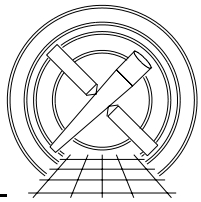
CHANDRA
X-ray Center 60 Garden St., Cambridge Massachusetts 02138 USA



MEMORANDUM

Date: August 29, 2006
From: Nancy Adams-Wolk, Paul Plucinsky, Royce Buehler, and Dan Schwartz
To: ACIS Ops and ACIS MIT
Subject: Requirements for SACGS changes to the energy to PHA conversions.
File: `spec_sacgs.tex`
Version: 3.0

1 Introduction

In a previous memo (Adams-Wolk,2005), we demonstrated the inadequacy of using one energy-to-PHA conversion for both the FI and BI CCDs based on the FI pre-launch performance and suggested new separate, energy-to-PHA conversions for the FI and BI CCDs. This memorandum is to specify the requirements for a change to the SACGS software. The change needed is to adjust the energy to PHA conversions for the FI and BI CCDs.

2 Requirement Specifications

Here we list the requirements that are needed for the software. These affect the parameters for the event filter, and are reflected in the parameter block and the window block as described below.

2.1 Definitions

The following definitions will be used in the requirements section:

Requested

OCAT:Aimpoint	The aimpoint specified in OCAT
OCAT:Event Filter	A Yes/No/Null flag indicating an event filter in OCAT
OCAT:Event Filter:Lower	The lower end of the event filter in OCAT (in keV)
OCAT:Event Filter:Range	The range of the event filter in OCAT (in keV)
OCAT:Window:Lower Energy	The lower end of the event filter for a window in OCAT (in keV)
OCAT:Window:Energy Range	The range of the event filter for a window in OCAT (in keV)

Programmed

PB:lowerEventAmplitude	The parameter block lower end of the event filter in adu
PB:eventAmplitudeRange	The parameter block range of the event filter in adu
Window:lowerEventAmplitude	A window lower end of the event filter in adu
Window:eventAmplitudeRange	A window range of the event filter in adu

The following definitions are used throughout this section: When **AIMPOINT CONVERSION** is specified, this refers to the I3 conversions being used when **OCAT:Aimpoint** = ACIS-I; and S3 conversions being used when **OCAT:Aimpoint** = ACIS-S. When **CCD-TYPE CONVERSION** is specified, this refers to the I3 conversions being applied to CCDs, I0,I1,I2,I3,S0,S2,S4, and S5; and S3 conversions being applied to CCDs S1 and S3. Table 1 contains the equations to be used for the conversions.

2.2 SACGS Requirements

1. There are three conversions each for I3 and S3: two for the lowerEventAmplitude: one for values in the 0.0–1.2 keV range and a second for values in the 1.2–5.0 keV range. The third conversion is for the eventAmplitudeRange parameter (0.01–15.0 keV). (See table 1)

2. The following defaults are to be used for the parameter block:
   PB:lowerEventAmplitude = 20
   PB:eventAmplitudeRange = 3750

3. The following defaults are to be used for any window block where the OCAT parameters **OCAT:Window:Lower Energy** OR **OCAT:Window:Energy Range** are not specified:

   - If **OCAT:Event Filter:Lower** and **OCAT:Event Filter:Range** are not specified, the following defaults shall be used:
     Window:lowerEventAmplitude = 20
     Window:eventAmplitudeRange = 3750
   - Otherwise, set the values internal to SACGS for:
     OCAT:Window:Lower Energy = **OCAT:Event Filter:Lower**
     OCAT:Window:Energy Range = **OCAT:Event Filter:Range**
     and apply the following rules.

4. Parameter Block event filters shall follow these rules:

   - If the **OCAT:Event Filter** is set to "N" or "Null", use the default values for **PB:lowerEventAmplitude** and **PB:eventAmplitudeRange**. If windows are specified, use the window rules in item 5.
   - If the **OCAT:Event Filter** is set to "Y" AND **OCAT:Event Filter:Lower** is *GREATER THAN* 0.5 keV:
     - There shall be 1 chip wide window per active CCD. If this is not true, SACGS shall fail to assign a parameter block and issue the appropriate warnings. Additional windows are allowed and follow the below rules of assignment as in item 5.
     - The following values shall be assigned to the parameter block.
       PB:lowerEventAmplitude = 20
       PB:eventAmplitudeRange = 6250
     - The window rules in item 5 apply.
   - If the **OCAT:Event Filter** is set to "Y" AND **OCAT:Event Filter:Lower** is *LESS THAN OR EQUAL* to 0.5 keV:
     - The **AIMPOINT CONVERSION** shall be used to determine **PB:lowerEventAmplitude** and **PB:eventAmplitudeRange**.
     - If windows are specified, apply the window rules below as in item 5.

