoord			+	+	+	+	
LineSpreadFunc						+	
LargeScaleSens			+				
MiscData	+						
ModeParam			+	+	+	+	
PatternLib				+		+	
PixToPixSens			+				
PSF1DRB			+				
PSFPileUp				+	+	+	
PhotToNat			+				
PhotVsLam			+				
PixToLam			+				
PixToPixSens			+				
QuantumEf				+	+	+	
QuickMag			+				
Redist				+	+	+	
RedistPileUp				+	+	+	
StrayLight			+				
TimeCorr			+	+	+		
VAreaEf		+					
VPSF		+					
VSLAreaEf		+					
VSLDist		+					
XAreaEf		+					
XEncirEn		+					
XPSF		+					
XSLAreaEf		+					
XSLDist		+					
WavelengthScale						+	
Zodiacal			+				

Table 2: [DCP: CR214-CCF03] Allowed calibration data types by scope

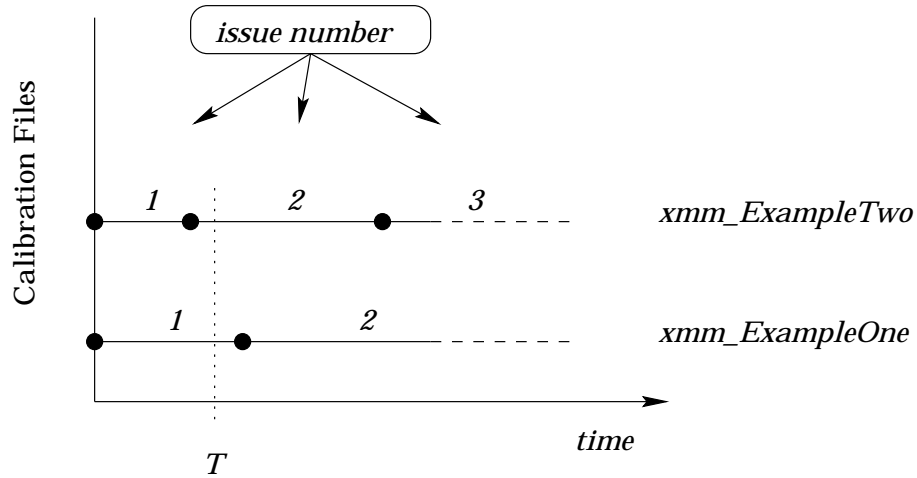


Figure 1: Current calibration file with two files. At the time T the current calibration file consists of *xmm_ExampleOne_0001.ccf* and *xmm_ExampleTwo_0002.ccf*

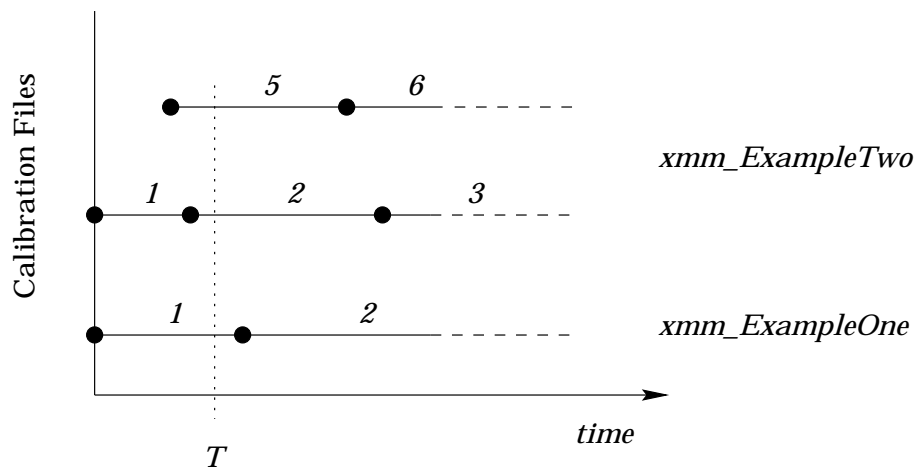


Figure 2: Current calibration file with two files: update. At the time T the current calibration file consists of *xmm_ExampleOne_0001.ccf* and *xmm_ExampleTwo_0005.ccf*

