



## MEMORANDUM

Date: August 26, 2008  
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To: ACIS Operations, ACIS MIT Team  
Subject: Day 225 NSM and BEP Bus Crash Timing  
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### 1 Introduction

On day 2008:225, Chandra experienced a transition to Normal Sun Mode (NSM). In this transition, the ACIS Front End Processors (FEPs) were powered down. Later, this caused an ACIS Back End Processor (BEP) bus crash which resulted in a Watchdog reboot. This memo will summarize the timing of the events on day 225.

### 2 What started the NSM?

The first series of events on day 2008:225 involved a reset of the Command and Telemetry Unit (CTU). The actual reset takes fractional seconds, according to the FOT. When the CTU restarts, the telemetry format switches to format 4 (FMT4), the Virtual Channel Data Unit (VCDU) counter for the CTU resets to 0 and the CTU attempts to synchronize with the On-Board Computer (OBC). The synchronization left timing errors that needed to be cleaned up later.

As part of the CTU reset, the setpoint for the thermal control of the ACA CCDs was lost. The CCDs warmed up and several bright pixels were observed. The PCAD system started to track bright pixels instead of the guide stars. The spacecraft executed the stored command sequence (SCS) to place itself in NSM, which includes enabling and executing SCS 107. The commanding to NSM does NOT change the telemetry format. ACIS was under the external calibration source (ECS) and starting a charge transfer inefficiency (CTI) measurement at the time of the CTU reset. The ACIS flight software on board was version 31.

All times are in GMT. All VCDU counts refer to CTU VCDU counts.

### 3 Timing

The timing of the Spacecraft events are as follows:

- VCDU counter 4475687: 2008:09:09:00—Maneuver starts
- VCDU counter 4476736:2008:09:26:28.6—Start Science command issued
- VCDU counter 4476739:2008:09:26:29.761—CTU resets; change to FMT4; VCDU counters out of synch
- ~2008:225:10:07:13—Maneuver ends. Chandra begins transition to NSM.
- ~2008:225:10:07:15—SCS 107 is called in transition to NSM

- ~2008:225:10:09:04–FEPs are powered down as part of SCS107<sup>†</sup>
- 2008:225:12:13:14 (Ground Time)–ACIS Ops requests a change to FMT2 to ascertain status of ACIS.
- ~2008:225:12:13:16–BEP is believed to have a Bus crash. First time ACIS HW LED mnemonics values change to show watchdog reboot.
- 2008:225:12:53:41 (Ground Time)–FOT decides to change back to FMT4
- 2008:225:18:17:52 (Ground Time)–FOT changes back to FMT2
- 2008:225:18:50:04 (Ground Time)–CTU/OBC VCDU counters are resynched.<sup>‡</sup>
- 2008:226:02:31:00 (Ground Time)–ACIS recovery from watchdog reboot is complete.

<sup>†</sup> The command to power down the FEPs occurs 66 seconds into the execution of SCS 107.

<sup>‡</sup> Note that at 2008:225:18:50:04, while the VCDU counters were resynched, the major frame counter (MJF) on the CTU is out of synch with the VCDU counters. The approximate times are based on the CTU times once the VCDU counters were out of synch. Ground Time refers to times recorded by the FOT/SOT when actions were taken on the ground.

## 4 What happened to ACIS?

Peter Ford (MIT) has explained the situation with ACIS:

“After creating the bias maps, the BEP kernel passed control to its bias thief task which filled the first 20 bias packet buffers and then waited because there were no more bias buffers available. The S/C entered NSM at about [2008:225:]10:07:00[sic] following which the FEPs were powered down. The switch out of FMT4 was made by R/T command at about [2008:225:]12:13:16[sic], and the bias thief task started to read more FEP bias values to create the 21st bias packet. Since the task assumed that the FEPs were powered up, it crashed.

In the[se] circumstances, it is hard to see how this could have been safely avoided. The operators would have had to power the FEPs back up before switching to FMT2, and I think that this would have been unwise given the lack of current BEP telemetry at that time. ”

## 5 What items were telemetered during FMT4?

After discussions with the FOT, it is clear that we receive most of the hardware data in FMT4. Items such as 1STAT[0-7]ST *are* telemetered and updated. The ACIS Ops team had originally assumed the BEP bus crash was simultaneous with the FEP power down. This led to confusion in understanding the 1STAT[0-7]ST values. A full list of ACIS MSIDs that are telemetered in FMT4 are listed in appendix A. The update rate and the number of major frames are also listed. This table should be used as a reference during future spacecraft anomalies.

## 6 Summary

The CTU reset left the ACA CCDs warm, leading to bright pixels being detected as guide stars. This lead the to execution of the SCS that places the spacecraft in NSM. Part of this SCS calls SCS 107,

which powers down the FEP. It was the combination of being in spacecraft telemetry FMT4 before the bias was completely telemetered, and powering down the FEPs, that lead to the BEP bus crash.

ACIS Flight Software version 44, Standard Patch C, optional patch C may not have corrected the problem in this particular case, but should handle a similar known BEP bus crash.