5. Windows shall be handled as follows. Each active CCD needs to be examined separately:

   - Regardless of **OCAT:Window:Lower Energy**, if a CCD has a chip wide window, all windows on that CCD will use the **CCD-TYPE CONVERSION** to determine each **Window:lowerEventAmplitude** and **Window:eventAmplitudeRange** that are specified.

- If *any* **OCAT:Window:Lower Energy** value on a CCD is above 0.5 keV, there must be a chip wide window for that CCD in addition to the requested windows. SACGS shall fail and issue the appropriate message if there is not a chip wide window on the selected CCD. Since a chip wide window must be present on that CCD, the preceding rule applies and the **CCD-TYPE CONVERSION** is used to determine all **Window:lowerEventAmplitude** and **Window:eventAmplitudeRange** that are specified on that CCD.
- If *all* **OCAT:Window:Lower Energy** values on a CCD are less than or equal to 0.5 keV, and no chip wide window is specified for that CCD, use the **AIMPOINT CONVERSION** to determine each **Window:lowerEventAmplitude** and **Window:eventAmplitudeRange** that are specified on that CCD.

6. SACGS shall fail to assign a parameter block and issue appropriate messages if the **PB:lowerEventAmplitude** is GREATER than ANY **Window:lowerEventAmplitude**.

7. SACGS shall fail to assign a parameter block and issue appropriate messages if the sum of **PB:eventAmplitudeRange** and **PB:lowerEventAmplitude** is LESS than the sum of **Window:eventAmplitudeRange** and **Window:lowerEventAmplitude** for ANY window.

8. For all energy to PHA calculations, PHA values shall be rounded down to the nearest integral PHA.

9. SACGS shall set the minimum **PB:lowerEventAmplitude** to 20 adu. This is to minimize the loss of telemetry in the case of a T-plane Latch-up.

10. All energy filter limits in the OCAT shall be specified to a precision no greater than 0.01 keV. SACGS shall truncate any keV value to 0.01 precision as necessary and issue an appropriate warning.

11. SACGS must provide CXC an algorithm to determine that the telemetered values of lowerEventAmplitude and eventAmplitudeRange in the PB and Window blocks are consistent with the OCAT values.

3 Conversions

This table presents the conversions to be used.

CCD	lowerEventAmplitude		eventAmplitudeRange
	0.0–1.2 keV	1.2–5.0 keV	0.01–15.0 keV
I3	-22.84+0.120*energy	-151.81+0.227*energy	0.0+0.250*energy
S3	-28.09+0.199*energy	-42.28+0.211*energy	0.0+0.250*energy

Table 1: Energy to PHA conversions for lowerEventAmplitude and energyAmplitudeRange for various CCDs. The units are ADU + ADU/eV. The input energy should be specified in eV.

Note that these conversions allow for an energy specified in either OCAT:Event Filter:Lower or OCAT:Window:Lower Energy to result in an assigned pulse-height in PB:lowerEventAmplitude and/or Window:lowerEventAmplitude which might be below the eventThreshold (38 ADUs for FI CCDs, 20 ADUs for BI CCDs). Since the eventThreshold is applied first, only events equal to or greater than

the eventThreshold will be accepted. This means for the four possible combinations of CCD type and conversion type:

- For a FI CCD with the I3 conversion, an OCAT:Event Filter:Lower or OCAT:Window:Lower Energy of 507eV or lower will result in events with PHs down to the eventThreshold (38 ADU) being accepted.
- For a FI CCD with the S3 conversion,an OCAT:Event Filter:Lower or OCAT:Window:Lower Energy of 332eV or lower will result in events with PHs down to the eventThreshold (38 ADU) being accepted.
- For a BI CCD with the I3 conversion, an OCAT:Event Filter:Lower or OCAT:Window:Lower Energy of 357eV or lower will result in events with PHs down to the eventThreshold (20 ADU) being accepted.
- For S1 and S3 (event threshold of 20 ADU) with the S3 conversion,an OCAT:Event Filter:Lower or OCAT:Window:Lower Energy of 242eV or lower will result in events with PHs down to the eventThreshold (20 ADU) being accepted.

4 References

ACIS Gain Changes for SACGS, Adams-Wolk, December, 2005;
http://asc.harvard.edu/acis/memos/ACIS_gain.pdf