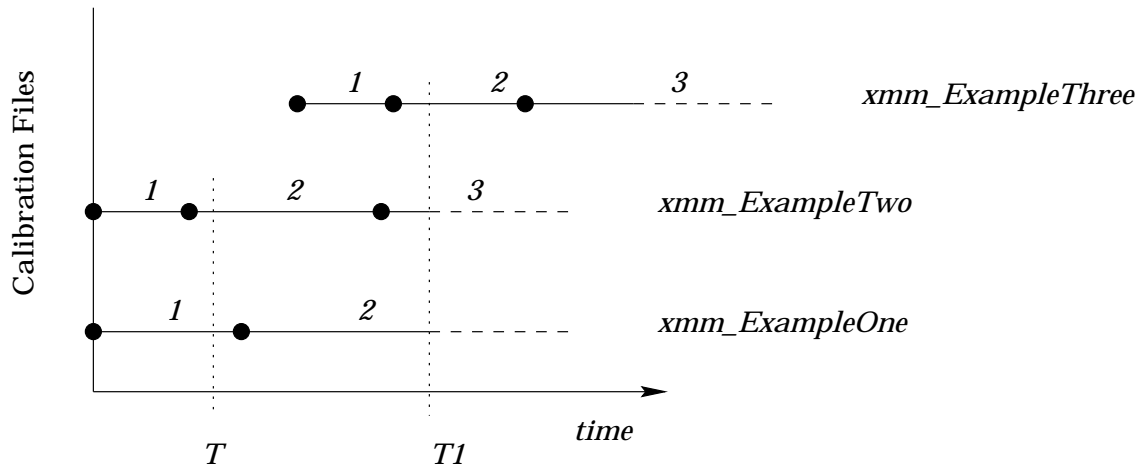


Figure 3: Current calibration file with three files. At the time $T1$ the current calibration file consists of *xmm_ExampleOne_0002.ccf* and *xmm_ExampleTwo_0003.ccf* and *xmm_ExampleThree_0002.ccf*

5.4.1 Version of the Current Calibration File

From the above it is now apparent that the notion of ‘version of the current calibration file’ loses its meaning. Updates of calibration files in the archive will not be made by issuing the whole set of constituents, but by updating and/or adding only the calibration files that have changed.

5.4.2 Indexing by the Archive Management Subsystem

Indexing in this context is understood as the scheme by which calibration files stored in the XMM archive are identified and retrieved with a key-word-based query.

Upon submission to the archive via the XMM file transfer system, each calibration file will be cataloged with a number of key words as specified in [2] and [4].

5.4.3 Indexing by the Science Analysis System

The details of this mechanism are outside the scope of this document. They are described in [5].

6 Detailed Interface Specifications

6.1 General

6.1.1 Data Structure

The XMM calibration files conform to the FITS standard [6]. In the following, familiarity with the FITS nomenclature is assumed.

Each file is comprised of:

- a primary header;
- a primary data array of zero length;
- zero or more extensions.

Each extension consists of an extension header and a binary section. Extensions are named and can appear in any order. Only the following FITS extensions are used:

- **table:** XTENSION=TABLE
- **binary table:** XTENSION=BINTABLE
- **image:** XTENSION=IMAGE

Wherever possible and desirable the calibration files follow the conventions of the OGIP FITS working group [7].

6.1.1.1 Primary Header Contents All XMM calibration files share a common primary header structure. Besides the mandatory FITS key words, a number of key words used by the science analysis system to index the contents of the current calibration file (section 5.4.3 and [5]) are also present, as illustrated in the following example:

```

GOCDROM =                               T / copy to CD ROM?
ORIGIN   = 'XMM-SOC '                     / processing site
DATE     = '2010-12-31T00:00:00' / file creation date (ccyy-mm-ddThh:mm:ss)
FILENAME= 'emos1_aduconv_0034.ccf' / file name
CREATOR  = 'fcreate V1.1'                 / FITS generating code
TELESCOP= 'XMM '                          / mission name
INSTRUME= 'EMOS1 '                        / instrument name
SCOPE    = 'EMOS1 '                        / scope identifier
TYPEID   = 'ADUConv'                       / type of calibration file
TYPEDESC= 'PHA to PI to energy conversion data'
ISSUE    =                               34 / issue number of this file
VALDATE  = '2000-01-01T13:34:99' / start of validity of calibration file
EXTSEQU  = 'NODEID'                       / diff. extensions hold data from diff. nodes
EXTSEQID= '1 2'                            / first ext.: node 1; second ext.: node 2
CATEGORY= 'XMMCCF'                         / this is a XMM calibration file

```

Additional key words may also be present. As for the extensions, key words may appear in any order.

6.1.2 Generation Method

The calibration files are produced by personnel at the XMM science operations center, who analyze the data with the tools made available within the framework of the science analysis system.

The generation of calibration files makes use of data collected during the normal operation of the observatory, data from the observation of calibration targets, output from the XMM science simulator, and data from the ground calibration campaign.

7 Size and Frequency of Transfers

Here we list the names of all the calibration files that are part of the current calibration file, their estimated size (refer to table 3 for a summary) and frequency of update.