## 7 Appendix A-Items Telemetered in FMT 4 for ACIS

MSID	Format	Samples per MF	Update Rate(s)	MSID	Format	Samples per MF	Update Rate(s)
1CBAT	4	1	32.8	1DEMVAOC	4	1	32.8
1CBBT	4	1	32.8	1DEMVBOC	4	1	32.8
1CRAT	4	1	32.8	1DEN0AVO	4	1	32.8
1CRBT	4	1	32.8	1DEN0BVO	4	1	32.8
1DABOEN	4	1	32.8	1DEN1AVO	4	1	32.8
1DABOAN	4	1	32.8	1DEN1BVO	4	1	32.8
1DABOBEN	4	1	32.8	1DEP0AVO	4	1	32.8
1DABOBON	4	1	32.8	1DEP0BVO	4	1	32.8
1DACTAT	4	128	0.26	1DEP1AVO	4	1	32.8
1DACTBT	4	1	32.8	1DEP1BVO	4	1	32.8
1DAHACU	4	1	32.8	1DEP2AVO	4	1	32.8
1DAHAT	4	1	32.8	1DEP2BVO	4	1	32.8
1DAHAVO	4	1	32.8	1DEP3AVO	4	1	32.8
1DAHBCU	4	1	32.8	1DEP3BVO	4	1	32.8
1DAHBT	4	1	32.8	1DEPSA	4	1	32.8
1DAH BVO	4	1	32.8	1DEPSAX	4	1	32.8
1DAH HAVO	4	1	32.8	1DEPSB	4	1	32.8
1DAH H BVO	4	1	32.8	1DEPSBX	4	1	32.8
1DAHTAEN	4	1	32.8	1DP28AVO	4	1	32.8
1DAHTAON	4	1	32.8	1DP28BVO	4	1	32.8
1DAHTBEN	4	1	32.8	1DPAMYT	4	1	32.8
1DAHTBON	4	1	32.8	1DPAMZT	4	1	32.8
1DE28AOC	4	1	32.8	1DPCPAOC	4	1	32.8
1DE28AVO	4	1	32.8	1DPCPBOC	4	1	32.8
1DE28BOC	4	1	32.8	1DPDBAON	4	1	32.8
1DE28BVO	4	1	32.8	1DPDBBON	4	1	32.8
1DEAMZT	4	1	32.8	1DPPSA	4	1	32.8
1DEDBAON	4	1	32.8	1DPPSAX	4	1	32.8
1DED BBON	4	1	32.8	1DPPSB	4	1	32.8
1DEICACU	4	1	32.8	1DPPSBX	4	1	32.8
1DEICBCU	4	1	32.8	1DPICACU	4	1	32.8

MSID	Format	Samples per MF	Update Rate(s)	MSID	Format	Samples per MF	Update Rate(s)
1DPICBCU	4	1	32.8	1PIN1AT	4	2	16.4
1DPP0AVO	4	1	32.8	1PRDBAON	4	1	32.8
1DPP0BVO	4	1	32.8	1PRDBBON	4	1	32.8
1HOPRAPR	4	1	32.8	1SSMYT	4	2	16.4
1HOPRBPR	4	1	32.8	1SSPYT	4	2	16.4
1LVDBAON	4	1	32.8	1STAT0ST	4	128	0.26
1LVDBBON	4	1	32.8	1STAT1ST	4	128	0.26
1MAHCAT	4	1	32.8	1STAT2ST	4	128	0.26
1MAHCBT	4	1	32.8	1STAT3ST	4	128	0.26
1MAHOAT	4	128	0.26	1STAT4ST	4	128	0.26
1MAHOBT	4	128	0.26	1STAT5ST	4	128	0.26
1MCATATR	4	1	32.8	1STAT6ST	4	128	0.26
1MCATBTR	4	1	32.8	1STAT7ST	4	128	0.26
1MCDRACL	4	1	32.8	1VAHCAT	4	2	16.4
1MCDRBCL	4	1	32.8	1VAHCBT	4	2	16.4
1MDBUAON	4	1	32.8	1VAHOAT	4	2	16.4
1MDBUBON	4	1	32.8	1VAHOBT	4	2	16.4
1MECLACL	4	1	32.8	1VVATATR	4	1	32.8
1MECLBCL	4	1	32.8	1VVATBTR	4	1	32.8
1MEOPAOP	4	1	32.8	1VVCDACL	4	1	32.8
1MEOPBOP	4	1	32.8	1VVADBCL	4	1	32.8
1MIPWAON	4	1	32.8	1VVCLACL	4	1	32.8
1MIPWBON	4	1	32.8	1VVCLBCL	4	1	32.8
1MODRAOP	4	1	32.8	1VVDBAON	4	1	32.8
1MODRBOP	4	1	32.8	1VVDBBON	4	1	32.8
1OAHAT	4	128	0.26	1VVODAOP	4	1	32.8
1OAHBT	4	1	32.8	1VVODBOP	4	1	32.8
1OHIRADF	4	1	32.8	1VVOPAOP	4	1	32.8
1OLORADF	4	1	32.8	1VVOPBOP	4	1	32.8
1PDEAAT	4	1	32.8	1WRAT	4	2	16.4
1PDEABT	4	1	32.8	1WRBT	4	2	16.4