With reference to table 3, these are the partial totals by scope (one instance): xmm 4.4 MB, xrt 26.7 MB, om 102.5 MB, emos 47 MB, epn 55.4 MB, rgs 54 MB, erm 0.03 MB. Total size of the current calibration file: \approx 450 MB. This corresponds to \approx 90 MB/m. These figures do not include the file CCDrmf as this type of constituent is not expected to be distributed on CD-ROM..

	xmm	xrt	om	emos	epr	rgs	erm	update frequency
AbsCoefs	4							12 m
ADUConv				0.06	0.06	0.03		3 m
AstroMet			2					4 m
Background				0.2	0.5	1		3 m
BadPix			7	0.02	0.02	5		1 m
BoreSight	0.02							6 m
CCDrmf						400		6 m
CTI				0.01	22	0.01		3 m
CalIndex	0.3							0.1 m
CalSourceData				0.35	3	3	0.02	3 m
ClockPatterns						0.01		6 m
ColorTrans			0.026					4 m
Contam				0.2	0.2	0.1		1 m
CrossPSF						0.1		6 m
DarkCurrent				0.01	0.04	5		3 m
DarkFrame			17	10	1	14		3 m
DiffuseGala			0.04					24 m
Efficiency				0.01	0.01			12 m
EventSizeDist				0.53	0.11	0.01		3 m
EXAFS				0.1	0.1	0.1		12 m
FilterTransV				0.02	0.02	1		3 m
FilterTransX				0.2	0.2			12 m
HKParmInt	0.01		0.026	0.01	0.01	0.02	0.01	6 m
LightLeak			17					24 m
LinCoord			0.01	0.01	0.01	0.01		3 m
LineSpreadFunc			0.1			0.1		3 m
LargeScaleSens			21					4 m
MiscData	0.1							6 m
ModeParam			0.01	0.01	0.01	0.01		3 m
PatternLib				0.02		0.02		6 m
PhotToNat			0.02					6 m
PhotVsLam			0.19					4 m
PixToLam			0.032					12 m
PixToPixSens			17					4 m
PSF1DRB			0.042					8 m
PSFPileUp				0.02	0.02	0.02		3 m
QuantumEf				10	10	4		3 m
QuickMag			0.1					6 m
Redist				25	18	20		3 m
RedistPileUp				0.1	0.1	0.1		6 m
StrayLight			21					12 m
TimeCorr			0.02	0.01	0.01			12 m
VAreaEf		0.01						6 m
VPSF		0.01						6 m
VSLAreaEf		0.01						6 m
VSLDist		0.01						6 m
XAreaEf		2						6 m
XEncirEn		0.2						6 m
XPSF		24						6 m
XSLAreaEf		0.02						6 m
XSLDist		0.4						6 m
WavelengthScale						0.01		3 m
Zodiacal			0.03					24 m

Table 3: [DCP: CR214-CCF03] Estimated file sizes in Mbytes.

7.1 Scope: xmm

There will be one instance of each of these files.

Calibration type: *AbsCoefs*

Description: Elemental absorption coefficients.

Calibration type: *BoreSight*

Description: Describes the alignment of the individual instruments with respect to XMM's reference frame in terms of Euler angles. The latter provide the rotation between the optical axes of the instruments to the reference frame.

Calibration type: *CalIndex*

Description: Master index file for all possible current calibration file constituents.

[DCP: CR214-CCF03]

Calibration type: *HKParmInt*

Description: House keeping parameter ranges used to generate good time intervals.

Calibration type: *MiscData*

Description: Lists various constants/setup parameters necessary in calculations or tracking of instrument configuration.

7.2 Scope: om

There will be one instance of each of these files.

Calibration type: *AstroMet*

Description: Contains the definition of the linear detector grid as keywords in the extension headers and the deviations of pixel positions from ideal (i.e. flat grid) locations.

Calibration type: *BadPix*

Description: Table of bad pixels, listing the position, the type of defect and the severity level. The size of the file will increase with the number of defected pixels (4.5 Mb corresponds to a bad area of 10% of entire image area).

Calibration type: *ColorTrans*

Description: Contains the coefficients for the color transformation, i.e. the transformation from the natural into a standard system.

Calibration type: *DarkFrame*

Description: Contains the dark current map. It comprises one image extension holding a map at full resolution.

Calibration type: *DiffuseGala*

Description: Contains information (image and spectrum) on diffuse galactic emissions.

Calibration type: *HKParmInt*

Description: House keeping parameter ranges used to generate good time intervals.

Calibration type: *LightLeak*

Description: Contains information (distribution on the focal plane) about light leaks.

[DCP: CR214-CCF03

Calibration type: *LinCoord*

Description: Data required to transform from pixel to physical coordinates on the CCD.

Calibration type: *LargeScaleSens*

Description: Contains the non-uniformity correction maps describing the large-scale sensitivity variations due to the filter defects, contamination, etc.

Calibration type: *ModeParam*

Description: Provides the most important parameters for the observation modes as a function of user selectable parameters.

Calibration type: *PhotToNat*

Description: Contains the conversion curve coefficients to correct the count rates for detector effects, such as linearity (livetime) and aging effects.

Calibration type: *PhotVsLam*

Description: Quantum efficiency (filter+detector) as a function of wavelength.

Calibration type: *PixToLam*

Description: Contains the conversion from off-set pixel to wavelength for the two gratings at the centre of the field of view.

Calibration type: *PixToPixSens*

Description: Contains map describing the non-uniformity of the detector response.

Calibration type: *PSF1DRB*

Description: Describes the shape of the supersampled 1-dimensional point spread function for each filter at 10 (TBC) different ratios of count-rate/framerate.

Calibration type: *QuickMag*

Description: Lookup table for a rough count to magnitude conversion for different spectral types. The file is sized to cope with 30 different spectral types.

Calibration type: *StrayLight*

Description: Contains the parameterisation of the OM straylight rejection performance.

Calibration type: *TimeCorr*

Description: Contains the parameterisation of timing related corrections.

Calibration type: *Zodiacal*

Description: Contains the intensity map characterising zodiacal light and the average spectrum of the zodiacal light.

7.3 Scope: xrt

There will be three instances of each of these files.

Calibration type: *VAreaEf*

Description: Optical collecting area of a single mirror module as a function of field angle and wavelength.

Calibration type: *VPSF*

Description: Optical point spread function of a single mirror module as a function of field angle and wavelength.

Calibration type: *VSLAreaEf*

Description: Optical collecting area within EPIC detector associated with a source located outside of EPIC field of view as a function of the source off-axis position and wavelength.

Calibration type: *VSLDist*

Description: Optical surface brightness distribution over EPIC detector area associated with a source located outside of EPIC field of view as a function of wavelength and off-axis position.

Calibration type: *XAreaEf*

Description: X-ray effective area of a single mirror modules vs energy, field angle and if necessary field azimuth.

Calibration type: *XEncirEn*

Description: X-ray encircled energy function of a single mirror module PSF vs energy, field angle and if necessary field azimuth.

Calibration type: *XPSF*

Description: X-ray point spread function of a single mirror module vs energy, field angle and if necessary field azimuth.

Calibration type: *XSLAreaEf*

Description: X-ray effective area over EPIC detector area associated with a monochromatic point source located outside of EPIC field of view as a function of the point source off-axis position and wavelength.

Calibration type: *XSLDist*

Description: X-ray surface brightness distribution over EPIC detector area associated with a monochromatic point source located outside of EPIC field of view as a function of the point source off-axis position and energy.

7.4 Scope: emos

There will be two instances of each of these files.

Calibration type: *ADUConv*

Description: Conversion factors of the digitized signal to pulse invariant, and further to observed energy units (keV), not accounting for charge transfer efficiency, GATTI and redistribution.

Calibration type: *Background*

Description: Spectrum and scalar modifiers for correlation to ERM spectra.

Calibration type: *BadPix*

Description: Table of bad columns/pixels including reference to the actual on-board table. Includes true flickering pixels (which cannot be reliably characterized by a noise value).

Calibration type: *CalSourceData*

Description: Spectrum and intensity maps of the on-board calibration sources.

Calibration type: *Contam*

Description: Set of coefficients used to model the effect of contaminants.

Calibration type: *CTI*

Description: Average charge transfer inefficiency values for the relevant clock shifts, needed to calculate the charge loss as a function of event coordinates and observing mode.

Calibration type: *DarkCurrent*

Description: Parametrized dark current to estimate its contribution to false signal.

Calibration type: *DarkFrame*

Description: Average dark image and typical dark spectra for a few standard cases.

Calibration type: *Efficiency*

Description: EPIC MOS to RGS effective area ratio

Calibration type: *EventSizeDist*

Description: Provides a reference event pattern distribution (normalized histograms) as a function of energy.

Calibration type: *EXAFS*

Description: CCD and filter EXAFS.

Calibration type: *FilterTransV*

Description: Filter (optical) transmission curves.

Calibration type: *FilterTransX*

Description: Filter (X-ray) transmission curves. Includes coefficients to characterize spatial distribution as a function of stepper motor position.

Calibration type: *HKParmInt*

Description: House keeping parameter ranges used to generate good time intervals.

Calibration type: *LinCoord*

Description: Contains the transformation matrix to convert CCD pixel coordinates into angular and linear offsets from the boresight.

Calibration type: *ModeParam*

Description: Provides the most important parameters for the observation modes as a function of user selectable parameters.

Calibration type: *PatternLib*

Description: EPIC MOS pattern library.

Calibration type: *PSFPileUp*

Description: The coefficients needed to calculate the effect of pileup on the apparent point spread function as a function of countrate.

Calibration type: *QuantumEf*

Description: Spatially varying CCD quantum efficiency.

Calibration type: *Redist*

Description: CCD energy redistribution data.

Calibration type: *RedistPileUp*

Description: The coefficients needed to calculate the effect of pileup on the effective RMF as a function of countrate.

Calibration type: *TimeCorr*

Description: Provides the time offset corrections to convert spacecraft time stamp to mean photon absorption time.

7.5 Scope: epn

There will be one instance of each of these files.

Calibration type: *ADUConv*

Description: Conversion factors of the digitized signal to pulse invariant, and further to observed energy units (keV), not accounting for charge transfer efficiency and redistribution.

Calibration type: *Background*

Description: Spectrum and scalar modifiers for correlation to the EPIC radiation monitor spectra.

Calibration type: *BadPix*

Description: Table of bad columns/pixels including reference to the actual on-board table. Includes true flickering pixels (which cannot be reliably characterized by a noise value).

Calibration type: *CTI*

Description: Average charge transfer inefficiency values for the relevant clock shifts, needed to calculate the charge loss as a function of event coordinates and observing mode.

Calibration type: *CalSourceData*

Description: Spectrum and intensity maps of the on-board calibration sources.

Calibration type: *Contam*

Description: Set of coefficients used to model the effect of contaminants.

Calibration type: *DarkCurrent*

Description: Dark current [e^-/s] to calculate contribution from additional integration time.

Calibration type: *DarkFrame*

Description: Average dark frame and image of statistical dark fluctuations for the default set of observing modes. Primarily used to estimate probability of false signal. Includes "flickering pixels" showing a large but quantifiable fluctuation.

Calibration type: *Efficiency*

Description: EPIC PN to RGS effective area ratio

Calibration type: *EventSizeDist*

Description: Provides a reference event pattern distribution (normalized histograms) as a function of energy.

Calibration type: *EXAFS*

Description: CCD and filter EXAFS.

Calibration type: *FilterTransV*

Description: Filter (optical) transmission curves.

Calibration type: *FilterTransX*

Description: Filter (X-ray) transmission curves.

Calibration type: *HKParmInt*

Description: House keeping parameter ranges used to generate good time intervals.

Calibration type: *LinCoord*

Description: Contains the transformation matrix to convert CCD pixel coordinates into angular and linear offsets from the boresight.

Calibration type: *ModeParam*

Description: Observation mode parameters.

Calibration type: *PSFPileUp*

Description: The coefficients needed to calculate the effect of pileup on the apparent point spread function as a function of countrate.

Calibration type: *QuantumEf*

Description: Spatially varying CCD quantum efficiency.

Calibration type: *Redist*

Description: CCD energy redistribution data.

Calibration type: *RedistPileUp*

Description: The coefficients needed to calculate the effect of pileup on the effective RMF as a function of countrate.

Calibration type: *TimeCorr*

Description: Provides the time offset corrections to convert spacecraft time stamp to mean photon absorption time.

7.6 Scope: erm

There will be one instance of each of these files.

Calibration type: *CalSourceData*

Description: Provides reference spectra of the artificially stimulated detectors.

Calibration type: *HKParmInt*

Description: House keeping parameter ranges used to generate good time intervals.

7.7 Scope: rgs

There will be two instances of each of these files.

Calibration type: *ADUConv*

Description: Coefficients tables and model to convert PHA to energy.

Calibration type: *Background*

Description: Background model and spectra.

Calibration type: *BadPix*

Description: Table of bad (hot/dead/flickering/pin holes) CCD pixels.

Calibration type: *CalSourceData*

Description: Data relative to the on board calibration sources: energies, reference pulse heights, illuminated regions, CCD images.

Calibration type: *CCDrmf*

Description: Large version of the CCD energy redistribution.

Calibration type: *ClockPatterns*

Description: CCD read out clock patterns

Calibration type: *Contam*

Description: Description of the loss of quantum efficiency due to contaminants.

Calibration type: *CrossPSF*

Description: Parameterized point spread function in the cross dispersion direction.

Calibration type: *CTI*

Description: Coefficients to correct for the CCD charge transfer inefficiency.

Calibration type: *DarkCurrent*

Description: Dark current map.

Calibration type: *DarkFrame*

Description: Dark frame for the baseline frame time, with associated statistical information.

Calibration type: *EventSizeDist*

Description: Distribution of CCD event types (single, 2-pixel, 3-pixel ...).

Calibration type: *EXAFS*

Description: CCD and filter EXAFS.

Calibration type: *FilterTransV*

Description: Optical properties of the CCD filters.

Calibration type: *HKParmInt*

Description: House keeping parameter ranges used to generate good time intervals.

Calibration type: *LinCoord*

Description: Data required to transform from pixel to physical coordinates on the CCD.

Calibration type: *LineSpreadFunc*

Description: Parameterised line spread function.

Calibration type: *ModeParam*

Description: Observation mode parameters.

[DCP: CR214-CCF03

Calibration type: *PatternLib*

Description: RGS pattern library.

Calibration type: *PSFPileUp*

Description: The coefficients needed to calculate the effect of pileup on the apparent point spread function as a function of countrate.

Calibration type: *QuantumEf*

Description: CCD quantum efficiency.

Calibration type: *Redist*

Description: CCD redistribution matrix.

Calibration type: *RedistPileUp*

Description: The coefficients needed to calculate the effect of pileup on the effective RMF as a function of countrate.

Calibration type: *WavelengthScale*

Description: Coefficients needed to calculate the wavelength scale.

Part II

Detailed File Description

In the following more details are given about the calibration files used by the payload monitoring [8] and calibration subsystems [9]. We only describe the data structure and keywords that are necessary for the proper operation of the above mentioned subsystems.

Note that the actual files will contain additional data structures and key words. The software used to access these files should not rely on any particular ordering of the extensions, key words, or table columns contained in said files.

Unless otherwise indicated, the same file structure applies to all of the XMM instruments.

In indicating the data type of a column or key word we use the FITS nomenclature. Namely:

rA	character string of length r
B	unsigned 8-bit byte
I	16-bit integer
J	32-bit integer
E	single precision floating point
D	double precision floating point
S	character string (used for key words)

In the definition of columns, the notation nX, where X is one of the numeric type descriptors above, is meant to refer to an array of n elements of type X.

7.7.0.1 Coordinate system for RAWX and RAWY It should be noted that for instruments other than the optical monitor, RAWX and RAWY are expressed in a coordinate system that is different from the one used in the observation data file [10]. In this coordinate system RAWX and RAWY run from 0, and position (0,0) corresponds to the first physical pixel on the detector. This means that before comparing the pixel coordinates in the calibration files with data from the observation data file the following steps should be carried out on the data contained in the observation data file:

- subtract any pre scan pixels
- remove any windowing

In the case of the reflection grating spectrometer, pixel coordinates take into account the current on-chip binning factor.

For the optical monitor, all coordinates are expressed at the maximum instrumental resolution.

7.7.0.2 Mode Identifier In the following the mode identifier MODE_ID assumes values in accordance with the remote proposal submission system [11].

8 ADUConv

Binary table: ADUCOEFF

column name	column type	column unit
CCD_ID	B	not applicable
NODE_ID	B	not applicable
OFFSET	E	chan
GAIN	E	eV/chan

9 AstroMet

Binary table: FILTER-U

key word name	key word type	key word unit	key word value
PLTSCALE	E	arcsec/pixel	may vary

column name	column type	column unit
RAWX	I	pixel
RAWY	I	pixel
RAWX_OFF	E	pixel
RAWY_OFF	E	pixel

There are nine other binary tables in the file, with the same structure and names as follows:

FILTER-B
FILTER-V
FILTER-UVW1
FILTER-UVW2
FILTER-UVM2
FILTER-WHITE
FILTER-MAGNI
FILTER-GRISM1
FILTER-GRISM2

10 BadPix

Binary table: BADPIX

column name	column type	column unit
CCD_ID	B	not applicable
NODE_ID	B	not applicable
RAWX	I	pixel
RAWY	I	pixel
YLENGTH	I	pixel
DESCRIPTION	A	not applicable

The column DESCRIPTION encodes the type of bad pixel. For the OM it also encodes the level of damage (severity) of the pixel. This latter encoding convention is not available yet.

d	the pixel is dead and uplinked
D	the pixel is dead
f	the pixel is flickering and uplinked
F	the pixel if flickering
h	the pixel is hot and uplinked
H	the pixel if hot
P	pin hole
B	blemish
T	turn on channel

11 BoreSight

[DCP: CR215-PMS29]

Binary table: BORESIGHT

column name	column type	column unit
INSTRUMENT_ID	5A	not applicable
EULER_PHI	D	rad
EULER_THETA	D	rad
EULER_PSI	D	rad

12 CalSourceData

12.1 rgs

Binary table: CALSOURCEREGIONS

column name	column type	column unit
CCD_ID	B	not applicable
NODE_ID	B	not applicable
CAL_LO_X	I	pixel
CAL_LO_Y	I	pixel
CAL_HLX	I	pixel
CAL_HLY	I	pixel

12.2 emos and epn

Binary table: CALSOURCEREGIONS

column name	column type	column unit
CCD_ID	B	not applicable
N_PEAKE	B	not applicable
PHA_SEARCH_LO	<i>n</i> I	chan
PHA_SEARCH_HI	<i>n</i> I	chan
PHA_CALC_RANGE	<i>n</i> I	chan
EXPECTED_COUNT_RATE	<i>n</i> E	Hz

In the above column definitions *n* equals N_PEAKE.

13 CTI

13.1 emos and epn

Binary table: CTI

column name	column type	column unit
CCD_ID	B	not applicable
CTLX	E	not applicable
CTLY	E	not applicable

14 DarkFrame

14.1 om

Image: DARKFRAME

key word name	key word type	key word unit	key word value
BITPIX		not applicable	-32
NAXIS	I	not applicable	2
NAXIS1	I	not applicable	2048
NAXIS2	I	not applicable	2048
CTYPE1	S	not applicable	rawx
CTYPE2	S	not applicable	rawy
BUNIT	S	1/s/pixel	may vary

14.2 emos

Image: DARKFRAME-1

key word name	key word type	key word unit	key word value
BITPIX		not applicable	-32
NAXIS	I	not applicable	2
NAXIS1	I	not applicable	610
NAXIS2	I	not applicable	602
CTYPE1	S	not applicable	rawx
CTYPE2	S	not applicable	rawy
BUNIT	S	1/s/pixel	may vary

There are six other image extensions in the file, with the same structure and names as follows:

DARKFRAME-2
DARKFRAME-3
DARKFRAME-4
DARKFRAME-5
DARKFRAME-6
DARKFRAME-7

14.3 epn

Image: DARKFRAME-1

key word name	key word type	key word unit	key word value
BITPIX		not applicable	-32
NAXIS	I	not applicable	2
NAXIS1	I	not applicable	64
NAXIS2	I	not applicable	200
CTYPE1	S	not applicable	rawx
CTYPE2	S	not applicable	rawy
BUNIT	S	1/s/pixel	may vary

There are twelve other image extensions in the file, with the same structure and names as follows:

DARKFRAME-2
DARKFRAME-3
DARKFRAME-4
DARKFRAME-5
DARKFRAME-6
DARKFRAME-7
DARKFRAME-8
DARKFRAME-9
DARKFRAME-10
DARKFRAME-11
DARKFRAME-12

15 Efficiency

[DCP: CR216-PMS30]

15.1 emos

Binary table: EFFICIENCY

column name	column type	column unit
FILTER_ID	16A	not applicable
EMOS_RGS_RATIO	E	not applicable

15.2 epn

Binary table: EFFICIENCY

column name	column type	column unit
FILTER_ID	16A	not applicable
EPN_RGS_RATIO	E	not applicable

For **epn** the filter identifier is OPEN.

16 LinCoord

Binary table: LINCOORD

column name	column type	column unit
CCD_ID	B	not applicable
NODE_ID	B	not applicable
X0	E	mm
Y0	E	mm
Z0	E	mm
EULER_PHI	E	rad
EULER_THETA	E	rad
EULER_PSI	E	rad
RAWX0	I	pixel
RAWY0	I	pixel

17 MiscData

Binary table: MISCDATA

column name	column type	column unit
INSTRUMENT_ID	5A	not applicable
PARM_ID	36A	not applicable
PARM_VAL	D	not applicable
PARM_UNIT	20A	not applicable

At least the following entries will be available in the file:

INSTRUMENT_ID	PARM_ID	PARM_UNIT
RGS _x	AREA_EFF	not available yet
RGS _x	ARCSEC_PER_MM_X	arcsec/mm
RGS _x	ARCSEC_PER_MM_Y	arcsec/mm
RGS _x	CCD_WIDTH	mm
RGS _x	CCD_CENTER	mm
RGS _x	MM_PER_PIXEL_X	mm
RGS _x	MM_PER_PIXEL_Y	mm
RGS _x	OPTICS_X	pixel
RGS _x	OPTICS_Y	pixel
RGS _x	PIXEL_SIZE	mm
EMOS _x	PLATE_SCALE_X	arcsec/mm
EMOS _x	PLATE_SCALE_Y	arcsec/mm
EMOS _x	AREA_EFF	not available yet
EMOS _x	MM_PER_PIXEL_X	mm
EMOS _x	MM_PER_PIXEL_Y	mm
EMOS _x	OPTICS_X	pixel
EMOS _x	OPTICS_Y	pixel
EMOS _x	OPTICS_CCD	not applicable
EMOS _x	OPTICS_NODE	not applicable
EPN	PLATE_SCALE_X	arcsec/mm
EPN	PLATE_SCALE_Y	arcsec/mm
EPN	MM_PER_PIXEL_X	mm
EPN	MM_PER_PIXEL_Y	mm
EPN	OPTICS_X	pixel
EPN	OPTICS_Y	pixel
EPN	OPTICS_CCD	not applicable
EPN	OPTICS_NODE	not applicable
OM	DETECTOR	not applicable

Where x can be 1 or 2.

18 ModeParam

18.1 emos and epn

Binary table: MODEPARAM

column name	column type	column unit
MODE_ID	B	not applicable
WINDOWX0	I	pixel
WINDOWY0	I	pixel
WINDOWDX	I	pixel
WINDOWDY	I	pixel

18.2 rgs

Binary table: MODEPARAM

column name	column type	column unit
MODE_ID	B	not applicable
PAR_TRANS_TIME	E	ms
SER_TRANS_TIME	E	ms
PIXEL_READOUT_TIME	E	ms

19 PhotToNat

Binary table: PHOTTONAT

key word name	key word type	key word unit	key word value
PHDFRAC	E	not applicable	may vary
THRESH	E	not applicable	may vary

column name	column type	column unit
PARAM00	10E	not applicable
DPARAM00	10E	not applicable

20 QuickMag

[DCP: CR61-CCF01]

Binary table: FILTER-U

column name	column type	column unit
STAR_TYPE	10A	not applicable
COUNT_RATE	15E	Hz
FLUX_MAG	15E	mag
D_FLUX_MAG	15E	mag
FLUX_ERG	15E	erg/s/nm/cm ²
D_FLUX_ERG	15E	erg/s/nm/cm ²

There are seven other binary tables in the file, with the same structure and names as follows:

FILTER-B
FILTER-V
FILTER-UVW1
FILTER-UVW2
FILTER-UVM2
FILTER-WHITE
FILTER-MAGNI

21 TimeCorr

21.1 emos

One FRAME_TIME value per CCD.

Binary table: FRAMETIME

column name	column type	column unit
MODE_ID	B	not applicable
FRAME_TIME	7E	ms

21.2 epn

One FRAME.TIME value per quadrant.

Binary table: FRAMETIME

column name	column type	column unit
MODE_ID	B	not applicable
FRAME_TIME	4E	ms

Part III

Reference

22 Acronyms

CCD	Charge Coupled Device
FITS	Flexible Image Transport System
OGIP	Office of Guest Investigator Programs
XMM	X-ray Multi-mirror Mission

Reference Documents

- [1] ESA. Specific Science Requirements Document for the Archive Management Subsystem. XMM-PS-GM-06 Issue 3.0, ESA/SSD, May 1996.
- [2] ESA. XMM Interface Control Document Top Level File Transfer System (FTS). XMM-SOC-ICD-0007-DPD Issue A5, ESA/DPD, Sept 1997.
- [3] J. Barrington-Cook. XMM Combined MCS-SCS development. XMM-OPS-SRD-0001-DPD issue A3, Logica, February 1997.
- [4] Mario Merri. Keyword Specifications for File Ingestion into AMS ICD. , ESA ESOC, 1998. XMM-SOC-TN-0023-GC.
- [5] U. Lammers. Indexing of the XMM Current Calibration File. XMM-PS-TN-24 issue 1.0, ESA, July 1997.
- [6] NASA/Science Office of Standards and Technology. Definition of the Flexible Image Transport System (FITS). NOST 100-1.1, NASA/NOST, September 1995.
- [7] The HEASARC FITS Working Group. Found at the following URL:
http://heasarc.gsfc.nasa.gov/docs/heasarc/ofwg/ofwg_intro.html.
- [8] Mario Merri. XSCS Technical Note: PMS and QLA algorithms. 0.3 (draft), ESOC, feb 1998.
- [9] Christian Erd, David Lumb, and Rudi Much. Calibration Summary Parameters Interface Control Document. XMM-SOC-ICD-0012-SSD, ESA, apr 1998.
- [10] ESA. XMM Interface Control Document: Observation and Slew Data Files (XSCS to SSC) (SciSIM to SOCSIM). XMM-SOC-ICD-0004-SSD Issue 2.1, ESA/SSD, December 1998.
- [11] K. Adamson. Proposal Database Parameters and IPPVs. XMM-SOC-TN-0007-SMD Issue 2 Rev 5, MOD-SMD, April 14 1998.

A New Proposal for Date Related FITS Key Words

Information about the new format for FITS date and time related key words can be found at the following address:

ftp://nssdc.gsfc.nasa.gov/pub/fits/year2000_agreement.txt

Information about FITS in general is found at the following address:

http://ssdoo.gsfc.nasa.gov/astro/fits/fits_home.html